NDSU

Dickinson Research Extension Center

OBJECTIVE

Our Objectives: For the families of North Dakota we research and report on agricultural methods that

- are **SENSIBLE**
- appear **SUSTAINABLE**
- advance **STEWARDSHIP**

GOAL

Our Goal: Engage in science-based research that achieve **SOLUTIONS**.

2008
ANNUAL REPORT

AGRONOMY RESEARCH

VARIETY TRIAL INFORMATION

GRASSLAND RESEARCH

HORTICULTURE RESEARCH

LIVESTOCK RESEARCH

LIVESTOCK RESEARCH CONTINUED

2008 BEEFTALK ARTICLES

Written by Dr. Kris Ringwall,
Animal Scientist and Director of the Dickinson Research Extension Center

2008 BEEFTALK ARTICLES CONTINUED

SUSTAINABLE AGRICULTURE

WASTE MANAGEMENT

STATION INFORMATION

WHEAT (*Triticum aestivum* L. 'Parshall')
Tan spot; *Pyrenophora tritici-repentis*
Septoria; *Septoria* spp.
Leaf rust: *Puccinia recondita*
Fusarium head blight; *Fusarium graminearum*

R.O. Ashley and G. Martin
Dickinson Research Extension Center, Dickinson, ND, 58601.

Evaluation of Gem, Prosaro and Stratego foliar fungicide treatments for control of leaf diseases & FHB in spring wheat at the Dickinson Research Extension Center, Dickinson, ND 2008.

The experiment was conducted at the Dickinson Research Extension Center (NW ¼, Section 5, T139N, R96W – Stark County, ND) with a previous cropping history of spring wheat in 2007. A randomized complete block design with four replications was used. Plots were 10 ft wide by 24 ft long. Plots were seeded with a no-till drill 23 Apr 2008 at the rate of 1.25 million PLS/acre. A pre-emergence application of Roundup Original Max + Actamaster was made at the rate of 0.75 pt/acre was made on 29 Apr. A post emergent herbicide application of 0.5 oz/acre Harmony GTXP + 0.66 pt/acre Puma + 0.75 pt/acre MCP ester on 29 May, 2008. Fungicide applications at 5 leaf stage were made on 05 Jun, applications at flag leaf stage were made on 23 Jun and applications at heading were done on 7 Jul. All treatments were applied in 19.1 gal/A water at 30 psi using a CO_2 pressurized hand-held spray boom equipped with 8002VS flat fan nozzles. Tan spot disease evaluations were conducted on 12 Jun, leaf spot disease evaluations were done on 30 Jun and leaf rust evaluations were conducted on 17 Jul. Fusarium head blight (FHB) evaluations were done on 21 Jul. Evaluations consisted of observations made on ten consecutive plants in the center row of each plot. Incidence was recorded as the percent of plants with at least one lesion observed, and severity was recorded as the average leaf area covered by lesions for all leaves for the early season evaluation, only the top three leaves for the mid-season evaluation, and the flag leaf for the late season evaluation. Crop injury observations were made at the same time as the disease evaluations. No crop injury from the fungicide applications was observed. No visual symptoms of FHB were detected. Grain samples from the control plots were sent to NDSU for DON analysis and no DON was detected in these samples. No further testing for DON in grain samples produced from fungicide treatments was done. Precipitation at the North Dakota Agricultural Weather Network Dickinson, ND weather station in Apr, May, Jun, and Jul was 0.23 1.7, 2.04 and 1.7 inches respectively or less than 60% of normal. Moist conditions near the end of May and the beginning of Jun promoted tan spot but dry, hot weather conditions at the end of Jun and throughout Jul were not conducive for any of the leaf diseases or FHB development. Disease ratings reflect moisture conditions at the time the crop was susceptible to infection. Harvest was with a Massy Ferguson 8XP combine on 1 Aug. Grain yield, test weight, and protein were adjusted to a 12% moisture basis. All data was statistically analyzed using SAS Statistical software v 9.1 Proc ANOVA.

		12 Jun evaluation			30 Jun evaluation			17 Jul evaluation			21 Jul
Treatment	Rate	CI[1]	I[2]	S[3]	CI[1]	I[2]	S[3]	CI[1]	I[2]	S[3]	FHB
	fl oz/acre	%	%	%	%	%	%	%	%	%	%
Untreated	-	0	35	3.25	0	0	0	0	0	0	0
Stratego @ 4 - 5 leaf	4	0	0	0	0	0	0	0	0	0	0
Gem 500 SC @ 4 - 5 leaf	2	0	7.5	0.5	0	0	0	0	0	0	0
Stratego @ flag leaf	8	0	30	3	0	0	0	0	0	0	0
Prosaro 421SC + NIS @ flag	6.5 + 0.125%	0	35	2.75	0	0	0	0	0	0	0
Prosaro 421SC + NIS @ heading	6.5 + 0.125%	0	35	2.25	0	0	0	0	0	0	0
Stratego FGS2 + Prosaro 421SC + NIS @ heading	4 + 6.5 + 0.125%	0	2.5	0.25	0	0	0	0	0	0	0
Mean		0	20.7	1.7	0	0	0	0	0	0	0
CV%		-	28	35.2	-	-	-	-	-	-	-
LSD .05		-	8.6	0.9	-	-	-	-	-	-	-
SE		-	2.9039	0.3021	-	-	-	-	-	-	-
Rep F Prob		-	0.7384	0.3036	-	-	-	-	-	-	-
Trt F Prob		-	0.0001	0.0001	-	-	-	-	-	-	-

[1] CI = crop injury
[2] I = Disease incidence
[3] S = Disease severity

Treatment	Rate	----- Grain[1] ----- Test weight	Yield
	fl oz/acre	lb/bu	bu/a
Untreated	-	56.6	10.8
Stratego @ 4 - 5 leaf	4	56.9	9.7
Gem 500 SC @ 4 - 5 leaf	2	56.6	10.3
Stratego @ flag leaf	8	56.0	9.1
Prosaro 421SC + NIS @ flag	6.5 + 0.125%	56.6	10.7
Prosaro 421SC + NIS @ heading	6.5 + 0.125%	57.8	11.7
Stratego FGS2 + Prosaro 421SC + NIS @ heading	4 + 6.5 + 0.125%	56.8	9.4
Mean		56.8	10.2
CV%		1.7	16.7
LSD .05		NS	NS
SE		0.49099	0.85505
Rep F Prob		0.4960	0.0043
Trt F Prob		0.3879	0.3946

1Grain values adjusted to a 12% moisture basis.

Wheat (*Triticum aestivum* 'Parshall')
Target diseases: *Fusarium* spp.
Pythium spp.
Bipolaris sorokiniana

R.O. Ashley, and G. Martin
Dickinson Research Extension Center
Dickinson, ND 5860

Bayer CropScience HRSW seed treatment performance trial near Mott, ND, 2008.

This experiment was conducted in a field located near Mott, ND (SE ¼ Section 14, T136N, R93W, Hettinger County, ND). The previous crop was wheat in 2007. A soil sample was collected on March 26 and analyzed by the North Dakota State University Soil Testing Laboratory. Soil nutrient levels reported were N=44 lb/a, P(Olsen) = 17 ppm, K = 382 ppm, pH = 6.2. Prior to seeding, seed was treated with Raxil MD, Charter PB, Raxil MD-W, Dvidiend Extreme, or an experimental compound. Untreated seed was used as a check. Plots were seeded with a drill equipped with Cross-slot openers on 9 May 2008 at the rate of 150 pls m^{-2}. Urea at the rate of 116 lbs/a (53lbs/a N) was applied through the drill in a separate band during the seeding operation. A post emergent herbicide and foliar fungicide application of Bromac Advance (Bromoxynil Octanoate and Heptonic + MCPA Isooctyl Ester) at 1.5 pt/a, Puma (Fenoxaprop-P) at 0.66 pt/, and Tilt (Propiconizole) at 2 fl oz/a.. Plant counts were made on 15 May and 5 Jun. Initial plant evaluations were made on 1Jul and soft dough plant evaluations were made on 21-22 Jul. Root samples taken during the soft dough analysis were submitted to the NDSU Plant Diagnostic Laboratory for identification of pathogens. Fusarium head blight was not observed probably because of the hot, dry growing conditions that occurred in Jul. Harvest was with a Massy Ferguson 8 XP combine on 25 Aug. Grain yield, and test weight were adjusted to a 12% moisture basis. All data was statistically analyzed using SAS Statistical Software.

Early season plant density was significantly improved for treatments L1397-C12, Raxil MD-W and Raxil MD when compared to the untreated check. Rainfall was normal for June but below normal for May, July, and August. No significant differences or trends were observed in this trial for any of the symptoms evaluated during the initial and soft dough root and crown evaluations. Lab analysis for pathogen presence indicated that *Bipolaris sorokiniana* was present on 10% of the root/crown samples submitted. *Rhizoctonia* spp., *Phytium* spp., and *Fusarium graminearum* were not detected. No significant differences were detected for mature plant height, head density, test weight, and grain yields though grain yields tended to be greater for treated seed than for the untreated check.

		15 May		5 Jun	
Treatment	Rate	Plant density	Vigor	Plant density	Vigor
	g AI/100Kg	m^{-2}		m^{-2}	
Untreated Check		155.4	6.5	193.9	7.5
L1397-C 8	8	172.7	6.3	178.4	7.5
L1397-C 12	12	177.7	7.8	191.4	9.5
L1397-C + Poncho	55	158.1	7	191.9	9.3
Raxil MD-W	8.8	191.8	7	201.2	9.5
Dividend Extreme	15	170.8	6.3	207.3	8
Charter PB	55	161.6	5.3	201	7
Raxil MD	3.8	180.4	6.5	206.8	9.3
Mean		171	6.56	196.4	8.4
CV%		9.01	25.08	10.35	23.76
LSD .05		22.7	NS	NS	NS
SE		7.7097	0.8229	10.1628	1.0022
Rep F Prob		0.332	0.8523	0.0073	0.737
Trt F Prob		0.0447	0.6076	0.5336	0.4102

Treatment	Rate	Plant length	Stage	Tillers	Subcrown[1] internode rating	Seminal roots	Crown roots
		---------- Initial plant evaluation ----------					
	g AI/100Kg	mm	Zadoks	no/plant		no/plant	no/plant
Untreated Check		480	43.1	1.8	1.8	2.6	9.5
L1397-C 8	8	459	39.1	1.8	1.7	3.0	8.6
L1397-C 12	12	488	43.4	1.9	1.7	2.8	8.9
L1397-C + Poncho	55	467	43.8	2.0	1.6	2.6	9.4
Raxil MD-W	8.8	488	43.1	1.9	1.7	2.7	9.3
Dividend Extreme	15	506	42.4	1.8	1.8	3.7	7.6
Charter PB	55	517	44.2	1.6	1.9	3.0	9.3
Raxil MD	3.8	524	43.0	2.2	1.9	2.9	10.2
Mean		491	42.8	1.9	1.8	2.9	9.1
CV%		4.9	6.1	17.6	10.1	14.8	15.2
LSD .05		NS	NS	NS	NS	NS	NS
SE		14.0107	1.50248	0.1896	0.1028	0.248	0.7987
Rep F Prob		0.9052	0.1786	0.0059	0.3979	0.1207	0.122
Trt F Prob		0.0532	0.4118	0.6101	0.4018	0.1067	0.5101

[1] Subcrown internode rating, 1-4. 1 = less than 25% of the internode infected, 2 = 25 – 50% of the internode infected, 3 = 51-75% of the internode infected, multiple lesions, and 4 = 75-100% of the internode infected, lesions coalesced.

Treatment Name	Rate	----- Soft dough evaluation ----- Root[1] color	Root[2] mass	Subcrown[3] internode rating
	g AI/100Kg			
Untreated Check		2.09	1.96	2.10
L1397-C 8	8	1.95	1.96	2.02
L1397-C 12	12	2.02	1.93	1.79
L1397-C + Poncho	55	2.00	1.97	1.86
Raxil MD-W	8.8	2.19	1.90	1.98
Dividend Extreme	15	2.00	1.89	2.02
Charter PB	55	2.00	1.90	1.88
Raxil MD	3.8	1.92	1.92	2.02
Mean		2.02	1.93	1.96
CV%		7.37	4.46	8.87
LSD .05		NS	NS	NS
SE		0.0745	0.0429	0.0869
Rep F Prob		0.0472	0.0019	0.1118
Trt F Prob		0.291	0.77	0.2221

[1]Root color 1 – 4; 1 = white, 4 = dark.
[2]Root mass 1 – 4; 1 = few roots, 4 = many roots.
[3] Subcrown internode rating, 1-4. 1 = less than 25% of the internode infected, 2 = 25 – 50% of the internode infected, 3 = 51-75% of the internode infected, multiple lesions, and 4 = 75-100% of the internode infected, lesions coalesced.

		----- Harvest -----		----- Grain[1]-----	
Treatment Name	Rate	Plant height	Head density	Test weight	Yield
	g AI/100Kg	mm	m^{-2}	lb/bu	bu/a
Untreated Check		530	249	56.6	16.7
L1397-C 8	8	511	256	56.6	16.9
L1397-C 12	12	538	271	57.2	18.8
L1397-C + Poncho	55	507	257	56.9	17.1
Raxil MD-W	8.8	503	256	56.9	17.9
Dividend Extreme	15	519	291	57.4	19.8
Charter PB	55	531	260	57.0	17.0
Raxil MD	3.8	514	276	57.2	17.9
Mean		519	264	57.0	17.8
CV%		5.9	12.4	1.3	9.4
LSD .05		NS	NS	NS	NS
SE		15.3	16.5	0.35	0.83
Rep F Prob		0.3515	0.775	0.4369	0.0162
Trt F Prob		0.6907	0.6802	0.7395	0.1706

[1]Grain values adjusted to a 12% moisture basis.

Wheat (*Triticum aestivum* 'CDC Buteo')
Target diseases: *Telletia caries*
Ustilago spp.
Fusarium spp.
Pythium spp.
Rhizoctonia spp.
Bipolaris sorokiniana

R.O. Ashley, and J. Ransom
Dickinson Research Extension Center
Dickinson, ND 58601
NDSU Extension Service
Fargo, ND 58108

Vincit HRWW wheat seed treatment performance on bunt trial, New Hradic, ND, 2007- 2008.

This experiment was conducted in a field located near New Hradec, ND (NE ¼ Sec 2, T140N, R97W, Stark County, ND). The previous crop was spring wheat in 2007. Prior to seeding, seed was treated singularly or in combinations of Vincit F, Vincit FS, Vincit Minima, Thiram, Allegiance or Raxil MD. Untreated seed was used as a check. Ground bunt contaminated wheat grain was added to seed as it was planted to inoculate the trial with bunt. Plots were seeded with a drill equipped with Cross-slot openers on 2 Oct 2007 at the rate of 100 pls m^{-2}. A blended fertilizer 29-19-6 was placed in a separate band at the rate of 193 lbs/acre during the seeding operation. A post emergent herbicide and foliar fungicide application of 12oz/a Husky + 2 oz/a of Propaconizol + AMS + Surfactant was applied 4 Jun 2008. Plant counts were made on 15 and 23 May 2008. A whole plant evaluation was done at the jointing stage. Root and crown samples of this trail were submitted for analysis of soil-borne pathogens at the soft dough stage of crop development. Harvest was with a Massy Ferguson 8 XP combine on 6 Aug 2008. Grain yield, and test weight were adjusted to a 12% moisture basis. Bunted kernels were sorted from 50g grain samples and counted. All data was statistically analyzed using SAS Statistical Software.

Rainfall was well below normal for Oct through May and Jul with Jun near normal which affected winter survival and development of the crop. Plant counts were unaffected by seed treatment though rate of emergence appeared to be increased. Plant counts appear to have decreased between the first and second counts probably due to extremely dry conditions that occurred throughout the fall, winter, and early spring. Seed treatments significantly affected plant size but only tended to increase root counts and tillering when compared to the check. Seed treatments did not increase yield over the check but did reduce the number of bunted kernels and increase test weight over the check. Tissue analysis for root and crown disease pathogens indicated that 48% of the sample submitted had *Fusarium graminearum* present. *Pythium* spp, *Rhizoctonia* spp. and *Bipolaris sorokiniana* were not detected.

		Emergence[1]		15 May		23 May	
Treatment	Rate	7 DAP	14 DAP	Plant count	Vigor	Plant count	Vigor
	fl oz/cwt	%	%	m^{-2}		m^{-2}	
Untreated Check	0	0	26.3	12.8	4	11.7	3.3
Vincit Minima + Thiram 42S + Allegiance FL	3.07 + 1.92 + 0.75	0	42.5	19.7	4.8	17.9	3.5
Vincit F + Allegiance FL	3.07 + 0.75	0	48.8	23	5	21.1	4.5
Vincit FS	3.07	0	53.8	22.6	4.8	19.6	4.5
Vinict Minima + Allegiance FL	3.07 + 0.75	0	52.5	25.1	5.8	22.8	4.5
Vincit Minima + Thiram 42S	3.07 + 1.92	0	42.5	23	5.8	21.1	4.5
Raxil MD	5	0	43.8	23.8	5.3	21.9	4.5
Mean		0	44.3	21.4	5	19.4	4.2
CV%		0	11.5	21.3	22.3	20.1	18.4
LSD .05		NS	7.5	6.8	NS	5.8	NS
SE		0	2.5394	2.2841	0.56256	1.9523	0.3845
Rep F Prob		-	0.192	0.3247	0.8575	0.1768	0.0388
Trt F Prob		-	<0.0001	0.0231	0.3446	0.0139	0.1077

[1] Emergence was visually evaluated 7 days after planting and 14 days after planting.

Treatment	Rate	Length	Stage of development	Tiller	Subcrown[1] internode rating	Seminal root count	Crown root count
		---------- Plant evaluation at jointing ----------					
	fl oz/cwt	mm		no/plant		no/plant	no/plant
Untreated Check	0	433	31.5	4.0	1	2.8	16.8
Vincit Minima + Thiram 42S + Allegiance FL	3.07 + 1.92 + 0.75	469	31.8	5.3	1	3.8	20.0
Vincit F + Allegiance FL	3.07 + 0.75	462	31.8	5.3	1	3.8	19.3
Vincit FS	3.07	480	31.8	4.5	1	3.3	18.3
Vinict Minima + Allegiance FL	3.07 + 0.75	461	31.5	4.5	1	3.8	18.5
Vincit Minima + Thiram 42S	3.07 + 1.92	461	31.5	4.8	1	2.8	17.8
Raxil MD	5	497	32.0	5.0	1	3.3	19.3
Mean		466	31.7	4.8	1	3.3	18.5
CV%		4.8	1.8	20.8	0	24.9	12.1
LSD .05		33.1	NS	NS	NS	NS	NS
SE		11.1343	0.288675	0.494012	-	0.41308	1.120259
Rep F Prob		0.1727	0.3211	0.0025	-	0.0082	0.0004
Trt F Prob		0.0276	0.8503	0.5462	-	0.3572	0.4931

[1] Subcrown internode rating, 1-4. 1 = less than 25% of the internode infected, 2 = 25 – 50% of the internode infected, 3 = 51-75% of the internode infected, multiple lesions, and 4 = 75-100% of the internode infected, lesions coalesced.

Treatment	Rate	Yield	Test weight	Bunted Kernels
		----- Grain[1] -----		
	fl oz/cwt	bu/acre	lb/bu	no $50g^{-1}$
Untreated Check	0	21.4	49.1	120.5
Vincit Minima + Thiram 42S + Allegiance FL	3.07 + 1.92 + 0.75	20.0	54.2	25.0
Vincit F + Allegiance FL	3.07 + 0.75	20.7	53.6	20.5
Vincit FS	3.07	21.9	55.2	14.3
Vinict Minima + Allegiance FL	3.07 + 0.75	21.3	54.2	26.0
Vincit Minima + Thiram 42S	3.07 + 1.92	20.6	55.2	25.0
Raxil MD	5	21.3	53.0	77.0
Mean		21.0	53.5	44.0
CV%		9.5	2.5	65.0
LSD .05		NS	2.0	42.5
SE		0.9947	0.6772	14.31
Rep F Prob		0.003	0.2578	0.7626
Trt F Prob		0.8648	<0.0001	0.0003

1Grain values are adjusted to a 12% moisture basis.

Wheat (*Triticum aestivum* 'Parshall')
Target diseases: *Fusarium* spp.
Pythium spp.
Bipolaris sorokiniana

R.O. Ashley, and G. Martin
Dickinson Research Extension Center
Dickinson, ND 5860

Vincit HRSW seed treatment performance trial near Mott, ND, 2008.

This experiment was conducted in a field located near Mott, ND (SE ¼ Section 14, T136N, R93W, Hettinger County, ND). The previous crop was wheat in 2007. A soil sample was collected on March 26 and analyzed by the North Dakota State University Soil Testing Laboratory. Nutrient levels reported were N=44 lb/a, P(Olsen) = 17 ppm, K = 382 ppm, pH = 6.2. Prior to seeding, seed was treated with Vincit Minima+Thiram+Methalaxyl, Vincit F + Metalaxyl, Vincit FS, Vincit Minima + Metalaxyl, Vincit Minima+ Thiram, or Dividend XL RTA. Untreated seed was used as a check. Plots were seeded with a drill equipped with Cross-slot openers on 9 May 2008 at the rate of 150 pls m^{-2}. Urea at the rate of 116 lbs/a (53lbs/a N) was applied through the drill in a separate band during the seeding operation. A post emergent herbicide and foliar fungicide application of Bromac Advance (Bromoxynil Octanoate and Heptonic + MCPA Isooctyl Ester) at 1.5 pt/a, Puma (Fenoxaprop-P) at 0.66 pt/, and Tilt (Propiconizole) at 2 fl oz/a.. Plant counts were made on 15 May and 5 Jun. Soft dough root and crown evaluations were made on 17-18 Jul. Root samples taken during the soft dough analysis were submitted to the NDSU Plant Diagnostic Laboratory for tissue analysis and identification of pathogens. Fusarium head blight was not observed probably because of the hot, dry growing conditions that occurred in Jul. Harvest was with a Massy Ferguson 8 XP combine on 25 Aug. Grain yield, test weight, and protein were adjusted to a 12% moisture basis. All data was statistically analyzed using SAS Statistical Software.

Plant counts and vigor observed in both the initial and second counts tended to be greater than the untreated check for most seed treatments. Rainfall was normal for June but below normal for May, July, and August. No significant differences or trends were observed in this trial for color or root mass but subcrown internode ratings were significantly lower for treated seed when compared to the untreated check during the soft dough root and crown evaluations. *Fusarium graminearum* was found on 48% of the root/crown samples submitted for tissue analysis. *Rhizoctonia* spp., *Phytium* spp., and *Bipolaris sorokiniana* was not detected. No significant differences were detected for mature plant height, head density, grain test weight, yield and protein.

	15 May		5 Jun	
Treatment	Plant count	Vigor	Plant count	Vigor
	m^{-2}		m^{-2}	
Untreated Check	141	5	278	5.0
Vincit Minima + Thiram + Metalaxyl	150	5	277	5.8
Vincit F + Metalaxyl	132	5.3	291	6.0
Vincit FS	161	6.3	284	6.0
Vincit Minima + Metalaxyl	155	5.3	289	6.0
Vincit Minima + Thiram	139	5.5	284	5.3
Dividend XL RTA	162	6.5	279	5.8
Mean	149	5.5	283	5.7
CV%	11.21	25.6	4.9	16.5
LSD.05	NS	NS	NS	NS
SE	8.3327	0.708508	6.981044	0.469295
Rep F Prob	0.937	0.7898	0.5512	0.0997
Trt F Prob	0.125	0.6364	0.7273	0.6318

Treatment	Soft dough evaluation		
	Root[1] color	Root[2] mass	Subcrown[3] internode rating
Untreated Check	2.1	1.9	2.0
Vincit Minima + Thiram + Metalaxyl	1.9	1.9	1.7
Vincit F + Metalaxyl	1.9	1.8	1.6
Vincit FS	1.8	1.7	1.7
Vincit Minima + Metalaxyl	1.8	1.9	1.6
Vincit Minima + Thiram	2.0	1.8	1.8
Dividend XL RTA	2.0	1.7	1.7
Mean	1.9	1.8	1.7
CV%	7.1	6.8	8.6
LSD.05	NS	NS	0.2
SE	0.06926	0.061189	0.0748332
Rep F Prob	0.0679	0.4174	0.0026
Trt F Prob	0.0678	0.416	0.0386

[1] Color - Root color, 1 = white, 4 = dark

[2] Root mass - 1 = few roots, 4 = many roots

[3] Subcrown internode rating, 1-4. 1 = less than 25% of the internode infected, 2 = 25 – 50% of the internode infected, 3 = 51-75% of the internode infected, multiple lesions, and 4 = 75-100% of the internode infected, lesions coalesced.

	----- Harvest -----		---------- Grain[1] ----------		
Treatment	Plant height	Head density	Test weight	Yield	Protein
	mm	m^{-2}	lb/bu	bu/acre	%
Untreated Check	556	243	54.3	23.4	17.3
Vincit Minima + Thiram + Metalaxyl	555	228	54.9	20.8	17.2
Vincit F + Metalaxyl	583	236	54.8	22.2	16.9
Vincit FS	568	244	55.1	21.5	17.4
Vincit Minima + Methalaxyl	578	236	55.3	22.2	17.3
Vinvit Minima + Thiram	569	226	54.9	23.5	17.3
Dividend XL RTA	558	226	54.9	21.3	17.2
Mean	566	234	54.9	22.1	17.2
CV%	4.9	4.9	1.36	12.7	2.97
LSD.05	NS	NS	NS	NS	NS
SE	13.9665	5.72718	0.3722	1.408459	0.255883
Rep F Prob	0.5512	<.0001	0.044	0.5735	0.8609
Trt F Prob	0.7273	0.1486	0.7089	0.7604	0.787

[1]Grain values adjusted to a 12% moisture basis.

Wheat (*Triticum aestivum* 'Parshall')
Target diseases: *Fusarium* spp.
Pythium spp.
Bipolaris sorokiniana

R.O. Ashley, and D. Barondeau
Dickinson Research Extension Center
Dickinson, ND 58601
Hettinger County Extension Agent
Mott, ND 58646

Crusoe HRSW seed treatment performance trial near Mott, ND, 2008.

This experiment was conducted in a field located near Mott, ND (SE ¼ Section 14, T136N, R93W, Hettinger County, ND). The previous crop was wheat in 2007. A soil sample was collected on March 26 and analyzed by the North Dakota State University Soil Testing Laboratory. Nutrient levels reported were N=44 lb/a, P(Olsen) = 17 ppm, K = 382 ppm, pH = 6.2. Prior to seeding, seed was treated with Crusoe Pinnacle, Dividend XL RTA, Vitaflow 280+Metastar, Crusoe Pinnacle W, Crusoe Pinnacle AW, Enhance AW, Vitaflow 280 or one of two experimental fungicides. Untreated seed was used as a check. Plots were seeded with a drill equipped with Cross-slot openers on 9 May 2008 at the rate of 150 pls m^{-2}. Urea at the rate of 116 lbs/a (53lbs/a N) was applied through the drill in a separate band during the seeding operation. A post emergent herbicide and foliar fungicide application of Bromac Advance (Bromoxynil Octanoate and Heptonic + MCPA Isooctyl Ester) at 1.5 pt/a, Puma (Fenoxaprop-P) at 0.66 pt/, and Tilt (Propiconizole) at 2 fl oz/a.. Plant counts were made on 15 May and 5 Jun. Initial root evaluations at the six-leaf stage were completed on 25 Jun. Soft dough root and crown evaluations were made on 28-29 Jul. Root samples taken during the soft dough analysis were submitted to the NDSU Plant Diagnostic Laboratory for identification of pathogens. Fusarium head blight was not observed probably because of the hot, dry growing conditions that occurred in Jul. Harvest was with a Massy Ferguson 8 XP combine on 25 Aug. Grain yield, test weight, and protein were adjusted to a 12% moisture basis. All data was statistically analyzed using SAS Statistical Software.

Plant counts observed in initial and second counts tended to be greater than the untreated check for all seed treatments while vigor observed during the second count was significantly different compared to the untreated check for Crusoe Pinnacle, Dividend XL RTA and Crusoe Pinnacle AW. Rainfall was normal for June but below normal for May, July, and August. No significant differences or trends were observed in this trial for root mass or subcrown internode ratings but root color was significantly improved for Dividend XL RTA, and Crusoe Pinnacle AW. *Rhizoctonia* spp., *Phytium* spp., *Fusarium graminearum* and *Bipolaris sorokiniana* was not detected in tissue samples submitted from this trial for lab analysis. No significant differences were detected for mature plant height, head density, test weight, grain yields and protein.

		15 May		5 Jun	
Treatment	Rate	Plant count	Vigor	Plant count	Vigor
	ml kg^{-1}	m^{-2}		m^{-2}	
Untreated Check	-	146	5.5	149	5.5
Crusoe Pinnacle	325	159	6.5	189	7.3
Experimental 1	325	175	7.0	176	6.5
Dividend XL RTA	325	176	6.8	190	7.3
Vitaflow 280 + Metastar	325 + 6.3	150	5.8	185	6.5
Experimental 2	370	164	6.8	177	6.5
Crusoe Pinnacle W	325	143	6.0	190	6.5
Crusoe Pinnacle AW	370	173	7.3	194	7.0
Enhance AW	250	153	6.8	156	5.5
Vitaflow 280	325	153	6.0	180	6.3
Mean		159	6.4	179	6.5
CV%		11.9	15.8	12.7	11.7
LSD .05		NS	NS	NS	1.1

Treatment	Rate	Initial root evaluation: Length	Stage	Tiller	Subcrown[1] internode	Seminal root	Crown root
	ml kg^{-1}	mm		plant^{-1}		plant^{-1}	plant^{-1}
Untreated Check	-	463	36	2.25	1.5	2.5	10.25
Crusoe Pinnacle	325	459	35	2.00	1.5	1.25	9.75
Experimental 1	325	459	36	1.75	1.5	1.5	9.25
Dividend XL RTA	325	483	37	1.75	1.25	2.25	9.5
Vitaflow 280 + Metastar	325 + 6.3	489	35	2.00	1.25	3.25	8.5
Experimental 2	370	474	35	2.50	1.5	2	10.5
Crusoe Pinnacle W	325	491	37	2.00	1.25	1.5	11.5
Crusoe Pinnacle AW	370	469	35	2.25	1.25	2	10
Enhance AW	250	491	35	1.75	1.5	2.25	9.25
Vitaflow 280	325	473	35	2.25	1.25	2.25	9.75
Mean		475	35.4	2.05	1.4	2.1	9.8
CV%		6.3	3.6	23.7	24.5	29.4	15.5
LSD .05		NS	NS	NS	NS	0.89	NS

[1] Subcrown internode rating, 1-4. 1 = less than 25% of the internode infected, 2 = 25 – 50% of the internode infected, 3 = 51-75% of the internode infected, multiple lesions, and 4 = 75-100% of the internode infected, lesions coalesced.

Treatment	Rate	Soft dough root evaluation: Root[1] mass	Root[2] color	Subcrown[3] internode
	ml kg^{-1}			
Untreated Check	-	1.84	2.18	2.29
Crusoe Pinnacle	325	1.92	2.17	2.12
Experimental 1	325	1.81	2.12	2.12
Dividend XL RTA	325	1.92	1.96	2.06
Vitaflow 280 + Metastar	325 + 6.3	1.85	2.12	2.15
Experimental 2	370	1.90	2.05	2.20
Crusoe Pinnacle W	325	1.79	2.31	2.23
Crusoe Pinnacle AW	370	1.86	1.97	1.92
Enhance AW	250	1.93	2.11	2.53
Vitaflow 280	325	1.88	2.08	2.24
Mean		1.87	2.10	2.18
CV%		4.4	5.30	12.1
LSD .05		NS	0.16	NS

[1]Root mass: 1 to 4, 1 = few roots, 4 = many roots.
[2] Root color: 1to 4, 1 = white, 4 = dark.
[3] Subcrown internode rating, 1-4. 1 = less than 25% of the internode infected, 2 = 25 – 50% of the internode infected, 3 = 51-75% of the internode infected, multiple lesions, and 4 = 75-100% of the internode infected, lesions coalesced.

Treatment	Rate	Harvest		---------- Grain[1] ----------		
		Plant height	Head density	Test weight	Yield	Protein
	ml kg^{-1}	mm	m^{-2}	lb bu^{-1}	bu a^{-1}	%
Untreated Check	-	520	245	57.7	19.2	17.4
Crusoe Pinnacle	325	515	249	57.8	19.2	17.4
Experimental 1	325	534	250	57.3	18.3	17.6
Dividend XL RTA	325	519	238	57.9	19.8	17.1
Vitaflow 280 + Metastar	325 + 6.3	513	242	57.8	20.0	17.5
Experimental 2	370	503	233	58.0	18.1	17.4
Crusoe Pinnacle W	325	534	241	58.0	19.3	17.3
Crusoe Pinnacle AW	370	523	247	58.2	18.6	17.0
Enhance AW	250	503	244	57.8	18.4	17.6
Vitaflow 280	325	511	253	56.6	17.1	17.8
Mean		517	244	57.7	18.8	17.4
CV%		4.4	15.9	1.3	8.5	2.2
LSD .05		NS	NS	NS	NS	NS

[1]Grain values adjust to a 12% moisture basis.

Wheat (*Triticum aestivum* 'Parshall')
Target diseases: *Fusarium* spp.
Pythium spp.
Bipolaris sorokiniana

R.O. Ashley, and D. Barondeau
Dickinson Research Extension Center
Dickinson, ND 58601
Hettinger County Extension Service
Mott, ND 58646

NuFarm HRSW seed treatment performance trial near Mott, ND, 2008.

This experiment was conducted in a field located near Mott, ND (SE ¼ Section 14, T136N, R93W, Hettinger County, ND). The previous crop was wheat in 2007. A soil sample was collected on March 26 and analyzed by the North Dakota State University Soil Testing Laboratory. Nutrient levels reported were N=44 lb/a, P(Olsen) = 17 ppm, K = 382 ppm, pH = 6.2. Prior to seeding, seed was treated with Raxil MD or one of two experimental fungicides. Untreated seed was used as a check. Plots were seeded with a drill equipped with Cross-slot openers on 9 May 2008 at the rate of 150 pls m^{-2}. Urea at the rate of 116 lbs/a (53lbs/a N) was applied through the drill in a separate band during the seeding operation. A post emergent herbicide and foliar fungicide application of Bromac Advance (Bromoxynil Octanoate and Heptonic + MCPA Isooctyl Ester) at 1.5 pt/a, Puma (Fenoxaprop-P) at 0.66 pt/, and Tilt)Propiconizole) at 2 fl oz/a.. Plant counts were made on 15 May and 5 Jun. Soft dough plant evaluations were made on 23 Jul. Root samples taken during the soft dough analysis were submitted to the NDSU Plant Diagnostic Laboratory for identification of pathogens. Fusarium head blight was not observed probably because of the hot, dry growing conditions that occurred in Jul. Harvest was with a Massy Ferguson 8 XP combine on 25 Aug. Grain yield, and test weight were adjusted to a 12% moisture basis. All data was statistically analyzed using SAS Statistical Software.

NUP07133 tended to have lower plant counts than all other treatments in this trial though not signficantly. Rainfall was normal for June but below normal for May, July, and August. No significant differences or trends were observed in this trial for any of the symptoms evaluated during the soft dough root and crown evaluations. *Rhizoctonia* spp., *Phytium* spp., *Fusarium* spp. and *Bipolaris sorokiniana* was not detected during lab analysis of plant tissue. No significant differences were detected for mature plant height, head density, test weight, and grain yields though grain yields.

		--15 May --		-- 5 Jun --	
Treatment Name	Dose	Plant count	Vigor	Plant density	Vigor
	fl oz/cwt	no m^{-2}		no m^{-2}	
UTC (naked seed)	-	170.5	5.3	194.5	5.8
NUP 08030	5.0	174.7	7.0	198.4	7.5
NUP 07133	5.0	158.4	5.8	179.1	6.8
Raxil MD	5.0	172.4	6.3	190.9	7.0
Mean		169.0	6.1	190.7	6.8
CV%		13.1	23.7	12.8	18.8
LSD .05		NS	NS	NS	NS
SE		11.0764	0.7181	12.2124	0.6346
Rep F Prob		0.7915	0.8436	0.5465	0.7473
Trt F Prob		0.7356	0.4053	0.7115	0.3201

Treatment Name	Dose	Soft dough root evaluation		
		Root[1] color	Root[2] mass	Subcrown[3] internode
	fl oz/cwt			
UTC (naked seed)	-	2.2	1.8	2.4
NUP 08030	5.0	2.1	1.9	2.3
NUP 07133	5.0	2.1	1.8	2.3
Raxil MD	5.0	2.3	1.8	2.4
Mean		2.2	1.8	2.4
CV%		4.7	5.1	8.2
LSD .05		NS	NS	NS
SE		0.0508	0.0457	0.0972
Rep F Prob		0.0035	0.1574	0.0005
Trt F Prob		0.6487	0.5027	0.7561

[1] Color - Root color, 1 = white, 4 = dark

[2] Root mass - 1 = few roots, 4 = many roots

[3] Subcrown internode rating, 1-4. 1 = less than 25% of the internode infected, 2 = 25 – 50% of the internode infected, 3 = 51-75% of the internode infected, multiple lesions, and 4 = 75-100% of the internode infected, lesions coalesced.

Treatment Name	Dose	Harvest		---------- Grain[1] ----------		
		Plant height	Head density	Test weight	Yield	Protein
	fl oz/cwt	mm	no m^{-2}	lb/bu	bu/acre	%
UTC (naked seed)	-	547.5	259.3	56.8	20.5	17.5
NUP 08030	5.0	545.6	264.0	56.1	19.6	17.8
NUP 07133	5.0	538.8	265.8	56.3	20.3	17.8
Raxil MD	5.0	527.5	260.0	55.8	19.0	17.8
Mean		539.8	262.3	56.2	19.8	17.7
CV%		5.2	8.0	1.1	10.8	1.4
LSD .05		NS	NS	NS	NS	NS
SE		13.8040	10.4695	0.2971	1.0732	0.1259
Rep F Prob		0.0844	0.2126	0.0004	0.0900	0.0002
Trt F Prob		0.7368	0.9641	0.2152	0.7669	0.4652

[1]Grain values adjusted to 12% basis.

Wheat (*Triticum aestivum* 'Seward')
Target diseases: *Telletia caries*
Ustilago spp.
Fusarium spp.
Pythium spp.
Rhizoctonia spp.
Bipolaris sorokiniana

R.O. Ashley, and D. Twist
Dickinson Research Extension Center
Dickinson, ND 58601
Dunn County Extension Service
Killdeer, ND 58640

NuFarm HRWW seed treatment performance on Bunt trial, New Hradic, ND, 2007- 2008.

This experiment was conducted in a field located near New Hradec, ND (NE ¼ Sec 2, T140N, R97W, Stark County, ND). The previous crop was spring wheat in 2007. Prior to seeding, seed was treated with Raxil MD, Dividend XL or one of two experimental fungicide treatments. Untreated seed was used as a check. Ground bunt contaminated wheat grain was ground and added to seed as it was planted to inoculate the trial with bunt. Plots were seeded with a drill equipped with Cross-slot openers on 2 Oct 2007 at the rate of 100 pls m^{-2}. A blended fertilizer of 29-19-6 was placed in a separate band at the rate of 193 lbs/acre was applied through the drill during the seeding operation. A post emergent herbicide and foliar fungicide application of 12oz/a Husky + 2 oz/a of Propaconizol + AMS + Surfactant was applied 4 Jun 2008. Plant counts were made on 21 Apr. Root and crown samples of this trail were submitted for analysis of soil-borne pathogens at the soft dough stage of crop development. Harvest was with a Massy Ferguson 8 XP combine on 6 Aug 2008. Grain yield, and test weight were adjusted to a 12% moisture basis. Bunted kernels were sorted from 50g grain samples and counted. All data was statistically analyzed using SAS Statistical Software.

Rainfall was well below normal for Oct through May and Jul with Jun near normal which affected winter survival and development of the crop. No significant differences were detected for grain yield, test weight, plant vigor or density. However bunted kernels were found in significantly greater numbers in the untreated check than any of the fungicide seed treatments but test weight did not appear to be affected. Tissue analysis for root and crown disease pathogens indicated that nearly half of the sample submitted had *Fusarium graminearum* present. *Pythium* spp, *Rhizoctonia* spp. and *Bipolaris sorokiniana* were not detected.

	21Apr		---------- Grain[1] ----------		
Treatment Name	Plant density	Vigor	Test weight	Yield	Bunted kernels
	no m^{-2}		lb/bu	bu/acre	no $50g^{-1}$
Check	41.5	5.8	54.9	17.4	151.8
NUP 07132 plus NUP 07267	51.8	7.3	54.9	16.8	14.8
NUP 07268 plus NUP 07267	48.6	7.3	54.2	16.8	29.0
Dividend Extreme	44.5	6.5	54.2	16.8	23.5
Raxil MD	47.0	6.8	54.9	18.5	20.5
Mean	46.7	6.7	54.7	17.7	47.9
CV%	16.1	16.0	1.6	12.7	39.9
LSD	NS	NS	NS	NS	29.4
SE	3.7678	0.5362	0.4426	1.1285	9.5461
Rep F Prob	0.0056	0.1211	0.0628	0.0893	0.5914
Trt F Prob	0.4074	0.3086	0.8035	0.5120	<0.0001

[1] Grain values adjusted to 12% moisture basis.

Wheat (*Triticum aestivum* 'Seward')
Target diseases: *Pythium* spp.
Fusarium spp.
Rhizoctonia spp.
Bipolaris sorokiniana

R.O. Ashley, and D. Twist
Dickinson Research Extension Center
Dickinson, ND 58601
Dunn County Extension Service
Killdeer, ND 58640

NuFarm HRWW seed treatment performance on Pythium trial, New Hradic, ND, 2007- 2008.

This experiment was conducted in a field located near New Hradec, ND (NE ¼ Sec 2, T140N, R97W, Stark County, ND). The previous crop was spring wheat in 2007. Prior to seeding, seed was treated with Allegiance or three experimental fungicide treatments singularly or in various combinations and rates. Untreated seed was used for the untreated check and an untreated check treated only with dye was included. Plots were seeded with a drill equipped with Cross-slot openers on 2 Oct 2007 at the rate of 100 pls m^{-2}. A blended fertilizer of 29-19-6 was placed in a separate band at the rate of 193 lbs/acre was applied through the drill during the seeding operation. A post emergent herbicide and foliar fungicide application of 12oz/a Husky + 2 oz/a of Propaconizol + AMS + Surfactant was applied 4 Jun 2008. Emergence was visually estimated at appropriate times. Plant counts were made on 15 May 2008. Root and crowns from each plot were sampled at the soft dough stage and evaluated for root color, root mass, and lesions on the subcrown internode. In addition to the visual analysis root and crown samples of this trail were submitted to the NDSU Plant Diagnostic Laboratory, Fargo for analysis of soil-borne pathogens. Harvest was with a Massy Ferguson 8 XP combine on 6 Aug 2008. Grain yield, and test weight were adjusted to a 12% moisture basis. All data was statistically analyzed using SAS Statistical Software.

Rainfall was well below normal for Oct through May and Jul with Jun near normal which affected winter survival and development of the crop. No significant differences were detected any of the characteristics analyzed. Tissue analysis for root and crown disease pathogens indicated that over 70% of the sample submitted had *Fusarium graminearum* present. *Pythium* spp, *Rhizoctonia* spp. and *Bipolaris sorokiniana* were not detected.

	----- Emergence[1] -----			--- 15 May ---	
Treatment	9 DAP	14 DAP	21 DAP	Density	Vigor
	---------- % ----------			no m^{-2}	
UTC1 Naked Seed	0	18.8	93.8	57.6	5.0
UTC2 (CF Clear, Water)	0	18.8	91.3	62.8	6.0
NUP 07121 low rate	0	17.5	91.3	60.1	5.5
NUP 07121 medium rate	0	17.5	92.5	69.7	6.5
NUP 07121 high rate	0	18.8	91.3	65.4	6.5
NUP 07121 low + NUP 07117	0	20.0	95.0	75.2	7.3
NUP 07121 med + NUP 07117	0	17.5	91.3	66.1	6.3
NUP 07121 high + NUP 07117	0	18.8	93.8	58.9	5.3
NUP 07117 plus NUP 07267	0	17.5	93.8	65.9	6.0
NUP 07117	0	20.0	91.3	70.2	7.0
Allegiance	0	18.8	93.8	60.0	5.5
Mean	0	18.5	92.6	64.7	6.1
CV%	-	13.3	2.3	13.1	18.0
LDS .05	NS	NS	NS	NS	NS
SE	0	1.2348	1.0704	4.2306	0.5449
Rep F Prob	-	0.6263	0.0151	0.3927	0.9143
Trt F Prob	-	0.8189	0.1125	0.1301	0.1196

[1] Emergence visually evaluated 9 days after planting, 14 days after planting and 21 days after planting.

	---Soft dough root evaluation ---		
Treatment	Mass[1]	Color[2]	SCI[3]
UTC1 Naked Seed	1.9	1.8	2.1
UTC2 (CF Clear, Water)	1.9	1.8	2.8
NUP 07121 low rate	1.9	1.8	2.3
NUP 07121 medium rate	2	1.9	2.2
NUP 07121 high rate	2	1.8	2.3
NUP 07121 low + NUP 07117	2.1	1.8	2.2
NUP 07121 med + NUP 07117	2	1.8	2.2
NUP 07121 high + NUP 07117	2	1.9	2.2
NUP 07117 plus NUP 07267	2	1.8	2.1
NUP 07117	2	2.0	2.1
Allegiance	2	1.9	2.0
Mean	2	1.9	2.2
CV%	9.1	9.2	21.4
LDS .05	NS	NS	NS
SE	0.0903	0.0852	0.2375
Rep F Prob	0.0197	0.0112	0.0229
Trt F Prob	0.9366	0.5700	0.6563

[1]Root mass 1 – 4; 1 = few roots, 4 = many roots.
[2]Root color 1 – 4; 1 = white, 4 = dark.
[3]Subcrown internode rating, 1-4. 1 = less than 25% of the internode infected, 2 = 25 – 50% of the internode infected, 3 = 51-75% of the internode infected, multiple lesions, and 4 = 75-100% of the internode infected, lesions coalesced.

	----- Harvest[1] -----		---------- Grain[2] ----------		
Treatment	Height	Density	Test weight	Yield	Protein
	mm	no m^{-2}	lb/bu	bu/acre	%
UTC1 Naked Seed	667.5	184.0	53.8	15.5	19.4
UTC2 (CF Clear, Water)	671.9	377.3	54.5	17.6	18.9
NUP 07121 low rate	681.8	217.0	55.4	15.8	19.2
NUP 07121 medium rate	699.4	224.5	53.8	17.4	19.0
NUP 07121 high rate	698.8	221.0	54.0	15.1	19.2
NUP 07121 low + NUP 07117	698.8	213.3	53.6	14.9	19.5
NUP 07121 med + NUP 07117	696.3	223.5	55.4	17.8	18.8
NUP 07121 high + NUP 07117	718.8	227.5	53.8	15.2	19.5
NUP 07117 plus NUP 07267	717.5	213.8	55.1	17.4	19.0
NUP 07117	728.1	227.5	54.2	16.0	19.4
Allegiance	693.8	217.8	54.5	16.0	19.4
Mean	697.5	231.5	54.4	16.2	19.2
CV%	5.5	42.2	2.9	13.0	2.9
LDS .05	NS	NS	NS	NS	NS
SE	19.0135	48.8599	0.7785	1.0579	0.2784
Rep F Prob	0.0046	0.4067	<0.0001	0.0158	0.0018
Trt F Prob	0.4652	0.4365	0.7104	0.4121	0.5856

[1] Plant height measured from ground surface to top of head at maturity
[2] Grain yield, test weight, and protein adjusted on a 12% moisture basis.

WHEAT (*Triticum aestivum* L. 'Reeder')
Tan spot; *Pyrenophora tritici-repentis*
Septoria; *Septoria* spp.
Leaf rust: *Puccinia recondita*
Fusarium head blight; *Fusarium graminearum*
Wheat stem sawfly: *Cephus cinctus*

R.O. Ashley and D. Barondeau
Dickinson Research Extension Center
Dickinson, ND, 58601
Hettinger County Extension Service
Mott, ND, 58646.

Evaluation of Quilt and Tilt foliar fungicide singularly and in combination with Warrior insecticide treatments for control of leaf diseases, FHB and wheat stem sawfly in spring wheat at Mott, ND 2008.

This experiment was conducted in a field located near Mott, ND (SE ¼, Section 14, T136N, R93W – Hettinger County, ND) with a previous cropping history of spring wheat in 2007. A randomized complete block design with four replications was used. Plots were 10 ft wide by 50 ft long with a 3 ft wide winter wheat buffer between plots. A soil sample was collected on March 26 and analyzed by the North Dakota State University Soi Testing Laboratory. Soil nutrient levels reported were N = 44 lb/a, P (Olsen) = 17 ppm, K = 382 ppm, pH = 6.2. A burndown application of 0.5 ae/acre glyphosate + 1 qt Actamaster/acre was applied on 4 May. Plots were seeded with a drill equipped with Cross-slot openers on 9 May 2008 at the rate of 150 pls m^{-2}. Urea at the rate of 116 lbs/a (53 lbs/a N) was applied through the drill in a separate band during the seeding operation. A post emergent herbicide application of Bromax Advance (Bromoxynil Octanoate and Heptonic + MCPA Isococtyl Ester) at 1.5 pt/a, and Puma (Fenoxaprop-P) at 0.66 pt/a. Fungicide and fungicide/insecticide applications at 5 leaf stage were made on 11 Jun, applications at flag leaf stage were made on 2 Jul and applications at heading were done on 11 Jul. All treatments were applied in 19.1 gal/A water at 30 psi using a CO_2 pressurized hand-held spray boom equipped with 8002VS flat fan nozzles. Tan spot disease evaluations were conducted on 23 Jun, leaf spot disease evaluations were done on 10 Jul and leaf rust evaluations were conducted on 21 Jul. Evaluations consisted of observations made on ten consecutive plants in the center row of each plot. Incidence was recorded as the percent of plants with at least one lesion observed, and severity was recorded as the average leaf area covered by lesions for all leaves for the early season evaluation, only the top three leaves for the mid-season evaluation, and the flag leaf for the late season evaluation. Crop injury observations were made at the same time as the disease evaluations. White heads and lodging were used as an indication of potential stem mining by wheat stem sawfly. Plants exhibiting these symptoms were dissected and then determined to have been caused by wheat stem sawfly or some other cause. No crop injury from the fungicideinsecticide applications was observed. No visual symptoms of FHB were detected. Grain samples from the control plots were sent to NDSU for DON analysis and no DON was detected in these samples. No further testing for DON in grain samples produced from fungicide treatments was done. Precipitation at the North Dakota Agricultural Weather Network Mott, ND weather station in May, Jun, Jul, and Aug was 1.7, 2.04, 1.7, and .74 inches respectively or less than 70% of normal. Moist conditions near the end of May and the into the third week of Jun promoted tan spot but dry, hot weather conditions at the end of June and throughout July were not conducive for any of the leaf diseases or FHB development. Disease ratings reflect moisture conditions at the time the crop was susceptible to infection. Wheat stem sawfly did not have significant impact on the crop at this site. Harvest was with a Massy Ferguson 8XP combine on 25 Aug. Grain yield, test weight, and protein were adjusted to a 12% moisture basis. All data was statistically analyzed using SAS Statistical software v 9.1 Proc ANOVA.

Treatment	Rate	Crop stage/application	---------- 23 Jun evaluation ----- CI[1]	I[2]	S[3]
	acre^{-1}			---------- % ----------	
Untreated Check			0	40.0	3.00
Quilt	7oz	4 to 5 leaf	0	0.0	0.00
Warrior II / Quilt	1.28oz/7 oz	4 to 5 leaf	0	0.0	0.00
Tilt	2oz	4 to 5 leaf	0	0.0	0.00
Warrior II/ Tilt	1.28oz/2oz	4 to 5 leaf	0	0.0	0.00
Warrior II	1.28oz	4 to 5 leaf	0	42.5	2.25
Quilt	14oz	flag	0	42.5	2.50
Tilt / Quilt	2oz/14oz	4 to 5 leaf/flag	0	0.0	0.00
Warrior	1.28oz	flag	0	42.5	2.00
Warrior	1.28oz	early heading	0	40.0	2.75
Warrior II /Tilt	1.28oz/4oz	early heading	0	42.5	3.00
Warrior II/Quilt	1.28oz/14oz	flag	0	42.5	2.75
Mean			0	24.4	1.5208
CV%			-	27.2	36.534
LSD .05			NS	9.5	0.80
SE			0	3.31672	0.2778
Rep F Prob			-	0.0812	0.3445
Trt F Prob			-	<.0001	<.0001

[1] CI = crop injury.
[2]I = Disease incidence.
[3]S= Disease severity.

Treatment Name	Rate	Crop stage/application	10 Jul evaluation CI[1]	I[2]	S[3]
	acre^{-1}		---------- % ----------		
Untreated Check			0	7.5	5.00
Quilt	7oz	4 to 5 leaf	0	2.5	2.50
Warrior II / Quilt	1.28oz/7 oz	4 to 5 leaf	0	5.0	5.00
Tilt	2oz	4 to 5 leaf	0	12.5	7.50
Warrior II/ Tilt	1.28oz/2oz	4 to 5 leaf	0	5.0	5.00
Warrior II	1.28oz	4 to 5 leaf	0	5.0	5.00
Quilt	14oz	flag	0	0.0	0.00
Tilt / Quilt	2oz/14oz	4 to 5 leaf/flag	0	0.0	0.00
Warrior	1.28oz	flag	0.25	7.5	7.50
Warrior	1.28oz	early heading	0	10.0	7.50
Warrior II /Tilt	1.28oz/4oz	early heading	0	7.5	5.00
Warrior II/Quilt	1.28oz/14oz	flag	0	0.0	0.00
Mean			0.0208	5.2	0.42
CV%			693	125	117
LSD .05			NS	NS	NS
SE			0.1863	3.2592	0.2436
Rep F Prob			0.4051	0.6374	0.872
Trt F Prob			0.4671	0.1618	0.2172

[1] CI = crop injury.
[2]I = Disease incidence.
[3]S= Disease severity.

Treatment	Rate	Crop stage/application	--- 21 Jul evaluation --- CI[1]	I[2]	S[3]	1 Aug White heads	25 Aug Lodging
	acre^{-1}		---------- % ----------				
Untreated Check			0	0	0	0.00	12.50
Quilt	7oz	4 to 5 leaf	0	0	0	0.50	12.50
Warrior II / Quilt	1.28oz/7 oz	4 to 5 leaf	0	0	0	0.25	11.25
Tilt	2oz	4 to 5 leaf	0	0	0	0.50	12.50
Warrior II/ Tilt	1.28oz/2oz	4 to 5 leaf	0	0	0	0.25	13.75
Warrior II	1.28oz	4 to 5 leaf	0	0	0	0.50	10.00
Quilt	14oz	flag	0	0	0	1.00	10.00
Tilt / Quilt	2oz/14oz	4 to 5 leaf/flag	0	0	0	0.50	12.50
Warrior	1.28oz	flag	0	0	0	0.25	11.25
Warrior	1.28oz	early heading	1	0	0	0.50	13.75
Warrior II /Tilt	1.28oz/4oz	early heading	1.5	0	0	1.00	11.25
Warrior II/Quilt	1.28oz/14oz	flag	1	0	0	0.00	13.75
Mean			0.29167	0	0	0.44	12.08
CV%			128	-	-	138	23
LSD .05			0.5361	NS	NS	NS	NS
SE			0.18634	0	0	0.3018	1.3989
Rep F Prob			0.4051	-	-	0.3532	0.9109
Trt F Prob			<.0001	-	-	0.3648	0.5338

[1] CI = crop injury.
[2]I = Disease incidence.
[3]S= Disease severity.

Treatment	Rate	Crop stage/application	Grain[1] Test weight	Grain[1] Yield
	acre^{-1}		lb/bu	bu/a
Untreated Check			54.9	20.6
Quilt	7oz	4 to 5 leaf	54.7	22.3
Warrior II / Quilt	1.28oz/7 oz	4 to 5 leaf	55.5	22.1
Tilt	2oz	4 to 5 leaf	55.1	21.7
Warrior II/ Tilt	1.28oz/2oz	4 to 5 leaf	54.6	21.8
Warrior II	1.28oz	4 to 5 leaf	55.1	23.1
Quilt	14oz	flag	55.4	21.7
Tilt / Quilt	2oz/14oz	4 to 5 leaf/flag	55.7	22.2
Warrior	1.28oz	flag	55.1	20.8
Warrior	1.28oz	early heading	54.7	20.5
Warrior II /Tilt	1.28oz/4oz	early heading	54.8	22.8
Warrior II/Quilt	1.28oz/14oz	flag	55.2	23.0
Mean			55.1	21.9
CV%			1.1	8.9
LSD .05			NS	NS
SE			0.3019	0.9688
Rep F Prob			0.2236	0.43
Trt F Prob			0.2599	0.6064

1Grain values adjusted to a 12% moisture basis.

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Producer participatory spring wheat variety evaluation for organic systems in Minnesota and North Dakota

Herman J. Kandel*, Paul M. Porter, Patrick M. Carr, and Steven F. Zwinger
H,J. Kandel, Dep. Plant Sci., North Dakota State Univ., P.O. Box 5051, Fargo, ND 58105-5051; P.M. Porter, Dep. of Agron. Plant Genetics, Univ. of Minnesota, St. Paul, MN; P.M. Carr and G.B. Martin, North Dakota State Univ., Dickinson Res. Ext. Ctr., 1041 State Ave., Dickinson, ND 58601-3267. *Corresponding author: hans.kandel@ndsu.edu.

Summary

Organic producers in Minnesota and North Dakota, USA, indicated that they wanted to participate in hard red spring wheat (Triticum aestivum L. emend. Thell) variety evaluations. The objectives were to determine if a farmer–researcher developed scoring system could be used to rank wheat varieties for yield potential when grown in certified organic fields, identify views of organic producers about on-farm research, and identify the educational impact of the participatory variety evaluation process. Hard red spring wheat varieties were compared for grain yield at six locations on certified organic farms in Minnesota and North Dakota over a three-year period. A scoring system was developed and then used to identify the relative rank of adapted varieties for yield. Producers were asked to rank all varieties on a scale from 1 to 9, where 1 is lowest yield potential and 9 is highest yield potential. Producers were able to distinguish higher producing varieties as a group in 2003 and 2004. ‘Oklee’ a high yielding variety was ranked lowest in 2005. There was a significant linear relationship between producer ranking and yield ($P < 0.05$) even though producers could not pick the highest yielding varieties consistently in the field. The producer survey showed that grain yield, protein content, wheat scab resistance, leaf disease resistance, early seedling vigor, test weight and canopy closure were traits producers valued most in a variety. Heading date, impact on succeeding crops, straw and stubble production were ranked lower. Multi-year variety evaluation on certified organic land was highly valued by the producers surveyed. From an educational perspective, the exercise was successful in that producers had to observe individual varieties carefully in order to come to a consensus producer ranking. The model of participatory research can be used for a variety of field research projects and field days.

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Wheat grain quality response to tillage and rotation with field pea

Patrick M. Carr*, Richard D. Horsley, and Glenn B. Martin[1]

P.M. Carr and G.B. Martin, North Dakota State Univ., Dickinson Res. Ext. Ctr., 1041 State Ave., Dickinson, ND 58601-3267; R.D. Horsley, Dep. Plant Sci., North Dakota State Univ., P.O. Box 5051, Fargo, ND 58105-5051. Received 17 Apr. 2008. *Corresponding author (Patrick.Carr@ndsu.edu).

Summary

Preceding spring wheat (*Triticum aestivum* L.) with field pea (*Pisum sativum* L.) can enhance wheat grain yield in a wheat-pea (WP) rotation compared with continuous wheat (WW). The pea-rotation benefits to wheat grain quality are uncertain. A 6-yr study was conducted to determine if: (1) grain protein content, kernel weight, and test weight were enhanced for wheat in a WP rotation compared with WW, and (2) an interaction between cropping and tillage systems existed. The WP and WW systems were maintained in subplots within clean-till (CT), reduced-till (RT), and no-till (NT) whole plots arranged in a randomized complete block as a split plot in southwestern North Dakota, USA. Grain protein content of wheat averaged 160 g kg^{-1} and was unaffected by cropping system ($P > 0.05$). However, grain protein content was 10 to 30 g kg^{-1} lower under NT compared with CT, depending on the year. Kernels were heavier in two of six years in the WP rotation compared with WW. No difference in kernel weight was detected between cropping systems in the other four years. A consistent trend in kernel weight was not detected across tillage systems, and interactions between cropping and tillage systems were not observed for either grain protein content or kernel weight. A three-way interaction between cropping systems, tillage systems, and years was detected for grain test weight. These results failed to demonstrate a consistent pea-rotation benefit to wheat grain quality.

Impact of Fall-Seeded Cover Crops and Cover Crop Termination Method on Weed Biomass in the Ensuing Crop.

Jeff J. Gunderson, Patrick M. Carr, Timothy Winch and Glenn B. Martin
North Dakota State University Dickinson Research Extension Center

SUMMARY

The inclusion of cover crops in a rotation can have several potential benefits, one of which is weed suppression in the following crop. Rye, and to a lesser extent wheat and hairy vetch, tissues are known to contain compounds which may inhibit the germination of small-seeded weeds when released into the soil during residue decomposition. Method of cover crop termination alters factors such as residue/soil contact and therefore may affect the extent of weed suppression. This study investigated the effect of five cover crop treatments (winter rye, winter wheat, hairy vetch, winter rye/hairy vetch intercrop and winter wheat/hairy vetch intercrop), in concert with three termination methods (disk, roller/crimper and wide sweep) on weed pressure in the subsequent cash crop. Overall, greater grass weed biomass occurred in crops following hairy vetch and winter rye than crops following winter wheat or the winter rye/hairy vetch intercrop. The effect of cover crop on broadleaf weed biomass in the subsequent crop was more complex, varying with termination method.

INTRODUCTION

Incorporating cover crops into a rotation is an excellent strategy for building organic matter and enhancing soil health, while also providing fertility and weed and disease suppression. The positive effects of cover cropping have been long recognized, but have grown in favor only recently as input costs rise. Cover crops are typically either relay-intercropped with a cash crop, or grown over a full season to provide a break in pest cycles. In either case, the crop provides an actively growing soil cover which suppresses weeds while still promoting soil microbiological activity, and serves as a source of organic matter and essential nutrients upon termination. Weed suppression occurs through direct competition while the cover is actively growing, as well as through the exudation of allelopathic compounds by some crops.

Allelopathic compounds are chemicals synthesized by growing plants that can suppress the germination of seeds of potential competitors. This suppression can occur not only while the crop is growing, as the chemicals are exuded from the roots of the plant, but can also persist after termination as these compounds leach from the crop residue. It is generally accepted that the allelopathic potential is greatest if the crop residue remains on the soil surface (Putnam et al., 1983). Generally, allelopathic chemicals are most effective in suppressing germination as seed size decreases. Many problematic weeds in agricultural systems produce large quantities of small, easily dispersed seeds, so enhancing the allelopathic effect of cover crop residues could provide weed suppression in the following crop, at least for a period of time long enough to endow the crop with a competitive advantage. Furthermore, most field crops will remain unaffected by allelopathy due to the somewhat larger seed size.

One crop most commonly cited for its allelopathic potential is rye, which is often used by organic growers as a weed suppressant and catch crop. Research suggests that allelopathic compounds synthesized by a rye cover crop may not only provide weed control while the crop is growing, but can remain effective germination-inhibitors of small-seeded weeds for some time after termination of the crop (Teasdale et al., 1991). However, incorporation of residues leads to more rapid decomposition and dissolution of these allelopathic compounds, as compared with leaving the residue on the soil surface, which allows the chemicals to leach more slowly from the residues (Putnam et al., 1983).

To harness the potential benefits of allelopathy, a roller/crimper has been used to terminate rye without disturbing the soil surface. The roller/crimper consists of a cylindrical drum with parallel chevron-shaped ridges which crush but do not cut the stalk of the growing crop, ideally resulting in firmly packed mulch on the soil surface into which the subsequent crop can be no-till seeded. This method can be used with other cover crops as well, and has achieved some success in several areas in the United States and abroad. However, it generally is necessary for rye (and many

other crops) to have reached at least the onset of flowering before rolling can effectively kill the plant.

Mowing, or other tillage methods can be used for cover crop termination as well. However, the burying of potentially allelopathic residue that results from tillage is known to reduce its effectiveness as a weed control device, while the exposure and disturbance of the soil surface resulting from tillage may also create favorable conditions for weed seed germination. Soil disturbance also destroys soil structure, reduces moisture retention and enhances the breakdown of organic matter; therefore, minimal soil disturbance is often recommended as a strategy for improving soil quality. Unfortunately, tillage is heavily relied upon in organic and some low-input management systems to control weeds. The potential of cover crops to enhance soil quality and ameliorate the detrimental aspects of tillage is great, while termination of these crops without soil disturbance, and their potential for weed suppression could reduce dependence on tillage in the above-mentioned management systems.

Cover cropping is also a useful way to enhance soil fertility. In order to maximize the supply of nutrients added to the soil, leguminous cover crops are often incorporated into rotations, due to their ability to fix significant amounts of nitrogen. In fact, including a broad selection of crops in the rotation, as well as applying organic amendments, is an important strategy for increasing the organic matter content of the soil. The inclusion of combinations of low and high-quality crop residues is important because high quality, low C:N ratio materials decompose quickly, contributing very little to overall OM content. Lower quality residues, on the other hand, break down more slowly in the soil due to higher C:N ratios. These low-quality residues increase soil organic matter content but contribute very few potentially mineralizable compounds (Seiter and Horwath, 2004). Therefore a diversity of crop residues ensures sufficient organic C and N for humus formation and ultimately engenders a pool of potentially available nutrients that can become mobilized according to crop demand. The importance of organic matter additions, through the inclusion of cover crops in the rotation as well as manure or compost application, cannot be overestimated. In fact, research has shown that when 150 lb/ac of synthetic nitrogen fertilizer is applied to a corn crop, soil organic matter still supplies up to 70% of the N taken up by the corn (Omay et al., 1998). Furthermore, it is estimated that 20 to 70% of the soil cation exchange capacity is due to humic substances, which highlights the importance of organic matter for nutrient storage (Seiter and Horwath, 2004).

The potential of cover crops for weed control, combined with their ability to enhance fertility and soil quality while sustaining ecosystem services during periods of non-cash cropping, suggest many benefits if incorporated into cropping systems. A potential fit for cover crops in the northern plains is seeding these crops post harvest and terminating in the spring prior to seeding a cash crop. The objective of the current study was to screen three different species for use as cover crops, including winter rye (WR), winter wheat (WW) and hairy vetch (HV) sown individually, as well as winter rye/hairy vetch (WR+HV) and winter wheat/hairy vetch (WW+HV) intercrops. Crops were evaluated specifically for their ability to reduce weed densities in a variety of subsequent cash crops (buckwheat, sweet corn and navy bean) without interfering with crop performance. A coincident goal of the study was to determine which method of termination - disking, wide sweep/noble blade, or roller/crimper - was most effective at killing the cover crop and also resulted in the least amount of weed pressure in the subsequent crop.

MATERIALS AND METHODS

Cover crop treatments consisted of winter rye (WR, 'Dakold'), winter wheat (WW, 'Ransom') and hairy vetch (HV, Common) sown individually as well as winter rye/hairy vetch (WR+HV) and winter wheat/hairy vetch (WW+HV) intercrops. All crops were seeded on September 20, 2007. The previous crop was oat and no fertilizer was applied prior to seeding the cover crops. The WR treatment was seeded at a rate of 140 lb/ac and the WW treatment was seeded at a rate of 150 lb/ac. In the WR+HV treatment rye was seeded at a rate of 112 lb/ac and vetch was seeded at a rate of 25 lb/ac, while in the WW+HV treatment wheat was seeded at 120 lb/ac and vetch at 25 lb/ac. Experimental design was a strip-split block and consisted of four randomized complete blocks with each block containing the three termination methods (disk, wide sweep, roller/crimper) established in random order. The cover crop treatments were established randomly in within each tillage treatment, even though tillage treatments were not applied until after the cover crop treatments

were in place. Cover crop treatments were seeded in strips 10 ft wide and 42 ft long. All crops were seeded with a John Deere 750 low-disturbance drill into a no-till seed bed. Termination of cover crops was accomplished with the implements mentioned above being run through the cover crop treatments parallel to seeding direction.

Cover crop plant counts were taken from a $0.5/m^2$ area in the six cover crop treatments within one of the tillage treatments in each block on October 11, 2007. Counts were taken again in the spring to evaluate crop winter survival. First flowers were observed in rye and vetch on June 16, 2008 and in wheat one week later. Approximately one week was then allowed for the stands to reach full flower, at which time the covers were terminated. The WR, WR+HV and HV treatments were terminated on June 24, 2008 and the WW and WW+HV treatments were terminated on July 2, 2008. Cover crop biomass, along with grass and broadleaf weed biomass samples were taken from a $0.5/m^2$ area within the first six cover crop treatment plots in each block just prior to termination. Broadleaf, grass and cover crop samples were separated and weighed. Samples were then dried at 130° F for 3 to 4 days and reweighed to obtain dry weight and moisture content.

On July 3, 2008, cash crops were seeded in random order within each of the four blocks in 6 ft wide, 180 ft long strips perpendicular to tillage and cover crop strips with a cross-slot no-till drill. Cash crops initially consisted of buckwheat ('Koma'), carrot ('Nelson'), sweet corn ('Earlivee'), navy bean ('Vista'), pinto bean ('Maverick'), and spring wheat ('Parshall'), although the carrot, pinto bean and wheat treatments were abandoned due to extremely poor germination and crop performance. An unplanted check treatment was also included along with the cash crop strips to determine weed pressure in absence of crop competition. Seeding rates were as follows: buckwheat at a rate of 52 lb/ac, carrot at 9 lb/ac, sweet corn at 7.5 lb/ac, navy bean at 40 lb/ac, pinto bean at 50 lb/ac and wheat at 65 lb/ac.

Cash crop plant counts were performed on July 25 for buckwheat and navy bean and July 28 for sweet corn to determine stand biomass. Cash crops were harvested, along with grass and broadleaf weeds, on September 15 and 16. Crop, grass weed and broadleaf weed sampled were separated and dried at 130° F for 3 to 4 days before being weighed.

Statistical analysis was performed to determine the effect of cover crop and termination method on weed biomass in the subsequent crop and yield of subsequent crop. Analysis was conducted using SAS version 9.1 (SAS Institute, 2003), and consisted of a mixed model approach with block being a random factor and tillage, cover crop and main crop being fixed factors and the cover crop being nested within the tillage factor ($\alpha = 0.05$). Interaction effects were evaluated by pairwise comparisons of least squares means with mixed model ANOVA.

RESULTS

Cover Crop Survival and Biomass

Winter rye survival was 92% in the WR treatment and 90% in the WR+HV treatment. Hairy vetch survival was 74% when grown alone, 40% in mixture with winter rye and 37% in mixture with winter wheat. Winter wheat survival was 42% alone and 36% in mixture with hairy vetch.

The WW, WR and WR+HV cover crop treatments produced the most biomass, while the HV treatment produced the least (Fig. 1). The fact that the WW treatment produced the most overall biomass is interesting given the poor winter survival of winter wheat. It is likely that, due to dry spring conditions, the lower plant population of winter wheat reduced intraspecific competition and in turn enhanced performance, compensating for low density. The fact that the intercropping of hairy vetch with winter wheat seems to have reduced the overall amount of biomass produced supports this hypothesis. In terms of winter rye, on the other hand, overall biomass in the rye/vetch intercrop was virtually indistinguishable from the rye sole crop. Generally, the weed suppressant potential of cover crops increases with increasing cover crop biomass. More biomass results in a thicker mulch layer, which serves to physically inhibit weed seed germination, and increases the potential of allelopathic crops. In both cases the weed suppressant effect is most pronounced when the residue is left on the soil surface, rather than incorporated. Obviously, cover crops producing more biomass will also be more competitive with weeds while actively growing. Therefore, the performance of winter wheat, winter rye and the winter rye/hairy vetch intercrop indicate potential for cover cropping in this region based on the amount of biomass produced, as well as their potential

allelopathic effect. Still, actual weed suppressant ability is the most important factor in this context.

Effect of Cover Crop on Grass Weed Biomass in Subsequent Crop

An overall effect of cover crop on grass weed biomass in the subsequent crop was observed, with more weeds by weight being present in crops following HV and WR covers than in crops following the WR+HV intercrop (Fig. 2). Termination method and main crop had no effect on grass weed biomass. Increased grass weed biomass under hairy vetch as compared with the hairy vetch/winter rye could be explained by vetch's lack of allelopathic effect, as well as the fact that the rapid decomposition of vetch (due to its low C:N ratio) could supply readily available nutrients for weed proliferation. The greater grass weed biomass after the winter rye sole crop compared to the winter rye/hairy vetch intercrop, on the other hand, is somewhat curious. If anything, it would seem logical that the winter rye sole crop would have an increased allelopathic effect in relation to the intercrop with hairy vetch. However, the interaction between the two crops and effects on soil ecology, microbial community structure and nutrient and moisture availability are likely to have had an influence on the reduced amount of grass weeds observed following the rye/vetch intercrop.

Effect of Cover Crop on Broadleaf Weed Biomass in Subsequent Crop

An effect of cover crop and termination treatments on broadleaf weed biomass in the subsequent cash crop was observed, while main crop, whether buckwheat, corn or navy bean, had no effect on broadleaf weed biomass. Weed biomass was greater following the HV treatment when terminated by the roller/crimper compared with weed biomass following HV in the two other tillage treatments (Fig. 3). This effect was also observed in the WW+HV treatment, while broadleaf weed biomass following the WW treatment was greater when terminated by the roller only in comparison with the wide sweep termination method. Broadleaf weed biomass in the WR+HV treatment was greater when the cover was disked than when it was rolled. To clarify, hairy vetch and the winter wheat/hairy vetch intercrop suppressed weeds in the subsequent crop to a greater extent when terminated with the disk or wide sweep than with the roller/crimper, while winter wheat suppressed weeds to a greater extent when terminated with the wide sweep than when terminated with the roller. The winter rye/hairy vetch intercrop, on the other hand, suppressed weeds in the subsequent crop to a greater extent when terminated with the roller/crimper than when terminated with the disk. Broadleaf weed suppression by winter rye was not affected by termination method.

Weed suppression was linked not only to the cover crop, but to the method by which the cover was terminated. In the case of the HV treatment, broadleaf weed control was reduced in the subsequent crop when the vetch was terminated by the roller. This may be a corollary of the rapid breakdown of the vetch residue and the minimal mulch that was therefore available to smother weed seedlings. In this case, performing tillage provided conditions less conducive to weed germination or survival, a fact that could be attributed to the exposure and subsequent desiccation of weed seeds resulting from tillage, especially given the extremely dry conditions. Furthermore, within the roller termination treatment, broadleaf weed biomass was greater following vetch than any other cover crop.

Given that it has been documented that rye, wheat and hairy vetch produce allelopathic compounds (Barnes et al., 1987, Putnam et al., 1983 and White et al., 1989), the fact that less broadleaf weed biomass was recovered from roller terminated treatments including rye or wheat could suggest a greater allelopathic effect from these crops. However, it is likely that this could again be due to the fact that the greater abundance of residues resulting from the other crops physically suppressed weed seed germination to a greater extent. In fact, in a similar study, Teasdale et al. (1991) found very little difference in the ability of rye and hairy vetch residues to suppress weeds in a subsequent corn crop, and identified the amount of biomass as the major factor in the extent of weed suppression.

Interestingly, within the four cover crop treatments that included a cereal, there was not a consistent reduction of subsequent weed biomass when terminated with the roller as compared to the other termination methods. For instance, while in the WR+HV treatment reduced broadleaf weed biomass was found subsequent to rolling as opposed to disking, the method of termination of the WR cover crop had no effect on subsequent weed biomass. Furthermore,

in the WW cover crop more weed biomass was subsequently recovered in the roller treatment than in the wide sweep treatment and in the WW+HV cover crop weed biomass was greater following the rolling than following either of the other two termination methods. Any effect of allelopathy as affected by tillage is therefore difficult to ascertain from these results, and in fact the positive effects of reduced till such as greater moisture retention may actually be a factor in the increased weed biomass present after rolling as opposed to the other termination methods.

Effect of Cover Crop on Subsequent Crop Biomass

Due to extremely dry conditions and the late date of planting there was no harvestable crop following any of the cover crop treatments. However, crop biomass was collected at the same time as weed biomass. No direct effect of cover crop on main crop biomass was observed, although there was a termination method effect on overall main crop biomass. Regardless of cover crop, all crops tended to yield better after the wide sweep termination treatment, even though biomass was very low in all cases (Table 1). This could be attributed to the effect of slight disturbance on soil biology. The minimal soil disturbance occurring with the wide sweep could have stimulated mineralization by aerating soil and bringing plant debris into closer contact with the soil. At the same time, this implement still left the majority of the plant residue on the soil surface, which could have led to increased moisture retention compared with disk tillage.

The need to defer rolling until flowering to prevent cover crop regrowth delayed planting of the main crop to an extent that severely hampered development. Lack of rainfall was a prominent factor in reducing crop performance, while diminishing day length and a limited growing season also played a role. In a year with normal precipitation it is possible that cover crop flowering would be significantly earlier and therefore allow for earlier seeding of the cash crop. This would obviate concerns related to day and season length but given that dry conditions are common in the latter part of the growing season in this region the availability of moisture for the cash crop would still be of concern. The benefit of heavy residue on the soil surface that results from no-till termination of the cover crop would be negligible if the cover had exhausted available soil moisture. Termination methods involving tillage could potentially be used to kill cover crops earlier in the season than could be done with the roller/crimper, allowing for early seeding of the cash crop, and possibly better utilization of spring rains. High-residue implements would be required to maximize soil cover, but this method (as with any tillage event) would be at least somewhat detrimental to soil structure and reduce water infiltration and storage, especially over time.

CONCLUSION

These results indicate that there was no cover crop or cover crop mixture that clearly suppressed all weeds to a greater extent than any other in the subsequent crop. Relative to hairy vetch alone covers including winter rye and winter wheat showed some potential in suppressing grass weeds, as well as broadleaf weeds in the subsequent crop when terminated by the roller. Whether this was an allelopathic effect, an effect on soil biology or nutrient availability, or simply a physical effect of no-till negating conditions necessary for weed seed germination is unclear. There was also no termination method that was clearly preferable. Conclusions as to the effect of cover crop on subsequent cash crop are difficult to make given the extremely dry conditions and the late date of planting. However, cash crops tended to fair best following the wide sweep termination method, for reasons discussed above.

This study also suggests that a cropping system in which covers are fall-seeded and spring-terminated may not be the best option for the northern plains, given precipitation and season length limitations. However, this study has only occurred in one year, and an extremely dry year at that, so strong conclusions cannot be drawn. If cover crops could in fact be terminated earlier the system could have potential in this region, and ultimately further research is necessary to identify whether this system of cover cropping or another is the best strategy for enhancing weed control while maintaining soil fertility and minimizing moisture loss.

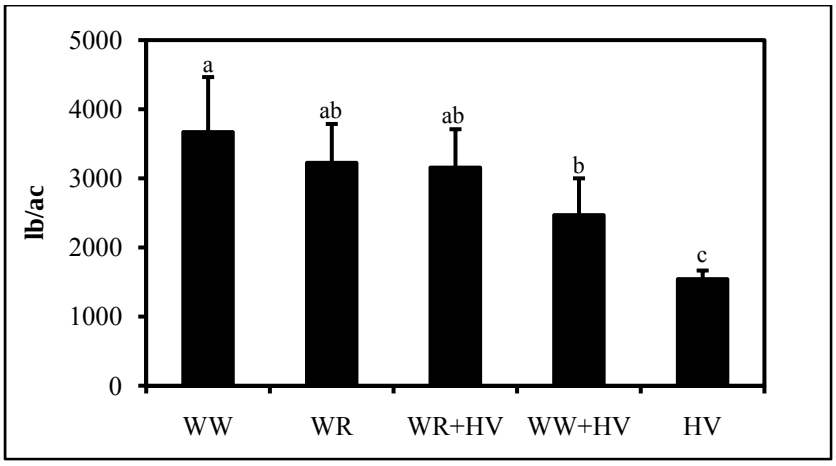

Figure 1. Overall biomass generated by cover crops.

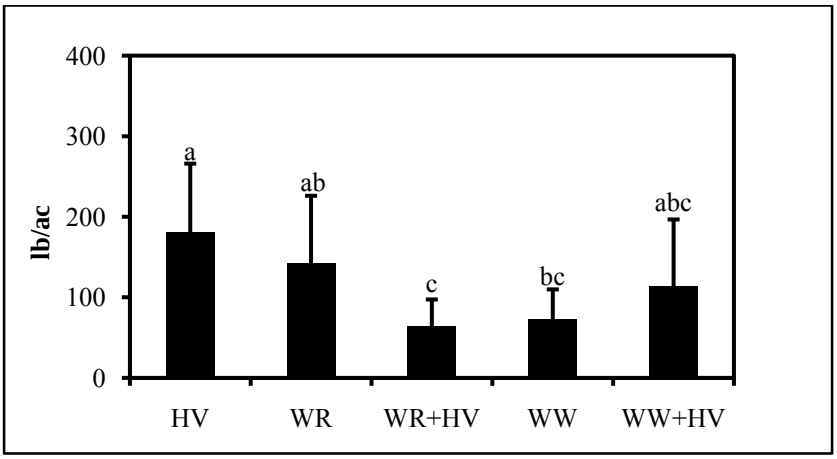

Figure 2. Grass weed biomass in subsequent crop as influenced by cover crop. Quantities with the same letter do not differ.

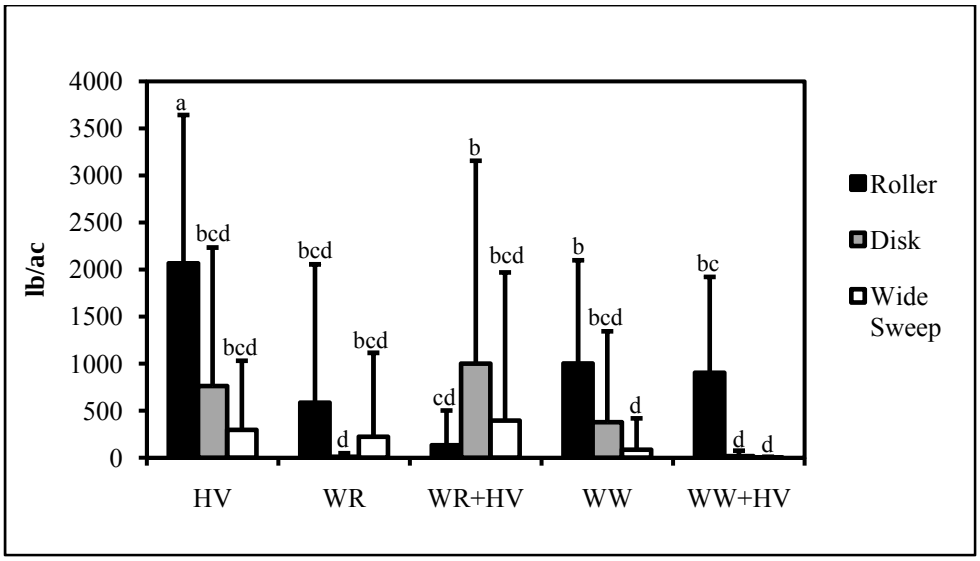

Figure 3. Broadleaf biomass in subsequent crop as influenced by cover crop and termination method. Quantities with the same letter do not differ.

Table 1. Overall main crop biomass (buckwheat, corn and navy bean) as affected by cover crop and termination method. Quantities with the same letter do not differ.

Termination Method	Cover Crop	Overall Main Crop Biomass
		— lb/ac —
Wide Sweep	HV	535.61a
Wide Sweep	WR	413.56ab
Disk	WR+HV	379.06b
Wide Sweep	WW	373.08b
Wide Sweep	WR+HV	319.49bc
Wide Sweep	WW+HV	278.42bcd
Disk	WR	272.62bcd
Disk	WW	265.75bcde
Disk	HV	212.78cdef
Disk	WW+HV	202.29cdef
Roller	WR+HV	130.97defg
Roller	WW+HV	117.20efg
Roller	WR	96.43fg
Roller	WW	45.26g
Roller	HV	6.51g

LITERATURE CITED

Barnes, J. P., A. R. Putnam, B. A. Burke, and A. J. Aasen. 1987. Isolation and characterization of allelochemicals in rye herbage. Phytochemistry 26:1385-1390.

Omay, A., C. Rice, D. Maddux and W. Gordon. 1998. Corn yield and nitrogen uptake in monoculture and in rotation with soybean. Soil Sci. Soc. Am. J. 62:1596-1603.

Putnam, A.R., J. DeFrank and J.P. Barnes. 1983. Exploitation of allelopathy for weed control in annual and perennial cropping systems. J. Chem. Ecol. 9:1001-1010.

Seiter, S. and W.R. Horwath. 2004. Strategies for managing soil organic matter to supply plant nutrients. p. 269-293. *In* F. Magdoff and R.R. Weil (ed.) Soil Organic Matter in Sustainable Agriculture. CRC Press, Boca Raton, FL, USA.

Teasdale, J.R., C.E. Beste and W.E. Potts. 1991. Response of weeds to tillage and cover crop residue. Weed Sci. 39:195-199.

White, R.H., A.D. Worsham and U. Blom. 1989. Allelopathic potential of legume debris and aqueous extract. Weed Sci. 37:674-679.

An Efficacy Trial of Potential Herbicides for Use in Organic Systems.

Jeff J. Gunderson, Patrick M. Carr and Timothy Winch
North Dakota State University Dickinson Research Extension Center

SUMMARY

Non-synthetic herbicides are herbicides utilizing naturally-occurring active ingredients for weed control. Under the National Organic Program, a small number of these herbicides have been approved for application on certified organic crop land (USDA AMS, 2002). These herbicides may provide an important tool for weed control in organic systems, if they prove effective. This study was concerned with evaluating the efficacy of three of these weed control products and to establish recommended rates for these products.

The three weed control products evaluated were corn gluten meal, vinegar and Racer. Corn gluten meal (CGM) has been shown to reduce germination of small-seeded weeds (Liu & Christians, 1996; Boydston et al., 2008), while vinegar (20% acetic acid) and Racer™ (ammonium nonanoate), have potential as burn down herbicides (Radhakrishnan et al., 2003; Webber III et al., 2008). All products were applied pre-plant and plots were subsequently seeded to pea. Grass weed abundance in pea was not affected by any of the products, while Racer reduced overall weed biomass according to visual evaluation and reduced broadleaf weed biomass compared to CGM.

INTRODUCTION

The National Organic Program, and most organic grower groups, place emphasis on preventative and cultural measures for weed control. These measures are an important component of a weed control strategy and can be effective in reducing severe weed problems, but in most cases weed control will still be necessary at some point during the growing season. Tillage is relied on heavily for weed control in many organic cropping systems, and can be an effective method of eliminating weeds. However, it is well known that excessive tillage can lead to problems with soil erosion and can negatively impact soil structure, organic matter content and humus formation. Furthermore, tillage can reduce soil water retention in comparison with no-till management, a fact that could have significant implications in low-rainfall, drought prone regions (Franzluebbers, 2004). Having a burn-down herbicide option could provide organic growers, especially those in dryland regions, with a useful tool for pre-emergence weed control that retains the benefits of minimized soil disturbance. A few herbicides are registered for use under the National Organic Standards, and therefore available to organic growers, although none of these products are presently labeled for use in North Dakota. These herbicides utilize naturally-occurring substances for weed control, such as clove and garlic oils, soap salts or acids, but little research has been conducted evaluating their efficacy.

Three non-synthetic, "natural" products were evaluated for their ability to control weeds in field pea. Racer™ bio-herbicide (Falcon Labs LLC, Wilmington, DE) Nature's Guide® Vinegar (Harvest Supply Company, Fort Worth, TX) and Nature's Guide® Corn Gluten Meal (Harvest Supply Company, Fort Worth, TX). The active ingredient in Racer is ammonium nonanoate (40%), a soap salt. Soap salts reduce the surface tension of water and lead to the collapse of guard cells around the stomata. As a result, the stomata become clogged and gas exchange is unable to occur, killing the plant (Ware and Whiteacre, 2004). Racer is a non-selective burndown herbicide. Vinegar containing high levels of acetic acid, well above the 5% acetic acid concentration of household vinegar, also has potential as a non-selective herbicide. Acetic acid works as a herbicide by causing the dissolution of cell membranes and the desiccation of the plant. Corn gluten meal is a byproduct of corn processing that has shown potential as a germination inhibitor of small-seeded plant species in research trials.

MATERIALS AND METHODS

The three products were all applied pre-plant. Treatments covered in this report include CGM at a rate of approximately 2.15 tn/ac, Racer at a rate of 14.4 lb ai/ac and Vinegar (20% acetic acid) at a rate of 35 gallons/acre. Corn gluten meal (CGM) was applied on May 20, Racer and Vinegar on May 27 and field pea was seeded on May 28. A weed-free

and a weedy check treatment were included. Weed control was evaluated visually 1, 7, 14 and 21 days after treatment (DAT) and was reported as % control. Crop and weed biomass samples were taken on July 23 in all treatments except the weed free check, in which biomass samples were taken on August 5.

RESULTS

Visual assessments indicated a significantly greater overall control of weeds by Racer compared to CGM 1 DAT and compared to CGM and vinegar 7 DAT (Table 1). No significant difference in % control was observed at 14 or 21 DAT. Even though Racer application initially resulted in greater weed control, at most control was only 10.75%, which occurred 1 DAT.

Crop and weed biomass sampling indicated that CGM produced the least control of broadleaf weeds (Fig. 1). Racer suppressed broadleaf weed biomass compared with CGM and weedy check plots, but field pea growth was reduced in plots where Racer was applied compared with weed-free (hand-weeded) plots. The reduced pea growth in Racer plots compared with weed-free plots probably reflects greater competition from weeds in the Racer plots, even though no difference in broadleaf weed biomass was detected statistically between the Racer treatment (weed biomass ≈ 793 lb/acre) and the weed-free treatment (weed biomass ≈ 24 lb/ac). We were unable to detect any difference in broadleaf weed growth between plots where vinegar or CGM was applied and plots where no weed control was attempted. Grass weeds were low in abundance and showed to no response to treatment effects.

Table 1. Mean % weed control by three non-synthetic products based on visual assessment up to 3 weeks after treatment.

Product	Rate	1 DAT	7 DAT	14 DAT	21 DAT
		———— % Control ————			
CGM	2.15 tn/ac	0.00	1.00	0.00	0.00
Racer	14.4 lb ai/ac	10.75	4.50	3.75	2.50
Vinegar	35 gal/ac	5.25	0.00	0.00	0.00
LSD α=0.05		7.38	1.55	NS	NS
P		0.0359	0.0001	0.1757	0.4393

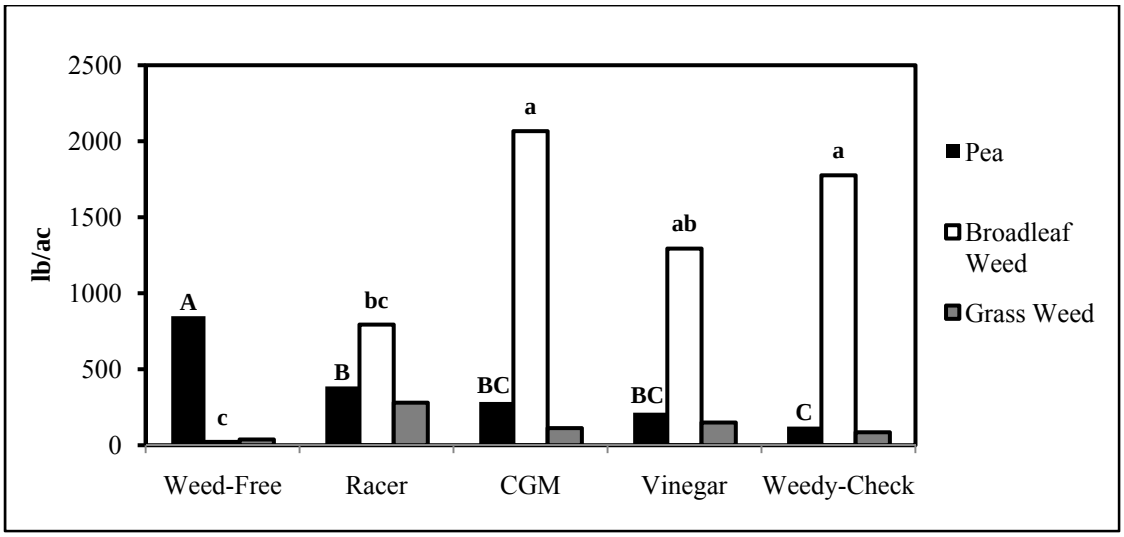

Figure 1. Average weed and crop biomass at harvest as affected by potential organic herbicides. Different uppercase letters denote significant between treatment differences in field pea biomass. Different lowercase letters denote significant between treatment differences in broadleaf weed biomass.

LITERATURE CITED

Boydston, R.A., H.P Collins and S.F. Vautghn. 2008. Response of weeds and ornamental plants to potting soil amended with dried distillers grains. Hort. Sci. 43(3): 800-803.

Franzluebbers, A.J. 2004. Tillage and residue management effects on soil organic matter. *In* F. Magdoff and R.R. Weil (ed.) Soil Organic Matter in Sustainable Agriculture. CRC Press. Boca Raton, FL.

Liu, D. L.-Y., & N.E. Christians, 1996. Isolation and identification of root-inhibiting compounds from corn gluten hydrolysate. J. Plant Growth Regul. 13:227-230.

Radhakrishnan, J., J.R. Teasdale and C.B. Coffman. 2003. Agricultural Applications of Vinegar [abstract]. Proc. Northeast. Weed Sci. Soc. 57:63-64.

United States Department of Agriculture, Agricultural Marketing Service. National Organic Plan website. National List of Allowed and Prohibited Substances. www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5068682&acct=nopgeninfo. Accessed 2/25/09.

Ware, G.W. and D.M. Whiteacre. 2004. The Pesticide Book, 4th ed. Meister Media. Willoughby, OH.

Webber III, C.L., L.P. Brandenberger, J.W. Shrefler, L.K. Wells and K. Shannon. 2008. Ammonium pelargonate/nonanoate as a potential organic herbicide [abstract]. Proc. South. Weed Sci. Soc. 61:136.

Organic Vegetable Production in the North Central U.S: Linking Growth Traits to Adaptation and Weed Suppression

Jeff J. Gunderson, Patrick M. Carr and Timothy Winch
North Dakota State University Dickinson Research Extension Center

SUMMARY

The potential for commercial vegetable production in western North Dakota is somewhat limited. However, gardeners, market growers or other, larger-scale operations with access to irrigation would benefit greatly from the identification of crop varieties that are well-suited to the particular climatic conditions. Very little work has been done in this area, and therefore, the objective of this study was to screen several varieties of three different vegetable crops (carrots, potatoes and sweet corn) for their suitability for production in western North Dakota. The linkage of performance with varietal growth characteristics is also of interest, and will be investigated further in years to come.

Yields were determined for all crops, carrots were ranked in terms of visual characteristics, and potatoes and carrots were subject to a taste test. Soil moisture and photosynthetically active radiation was measured in potatoes.Yields of all crops were low, resulting to a great extent from the extremely dry growing season in 2009. Of the carrot varieties screened, Hercules and Napoli generally performed the best, while Sugarsnax 54 was a poor performer. In potatoes, Superior and Red Gold showed some potential, and in sweet corn, Sugar Pearl was the best performer.

INTRODUCTION

Current production of fresh market vegetables in western North Dakota is limited, most notably due to climate conditions. However, interest in organic production and local food systems is growing. Organic farming methods seek to reduce dependence on off-farm inputs while stressing sustainable and ecologically sound production practices. Consonantly, the local foods movement seeks to create a food production and delivery system that identifies and fosters markets for locally grown crops. This system stresses local sourcing of foods whenever possible in order to strengthen regional economies and reduce the transportation time of food, while also striving to provide opportunities for small growers to compete for market share. As food safety and climate considerations gain precedence, the potential for small-scale vegetable production in the form of home or market gardens is anticipated in the region. Depending on the particular crop, availability of irrigation and site specific characteristics, larger scale production could conceivably be possible as well.

The climate of western North Dakota is characterized by a warm but short growing season, with a frost-free period of approximately 110-130 days. Growing season temperatures average 58-60° F, with a cool spring giving way to a relatively hot summer, averaging 16-24 days above 90° F each year. The climate is sub arid and prone to drought, especially later in the season. Average annual precipitation in western North Dakota is highly variable, but averages 16-17 in. Rainfall occurs predominantly in the spring, with cumulative April-June precipitation averaging 5 to 7 in., and decreases later in the season, with cumulative July-September rainfall averaging 4 to 5.5 in. Breezy conditions prevail throughout the season, with monthly maximum wind speeds averaging approximately 25 mph for April through June, and 23 mph for July through September.

Given the short growing season, low precipitation and windy conditions, a prominent issue for vegetable growers in the region is the identification of varieties and accompanying growth traits that are well suited to the climatic conditions of the region. Organic and conventional growers alike desire varieties that compete well with weeds, are resistant to disease and pest pressure, perform well under dry, windy conditions, and ultimately maintain high yields. Therefore, the objective of this study was to identify vegetable crop varieties suitable for production in this region. The performance of several varieties of three types of common vegetable crops, carrots, potatoes, and sweet corn was assessed using several variables. In future growing seasons, this experiment will be expanded to include not only other species of vegetables, but the number of measured parameters will also be broadened to facilitate the correlation of varietal growth traits with actual performance as evinced by resistance to weed, insect and disease pressure.

MATERIALS AND METHODS

Five varieties of potatoes, six varieties of carrots, and eight varieties of sweet corn were grown in separate experiments during the 2008 growing season (Table 1). Potatoes and carrots followed oat stubble fallow and sweet corn followed field pea. Soil type is a Parshall fine sandy loam. Experimental design was a randomized complete block with four replications for

each crop. Seedbed preparation consisted of one pass with a tandem disk. Sweet corn was seeded in 32 in. rows on May 14 and carrots and potatoes were seeded on May 16 in 32 in. rows and 30 in. rows respectively. Corn was cultivated with a Lorenz 2 row "high trash" cultivator on June 23, and hoed and hand-weeded on June 27, July 2 and August 5 to control persist and in-row weeds. Weed control in carrots was performed by hoeing or hand-weeding as required on June 19, June 24, July 16 and August 18 and in potatoes on June 18, June 27, July 16 and August 18 by the same methods. Weeds occurring in alleys of the carrot study were controlled with a rototiller on June 21. Corn was thinned to a population of 18,000 plants/acre on June 27 and carrots were thinned to approximately 12 plants/row ft on July 22 and 23. Carrots were irrigated with an impact sprinkler on July 3 and August 6, resulting in approximately 2 to 3 in. of supplementary water. Harvest was performed by hand for all crops on August 25 in the case of sweet corn and August 29 in the case of carrots and potatoes.

Yield was determined for all crops, by harvesting a subsection of each whole plot and obtaining weights of the samples. Potato date of flowering was recorded, as was date of corn tasseling. Photosynthetically active radiation at soil surface was assessed in potato on July 21, July 28 and August 6. Three replicate readings were taken from each plot on each date below the plant canopy, while one above canopy reading was also taken in each plot. Volumetric soil moisture content was recorded in Potatoes on July 22, August 5 and August 19 with a Delta-T PR2 Profile Probe. This probe consists of a polycarbonate rod approximately 25 cm in diameter with electronic sensors at fixed intervals along its length. The probe is inserted to a consistent depth via seasonally permanent access tubes, installed on July 16 in each plot of two replicate blocks. Water content measurements were obtained at depths of 3 and 19 in.

Variables recorded in sweet corn included marketable ears/acre, plant height, cob length, cob diameter and number of kernel rows. Early season vigor was also recorded in corn on June 19. This was accomplished by walking through the study and visually ranking the varieties as -1, 0 or +1, which referred to below average, average and above average in terms of vigor, respectively. This procedure was repeated twice, once earlier and once later in the day, and the scores were averaged.

Carrot root length and diameter was recorded, while carrot roots were also visually ranked in categories of "root condition", which referred to the extent of cracking, blemishes and branching, "uniformity", which referred to the consistency of the root appearance within varieties, "true to type", which referred to the extent of similarity between the sample and the varietal standard, and "visual appeal", which described the overall attractiveness of the roots. A "size" category was also included, which pertained not to relative size differences between varieties, but to the extent to which variety best represented an acceptable fresh market carrot size in the opinion of the individual performing the rankings. Rankings were performed by randomly selecting ten roots from each variety, visually assessing the qualities described above and ranking on a scale of 1 to 6 (one being the best, six being the worst). Two individuals performed the rankings separately and the scores were averaged.

A taste test was also undertaken with harvested potatoes and carrots. Approximately 5 lbs of potatoes and 10 carrots were selected; carrots were peeled, cut into uniform wedges and served raw while potatoes were baked and served with skins. Varieties were randomly assigned a letter that only the test administrator was aware of and participants were asked to rank the varieties based on two variables: taste and color/texture.

Statistical analysis of the various parameters was performed by either mixed model ANOVA, with block as a random factor, or one-way ANOVA. Fisher's LSD was calculated to describe differences between varietal means ($\alpha = 0.05$). Least significant difference values cannot meaningfully be reported for transformed data, so where data transformation was necessary to homogenize variances, significant differences between groups are reported using letter groups.

RESULTS

Growing Conditions

The 2008 growing season was characterized by extreme drought, with only 6.41 inches of precipitation occurring from the first of the year until trial harvest (Fig. 1). Of this amount, 5.43 in. fell over the period from May 14 to August 29. Average growing season temperatures were below normal by 1°F in May and 2°F in June, while average temperatures were 4° and 3° above average in July and August (Fig. 2). These higher average temperatures, which were illustrated by the fact that the temperature exceeded 90°F on 24 days of the season, combined with the extremely dry conditions, imposed severe stress on crops later in the season.

Carrots

General varietal characteristics of the types grown in this study are as follows: Hercules is a mid-season carrot with thick, tapered roots, Napoli is a Nantes type with blunt roots of average length, and

Nectar a full-season carrot similar to Negovia, but with slightly longer tapering roots sometimes grown for processing. Nelson is a commonly grown Nantes type that possesses short, blunt roots and is often harvested as a baby. Mokum is another early season carrot, while Sugarsnax 54 is a full-season carrot that produces long, slender roots.

Carrot yields were very low due to extreme drought (Table 2). The supplementary water applied undoubtedly improved yield to some extent, but not to a level that could be considered commercially competitive. Yields in the current trial ranged from 5191 kg/ha for Sugarsnax 54 to 8017 kg/ha for Hercules, while United States average commercial carrot yields in 2008 averaged approximately 15,000 kg/ha for fresh and 23,000 kg/ha for processing carrots (NASS). Overall, no significant differences in yield between varieties were observable, although Hercules and Napoli performed substantially better than the other four varieties, indicating some resistance to the dry conditions.

Significant differences in root length and diameter were observed between varieties. Sugarsnax 54 possessed the longest roots, with an average length of 17.8 cm. This is to be expected as this variety is known for its long roots. In fact, the varietal standard length of Sugarsnax 54 is 22 to 23 cm. Hercules, Napoli and Nectar had intermediate lengths, while Nelson and Mokum had the shorter observed lengths, averaging 12.5 and 13.7 cm, respectively. Hercules had the thickest roots, with diameter averaging 3.1 cm, Napoli and Nectar were intermediate, and Sugarsnax 54, Mokum and Nelson had the smallest diameters.

In terms of visual rankings, Hercules consistently ranked the highest and Sugarsnax 54 the lowest, although significant differences were not always observed between varieties. In the "condition of root" category, for instance, varieties did not differ significantly. In the other categories, however, Hercules appeal was demonstrated. In the "uniformity" category, Mokum and Nectar joined Hercules in having the most consist root structure, while in the "true to type" category Napoli, along with Hercules, had the highest ranking. In terms of the "visual appeal" and "size" categories, Hercules, Napoli, Nectar and Mokum had the highest rankings. Other than Sugarsnax 54, Nelson also consistently ranked poorly, and whereas Sugarsnax 54 tended to be branched, irregular and spindly, Nelson tended to be the most diminutive and least robust variety in the trial.

Taste tests did not indicate a distinct preference for any one variety, although Napoli ranked highest and Sugarsnax 54 the lowest. Analogously, in the color/texture category no clear winner emerged, although in this category Napoli again ranked highest and Nelson the lowest.

These results indicate that Hercules and Napoli may have some potential for production in the region, given their relatively high yield, visual ranking scores, and in the case of Napoli, taste preference. Sugarsnax 54, on the other hand, was a uniformly poor performer in all categories.

Potatoes

Of the five varieties screened in this study, Gold Rush is an early, white-fleshed russet type, while Red Gold has a thinner reddish skin, yellow flesh and is often used as a new potato. Yukon Gold possesses golden flesh and the waxier skin of a boiler. Superior is medium maturing white and Russian Banana is a specialty potato that produces many small, ellipsoid tubers which possess a thin waxy skin that withstands boiling.

Potato yields were similar (approximately 10 to 13,000 lb/ac) for all varieties except Russian Banana, which differed significantly from all other varieties and yielded only 1357 lb/ac (Table 3). The low yields of this variety are likely due in some part to its late flowering date, indicating that a longer season may be required for this variety than can be expected in western North Dakota. Average flowering dates for the other varieties ranged from July 3 for Superior to July 17 for Red Gold.

Photosynthetically active radiation below the potato leaf canopy did not differ between varieties (Fig. 3). Above canopy PAR, however, was always significantly greater than below, while overall PAR did not differ below or above canopy over the three dates.

Volumetric soil water content under potatoes did not differ between varieties at either depth on any date, but soil moisture under all varieties was significantly greater at the 19 in. depth than at the 3 in. depth on every date (Fig. 4). Interestingly, overall soil moisture remained consistent over all three dates at both depths, with values between 20 and 25% at the 3 in. depth and between 36 and 38% at the 19 in. depth. This indicates that no significant decline in water content occurred as the season progressed, even though extremely dry conditions were extent. This is not an entirely surprising observation at the 19 in. depth, given the relative resistance of the lower soil profiles to moisture depletion, but the fact that moisture remained consistent at a 3 in. depth is unexpected. Although soil samples were not taken as part of this study, it can be presumed that soil physical properties had much to do with this phenomenon.

A soils capacity for water storage is influenced by its structure and organic matter content.

Generally, a sandy, coarser textured soil has larger, more continuous soil pores and therefore a higher hydraulic conductivity. This translates into a diminished water holding capacity compared with finer textured soils. However, good soil structure and the presence of water stable aggregates can aid in soil water retention by providing a large amount of total pore space while concurrently slowing downward water movement and remaining resistant to erosion. Aggregate stability, in turn, is directly related to soil organic matter content (Brady and Weil, 1999). Soil organic matter is extremely important to water holding capacity in soil not only because it enhances aggregate stability, but also because it directly absorbs and stores water. While the soil at this location is relatively coarse textured, moisture content was maintained at approximately 20-25% at the 3 in. depth late into the season, translating to approximately 1/4 to 1/3 in. of available water according to government estimates (NRCS). The retention of this amount of water could very well be due to the positive effects of substantial organic matter content in the upper soil horizons as a result of historic no-till management. While the specific depth to which the potatoes were able to access water was not determined, it can be assumed that the ability of the upper soil profile to retain water was integral in guarding against permanent wilting in the potato crop. Furthermore, water retention under potatoes was also surely enhanced to some degree by the reduced light penetration through the crop canopy, as indicated by the significantly lower PAR observations below the canopy as opposed to above.

Russian Banana was somewhat susceptible to insect pest damage, presumably leafhopper, while no other varieties sustained any insect damage. Verticillium was responsible for the death of two Red Gold plants, but did not spread to neighboring plants. The source of the infection was assumed to be the seed.

The taste test indicated no preference for any particular variety, although Red Gold ranked the highest and Superior and Gold Rush the lowest. In terms of texture and color, Red Gold and Gold Rush ranked the highest and Superior the lowest, although no statistically significant difference in scores was discernable.

Sweet Corn

Eight sweet corn varieties were included in this trial. The Xtra Tender varieties are supersweet (*sh2*) types, while all other are sugary enhanced (*se*). As for maturity, Spring Treat is an early season variety, Sugar Pearl, Luscious and Xtra Tender 272A are mid-season varieties and the remainders are generally recognized to be full-season varieties.

Of the three vegetable crops grown in 2008, sweet corn suffered the most from the dry conditions. Early season vigor ratings were most favorable for Spring Treat (Table 4). Xtra Tender 378A followed Spring Treat in the rankings, which is somewhat surprising considering the tendency of sh2 varieties for reduced vigor in cooler soils. Luscious and Xtra Tender 277A, on the other hand, received the lowest scores. Interestingly, even though Luscious received a low early season vigor rating, it had the second earliest average date of tasseling, July 30, with only Spring Treat having an earlier tasseling date, July 24.

Sweet corn yields were very low. Sugar Pearl had the highest overall yields, averaging 3543 kg/ha, while Brocade and Xtra Tender 378A and 277A had the lowest yields. Additionally, actual marketable yield was markedly reduced in all varieties due mainly to arrested kernel development and uneven fill. On average, only about 25 to 30% of harvested ears were deemed of market quality, with Sugar Pearl producing the highest number of marketable ears, at 2133 per acre. Although large variability did not allow for any statistically significant differences to be observed in number of marketable ears, the variety producing the next greatest number was Xtra Tender 275A, with 960 ears/acre. One variety, Brocade, produced ears deemed marketable at all.

Given the dry conditions, plant heights of all varieties were low, with Sugar Pearl producing the tallest plants at 111 cm, although Luscious, Brocade and Xtra Tender 275A did not differ significantly in height from Sugar Pearl. Spring Treat was the shortest variety, with plants averaging only 78.1 cm tall.

Ear lengths were relatively uniform between varieties, averaging 18.1 cm, except for Spring Treat, which had significantly shorter cobs, measuring only 14.1 cm on average. In terms of ear width, Luscious produced the thickest ears, averaging 4.4 cm, while Brocade, Spring Treat, Sugar Pearl and Xtra Tender 277A produced the lowest average ear widths, averaging between 3.6 and 3.8 cm. Xtra Tender 277A and 378A had the greatest number of kernel rows/ear with 17. Spring Treat had the lowest with only 10. In the case of Spring Treat, and to a lesser extent in the other varieties, many ears contained unfertilized or aborted kernels and high variability in the fill pattern within the ear. Number of kernel rows is highly dependent on climatic and fertility conditions prior to and during silking, while stressful conditions later in the season can lead to aborted and unfilled kernels. It is assumed that the extremely variable kernel fill (and reduced ear length in Spring Treat) was attributable to the dry conditions in 2008.

CONCLUSION

Sweet corn was the most negatively impacted crop, but one variety, Sugar Pearl, did stand out as having relatively greater resistance to drought, even though its early season vigor was somewhat impaired. Sugar Pearl produced substantially more marketable ears than any other variety, although still yielding well below what could be considered economically viable. Nonetheless, this variety has been identified as having some potential for region and will be screened further in future years, as will the other varieties involved.

The other two vegetables screened, carrots and potatoes performed somewhat better overall than sweet corn. These vegetables are root or tuberous crops, which may have spared them somewhat from the most extreme effects of the drought. Still, yields were low in both crops. Carrots received minimal supplemental water, which undoubtedly boosted yields, but not to the level of average commercial yields. The Hercules carrot had the highest yield, although not significantly different from any other, and consistently ranked high in the visually assessed categories. Napoli also had a relatively favorable yield and performed adequately in the visual ranking, although uniformity seemed to be a slight issue for this variety. This variety also garnered the highest ratings in the taste test, although again, no statistical differences could be discern between varieties. The performance of these two varieties, Hercules and Napoli, indicate that they may have some drought resistance and therefore potential for the region. These varieties will be screened further to assess long term performance. The Sugarsnax 54 variety, on the other hand, stood out for its poor performance, in terms of yield, visual qualities and taste.

As stated, potato yields were low, although no plants succumbed to drought or heat stress, indicating that sufficient water was retained in the soil to allow for normal development, a conclusion further substantiated by soil moisture measurements. Superior, the earliest flowering variety, had the highest yield (although not significantly greater than any other), but ranked low in the taste test. On the other hand, the second highest yielding variety, Red Gold, performed well on the taste test, illustrating potential interest from consumers.

As stated several times previously, the biggest factor affecting vegetable performance in 2008 was the extremely dry conditions. Yields of all crops suffered greatly, but nonetheless, the data obtained proved useful in assessing the response of the utilized varieties to extreme climatic conditions. One way to alleviate some water and drought stress in the future may include experimenting with mulches or no-till seeding methods, both which are known to increase water infiltration and reduce evaporation from the soil surface. Overall, the extension of these trials into future years will provide further insight into the best variety choices for the region, and hopefully spur interest in vegetable production in the region, whether for personal use or for commercial applications.

Table 1. Vegetable crop varieties used in the experiment.

Sweet Corn	Carrots	Potatoes
Brocade	Hercules	Gold Rush
Luscious	Mokum	Red Gold
Spring Treat	Napoli	Russian Banana
Sugar Pearl	Nectar	Superior
Xtra Tender 272A	Nelson	Yukon Gold
Xtra Tender 275A	Sugarsnax 54	
Xtra Tender 277A		
Xtra Tender 378A		

Table 2. Characteristics of the six carrot varieties included in the present study.

Variety	Length	Diameter	Yield	Visual Rankings†					Taste Test	
				Condition of root	Uniformity	True to Type	Visual Appeal	Size	Taste	Texture/Color
	——— cm ———		kg/ha							
Hercules	14.4	3.1	8017	2.5	2.3	1.8	2.3	2.5	3.00	3.50
Napoli	15.6	2.6	7688	3.1	4.1	2.9	2.8	3.0	2.00	2.30
Nelson	12.5	1.8	5448	3.9	3.9	3.9	3.8	4.5	4.00	4.50
Nectar	15.4	2.4	5356	4.0	3.4	3.6	3.0	3.0	3.75	3.80
Mokum	13.7	1.9	5219	3.1	2.4	3.6	3.6	3.0	3.80	3.30
Sugarsnax 54	17.8	2.1	5191	4.4	5.0	4.9	5.6	5.0	4.50	3.80
Mean	14.9	2.3	6153	3.5	3.5	3.4	3.5	3.5	3.51	3.53
CV (%)	29.2	33.1	38	49.3	49.3	49.1	49.3	28.6	49.79	49.79
LSD ($\alpha = 0.05$)	1.8	0.3	NS	NS	1.5	1.5	1.4	2.0	NS	NS
P	0.0001	0.0001	0.1460	0.2590	0.0048	0.0040	0.0014	0.0121	0.433	0.6504

†Visual and taste test rankings are relative, with 1 being the highest ranking and 6 being the lowest.

Table 3. Characteristics of the five potato varieties included in the present study.

			Taste Test†	
Variety	1st flower	Yield lb/ac	Taste	Texture/Color
Superior	July 3	12770	3.50	4.25
Red Gold	July 17	12145	2.50	2.25
Gold Rush	July 10	10896	3.50	2.25
Yukon Gold	July 14	10078	2.75	3.00
Russian Banana	July 29	1357	2.75	3.25
Mean	July 16	7063	3.13	3.75
CV (%)	5	58	48.37	48.37
LSD ($\alpha = 0.05$)		3967	NS	NS
P		0.0001	0.8334	0.2745

†Taste test rankings are relative, with 1 being the highest ranking and 6 being the lowest.

Table 4. Characteristics of the eight sweet corn varieties included in the present study.

Variety	Vigor†	Tassle Date	Ears	Marketable Ears	Yield‡	Plant Height	Ear Length	Ear Diameter	Kernel Rows
			——— no./ac ———		kg/ha	——— cm ———			
Spring Treat	0.75	July 24	5733	751	1961b	78c	14.1b	3.6c	10d
Xtra Tender 378A	0.25	Aug 5	1445	285	788cd	102b	18.7a	4.0ab	17a
Xtra Tender 275A	-0.25	Aug 4	2942	960	1619bc	106ab	17.9a	4.1a	16b
Sugar Pearl	-0.75	July 31	5463	2133	3543a	111a	18.4a	3.8bc	15c
Xtra Tender 272A	-0.75	Aug 2	2153	680	1272bc	93b	16.6a	4.1a	16b
Brocade	-0.75	Aug 1	846	0	582cd	109a	18.9a	3.8bc	14c
Xtra Tender 277A	-1.00	Aug 4	603	490	417d	98b	18.9a	3.7bc	17a
Luscious	-1.00	July 30	2541	777	1719bc	105ab	17.2a	4.4a	16b
Mean	-0.44	1-Aug	2716	757	1488	100	18	4	15
CV (%)	173.56	5	92	104	93.00	12.9	12.0	10.6	15
LSD ($\alpha = 0.05$)	0.76	–	2769	NS	–	–	–	–	–
P	0.0004	–	0.0045	0.0985	0.0087	0.0005	0.0011	0.0503	0.0001

†Vigor ratings are on a scale of -1 (below average) to +1 (above average).
‡Where data transformations were necessary LSD is not reported. Values within each column followed by the same letter do not differ significantly when $\alpha = 0.05$.

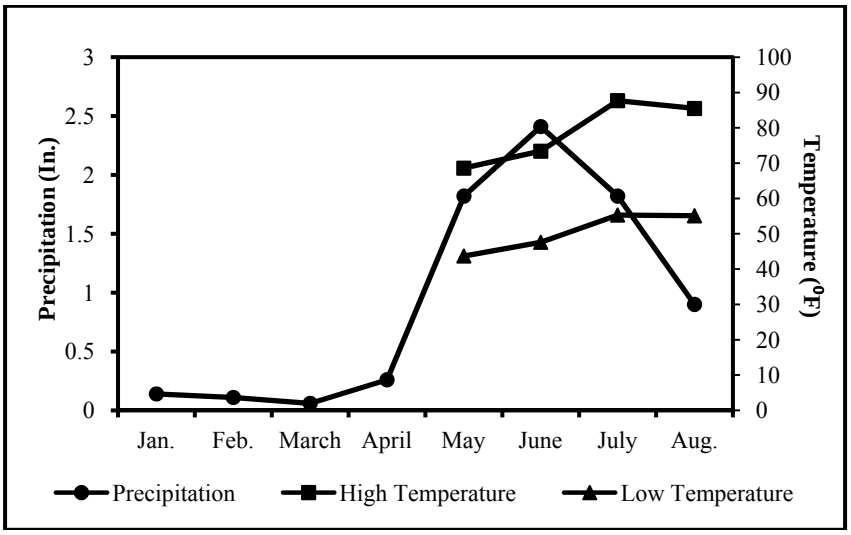

Figure 1. Average monthly precipitation and high and low temperatures for 2008.

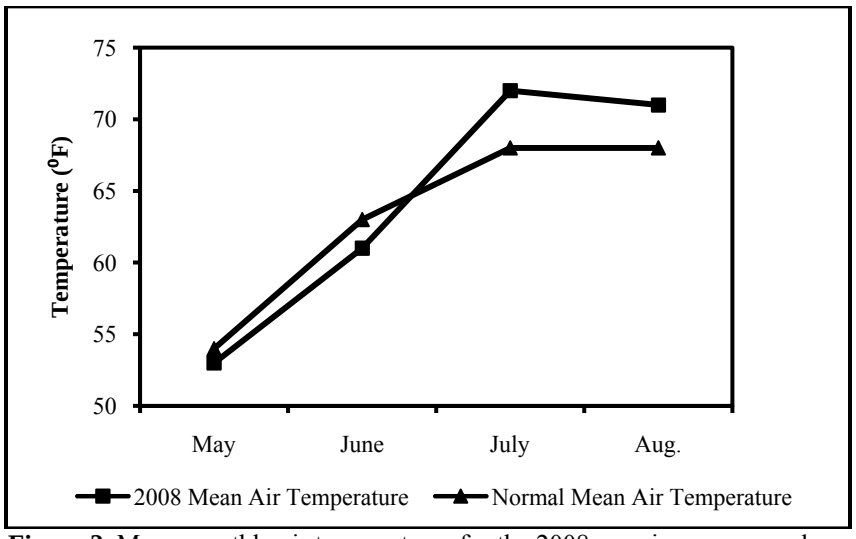

Figure 2. Mean monthly air temperatures for the 2008 growing season and annual averages for the period.

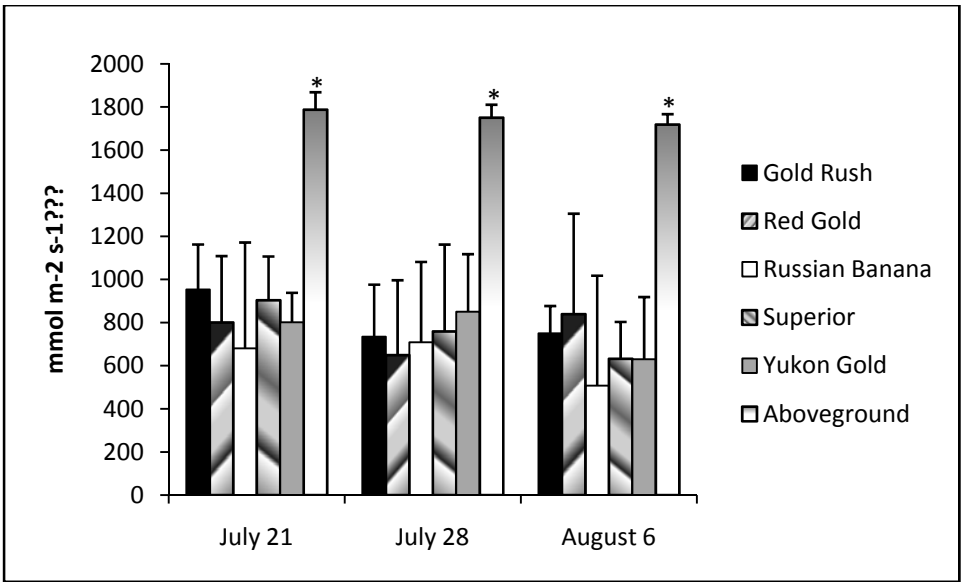

Figure 3. Photosynthetically active radiation as measured in potatoes on the three dates indicated. Asterisks denote significantly great above canopy PAR compared to all others on each date.

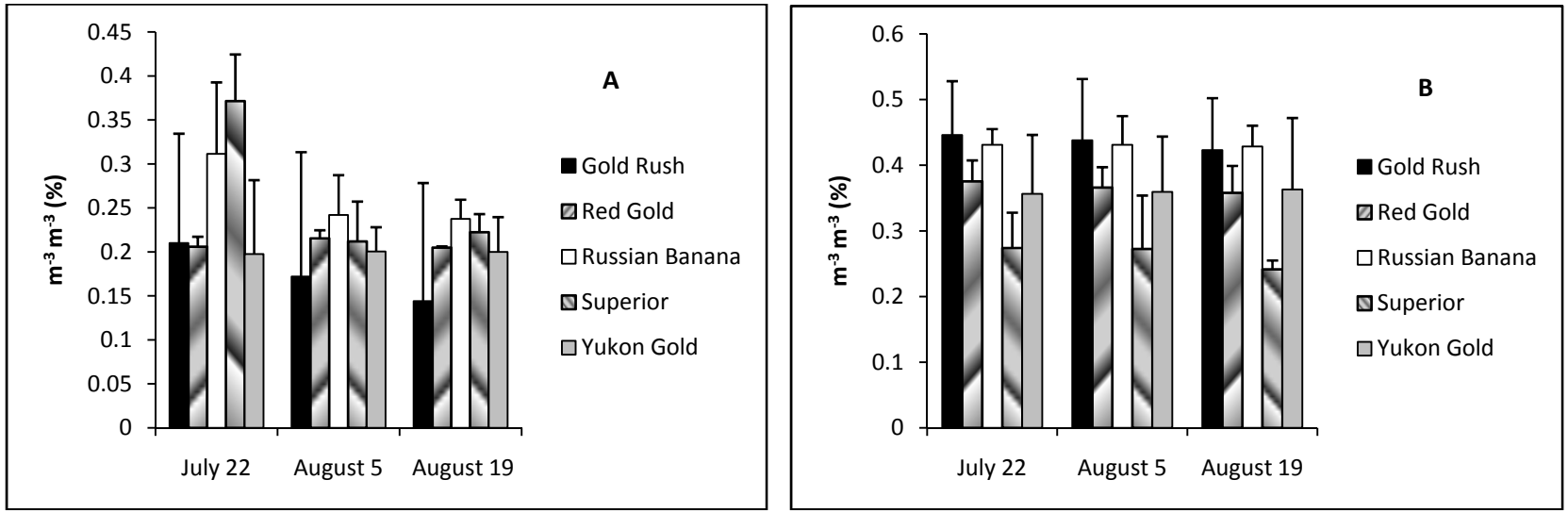

Figure 4. Volumetric water content at the (A) 3 inch and (B) 19 inch depth as measured in potatoes on the three dates indicated.

LITERATURE CITED

Brady, N.C. and R.R. Weil. 1999. The Nature and Properties of Soils. 12th ed. Prentice-Hall, Upper Saddle River, NJ, USA.

National Agricultural Statistics Service. National statistics on carrot production. Online at http://www.nass.usda.gov/QuickStats/index2.jsp. Accessed on March 27, 2009.

National Resources Conservation Service- Montana. Sandy Loam and Fine Sandy Loam Soils. Online at http://www.mt.nrcs.usda.gov/technical/ecs/agronomy/ soilmoisture/sandyloam.html. Accessed on March 27, 2009.

2008 Cultivar Trials of Bedding Plants

Barbara A. Laschkewitsch, M.S.
Trial Garden Coordinator

Ronald C. Smith, Ph.D.
Extension Horticulturist – Department of Plant Sciences

Introduction

The Plant Sciences Department at NDSU conducted performance trials on over 300 annual bedding plants during the 2008 growing season. The main research garden is located in Fargo, on the corner of 18th street and 12th avenue north. Two other sites are located at the Research Extension Centers in Dickinson and Williston, ND. Official entries (usually 150-200) are grown at all three sites while an additional 150-200 cultivars are also grown at the Fargo site.

The Horticulture Demonstration and Research plots in Fargo are for education, research and display purposes. Current gardens include the bedding plant trials, daylily display gardens and iris display gardens. Two small shade beds for annuals were added this year as well as pathways in the perennial area and a wheelchair accessible garden. Additional gardens being planned include a rose garden, an Indian garden, an area for vegetables and a sensory garden. The bedding plant trial is an official display garden of All-America Selections. The daylily garden is an official display garden of the American Hemerocallis Society and houses more than 1100 cultivars of daylilies, most of which are considered historical, or pre-1970, cultivars.

The beds are open to the public throughout the growing season and guided tours are available upon request. See 'Contact Information' on page 5 for more information.

Culture

The majority of the plants for the bedding plant trials are seeded in the horticulture and forestry greenhouse on the NDSU campus from January through April. When at the proper stage, seedlings are transplanted into cell packs containing a peat-based growing medium. Exceptions to this are entries from Fischer USA, Inc. which were received as rooted cuttings in March and finished in the greenhouses.

The Dickinson and Williston sites had six plants of each official cultivar tested while Fargo had twelve of each official cultivar, 12 plants of mixed cultivars, and 6 of the unofficial cultivars planted. The Dickinson beds were planted May 20 and the Williston beds on May 21. In Fargo, planting took place from May 28 until June 10. Rain during the first week in June delayed the Fargo planting a bit.

In Dickinson and Williston plants were watered in with Scotts Miracle-Gro® Liquafeed™ (12-4-8)[1] while Preen® Garden Weed Preventer Plus Fertilizer (9-17-9) was put down at the Fargo site. Preen was also put down at the Dickinson site. Fargo plants were fertilized once more in July with Miracle-Gro® Liquafeed™ while the Dickinson staff fertilized June 16 and July 30. Liquid iron was also applied to the *Verbena* and *Calibrachoa* in Dickinson to combat yellowing foliage.

Weeding was done by hand in Dickinson and Williston while Razor® and Preen® were used in Fargo along with hand-weeding.

The Dickinson site has overhead irrigation set up on a timer, while Williston and Fargo have drip irrigation applied as needed.

[1] Disclaimer-Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by NDSU or the North Dakota Agriculture Experiment Station is implied.

Site Information

Fargo

The main trial garden is located in Fargo at the corner of 18th street and 12th avenue north on the west side of campus. The majority of the annual beds are raised with a loam-compost mix of soil. Drip irrigation using t-tape is built into the beds.

Two shade beds for annuals were added into some trees on the site in 2008. This area will be expanded in the future. Wheelchair accessible gardens were also added and will be planted in spring 2009 with a mix of flowers and vegetables.

There were no major insect or disease problems at the Fargo site in 2008. Some Aster Yellows showed up late in the season on marigolds, vinca and some petunias.

As seen in table 1, temperatures in Fargo were slightly below average in May and June and slightly above average in July and August. Precipitation was especially heavy in June and August.

Table 1. 2008 and 1971-2000 May-August Average Temperature and Precipitation for Fargo, ND. [2]

	Average Temperature (°F)		Precipitation (inches)	
	2008	1971-2000	2008	Avg. 1971-2000
May	54	57.4	2.19	2.61
June	64	66.0	6.38	3.51
July	71	70.6	1.67	2.88
August	70	69.0	4.52	2.52

Dickinson

The Dickinson Trial garden is located at the Research Extension Center on the west side of State Street. The soil here is lighter and sandier than in Fargo and the weather tends to be drier. Shade plants are grown in raised beds under natural shade provided by trees.

[2] Temperature and precipitation data are from NDAWN and the National Climatic Data Center.

As last year, *Calibrachoa* in Dickinson declined after July and were all dead by the September evaluation. Other than that, there were no significant insect or disease problems.

As seen in table 2, temperatures were a bit below average in May and June but a bit above average in July and August. Rainfall was below average all summer.

Table 2. 2008 and 1971-2000 May-August Average Temperature and Precipitation for Dickinson, ND.

	Average Temperature (°F)		Precipitation (inches)	
	2008	1971-2000	2008	Avg. 1971-2000
May	53	53.4	1.70	2.24
June	61	62.4	2.04	3.57
July	72	68.1	1.70	2.20
August	71	67.3	0.74	1.65

Williston

The Williston Trial garden is located at the Research Extension Center on Highway 2 west of Williston. The soil here is also fairly light but heavier than in Dickinson. Drip irrigation is used for supplemental watering and shade plants are grown under the natural shade of pine trees.

There were no major insect or disease problems in the Williston beds. The geraniums were nice but did not perform as well this year as they have in the past.

Table 3 shows temperature and precipitation data for Williston.

Table 3. 2008 and 1971-2000 May-August Average Temperature and Precipitation for Williston, ND.

	Average Temperature (°F)		Precipitation (inches)	
	2008	1971-2000	2008	Avg. 1971-2000
May	54	57.1	1.38	2.09
June	62	65.7	2.13	2.72
July	72	71.1	0.78	2.45
August	70	70.2	1.30	1.63

All-America Selections

The NDSU trial garden is an official display garden of All-America Selections (AAS). AAS was founded in 1932 as a way for home gardeners to learn about new and improved varieties of flowers and vegetables. The red, white and blue AAS logo found on seed packets, in catalogs, and in garden articles usually indicates superior cultivars that have been tested in a variety of locations across the United States and Canada. The following are AAS winners grown at all three locations in 2008.

2004 Winners:
Celosia 'Fresh Look Red'
Celosia 'Fresh Look Yellow'
Gypsophila 'Gypsy Deep Rose'
Hollyhock 'Queeny Purple'
Petunia 'Limbo Violet'

2005 Winners:
Gaillardia aristata 'Arizona Sun'
Vinca 'First Kiss Blueberry'
Zinnia 'Magellan Coral'

2006 Winners:
Dianthus 'Supra Purple'
Diascia 'Diamonte Coral Rose'
Nicotiana 'Perfume Deep Purple'
Ornamental Pepper 'Black Pearl'
Salvia farinacea 'Evolution'
Viola F1 'Skippy XL Red-Gold'
Zinnia 'Zowie! Yellow Flame'

2007 Winners:
Celosia 'Fresh Look Gold'
Petunia 'Opera Supreme Pink Morn'
Vinca 'Pacifica Burgundy Halo'

2008 Winners:
Osteospermum 'Asti White'
Viola F1 'Skippy XL Plum Gold'

2009 Winner:
Viola 'Rain Blue and Purple'

Evaluations

Plants were evaluated twice over the growing season for height, spread, vigor, uniformity of size and bloom, and overall appearance. In Fargo, the first evaluation was July 29 while the second was September 8 & 9. The Dickinson evaluations were July 9 and September 4. Williston plants were evaluated July 10 and September 3.

If plants had good bloom but were lacking in size uniformity, there is an * preceding the height and spread measurement on the evaluation table for that site (pages 17-48). If the cultivar had good bloom, vigor and uniformity of size and bloom, there is ** preceding each height and spread measurement; and if a cultivar was an outstanding performer, there is *** preceding each height and spread measurement.

Top performers (*, **, or *** for **either** evaluation time) and star performers (*, ** or *** for **both** evaluation times) for each location are on pages 6-16 of the report. The following 12 cultivars got top ratings at all 3 locations for both evaluation times:

Begonia 'BIG Red Green Leaf'
Begonia 'BIG Rose Bronze Leaf'
Capsicum 'Calico'
Gaillardia 'Sunburst Burgundy Picotee'
Lobelia 'Techno Heat Upright Light Blue'
Osteospermum 'Tradewinds Deep Purple'
Pelargonium 'Americana Rose Mega Splash'
Pelargonium 'Avenida Mosaic Red'
Pelargonium 'Graffiti Double Salmon'
Verbena 'Lanai Lavender Star'
Verbena 'Lanai Royal Purple with Eye'
Verbena 'Lanai Upright Magenta'

Field Days

Field Days in Dickinson and Williston were held July 9 and July 10, respectively, in conjunction with field days at the research extension centers. Field day in Fargo was not held this year due to construction in the beds.

Acknowledgements

Many thanks go to supporters of the 2008 gardens: All-America Selections; Ball Seed Company; Ernst Benary of America, Inc.; Fischer, USA, Inc.; Grimes Seeds and Plants; and PanAmerican Seed. The support of these companies is greatly appreciated and we hope results from our efforts are beneficial in their research for new and improved cultivars.

Thanks also to Kris Ringwall and the staff at the Dickinson Research Extension Center, including retired county agent Jerry Larson; and Neil Riveland, Lorna Bradbury and the staff at the Williston Research Extension Center.

I'd also like to extend a special thank you to Ron Smith, extension horticulturist in the Plant Sciences Department at NDSU, and the Master Gardeners who volunteered their time in Fargo: Edna Holm, Margaret Loken, Gerri Elznic, Sandy Holbrook, Becky McCleary, Gayle Ferber, Linda Thorseth, Mary Beth Peterson and Kathy Johnson. Their help was appreciated more than they know. Without the assistance of so many talented and dedicated people, the bedding plant trials would not be possible.

A final thank you to Deb Tanner, publication coordinator/designer in Extension Agriculture Communication, who does a wonderful job designing the cover of the bedding plant trials cd.

Contacts

For more information about the bedding plant trials at North Dakota State University, please contact:

Barb Laschkewitsch
166 Loftsgard Hall
North Dakota State University
Fargo, ND 58105.

Phone: 701-231-7484

E-mail: barbara.laschkewitsch@ndsu.edu

Fargo Top Performers-2008

Top performers received *, **, or *** during **either** evaluation time as seen in the evaluations for each site (pp.17-48). Plants are listed in alphabetical order by genus.

July 29

Achillea 'Gypsy White'	*Cobaea* 'Royal Plum'	*Osteospermum* 'Asti White'
Acroclinium 'Best Mix'	*Coreopsis* 'Corey Yellow'	*Osteospermum* 'Tradewinds Deep Purple'
Agastache 'Golden Jubilee'	*Dianthus* 'Amazon Neon Duo'	*Osteospermum* 'Tradewinds Pearl White'
Agastache rupestins	*Dianthus* 'Amazon Neon Rose Magic'	*Osteospermum* 'Tradewinds Purple Bicolor'
Ageratum 'Patina Blue'	*Diascia* 'Darla Light Pink'	*Osteospermum* 'Tradewinds Yellow Bicolor'
Alternanthera 'Royal Tapestry'	*Diascia* 'Darla Rose 08'	*Pelargonium* (Geranium-Zonal) 'Americana Cherry Rose'
Angelonia 'Serena White'	*Diascia* 'Diamonte Coral Rose'	*Pelargonium* (Geranium-Zonal) 'Americana Cranberry Red'
Antirrhinum (Snapdragon) 'Frosted Sunset'	*Dorotheanthus* 'Mezoo Trailing Red'	*Pelargonium* (Geranium-Zonal) 'Americana Pink'
Antirrhinum (Snapdragon) 'Rocket Mix'	*Gaillardia* 'Sunburst Burgundy Picotee'	*Pelargonium* (Geranium-Zonal) 'Americana Red'
Antirrhinum (Snapdragon) 'Speedy Sonnet Rose'	*Gaillardia* 'Sunburst Scarlet Halo'	*Pelargonium* (Geranium-Zonal) 'Americana Rose Mega Splash'
Antirrhinum (Snapdragon) 'Speedy Sonnet White'	*Ipomoea* (Sweet Potato Vine) 'Blackie'	*Pelargonium* (Geranium-Zonal) 'Americana Salmon 09'
Begonia 'BIG Red Bronze Leaf'	*Ipomoea* (Sweet Potato Vine) 'Margarita'	*Pelargonium* (Geranium-Zonal) 'Americana Trailing Dark Red'
Begonia 'BIG Red Green Leaf'	*Ipomoea* (Sweet Potato Vine) 'Sidekick Black Heart'	*Pelargonium* (Geranium-Zonal) 'Americana Violet'
Begonia 'BIG Rose Bronze Leaf'	*Ipomoea* (Sweet Potato Vine) 'Sidekick Black Palmate'	*Pelargonium* (Geranium-Zonal) 'Americana White 09'
Bidens 'Mexican Gold'	*Ipomoea* (Sweet Potato Vine) 'Tricolor'	*Pelargonium* (Geranium-Zonal) 'Americana White Splash 09'
Bracteantha 'Strawburst Yellow'	*Ipomoea x multifida* (Cardinal Climber)	*Pelargonium* (Geranium-Zonal) 'Avenida Mosaic Red'
Calibrachoa 'Callie Coral Pink'	*Ipomoea* 'Star of Yelta'	*Pelargonium* (Geranium-Zonal) 'Black Velvet Appleblossom'
Calibrachoa 'Callie Deep Yellow'	*Juncus* 'Blue Arrows'	*Pelargonium* (Geranium-Zonal) 'Black Velvet Rose'
Calibrachoa 'Callie Gold with Red Eye'	*Juncus* 'Blue Dart'	*Pelargonium* (Geranium-Zonal) 'Black Velvet Salmon'
Calibrachoa 'Callie Light Blue'	*Lablab* (*Dolichos lablab*) (Purple Hyacinth Bean)	*Pelargonium* (Geranium-Zonal) 'Black Velvet Scarlet'
Calibrachoa 'Callie Painted Coral'	*Lathyrus* (Sweet Pea) 'Mammoth Scarlet'	*Pelargonium* (Geranium-Zonal) 'Eclipse Dark Red'
Calibrachoa 'Callie Peach'	*Laurentia* 'Avant-Garde Blue'	*Pelargonium* (Geranium-Zonal) 'Eclipse Light Salmon II'
Calibrachoa 'Callie Purple 07'	*Laurentia* 'Avant-Garde Pink'	*Pelargonium* (Geranium-Zonal) 'Eclipse Rose Mega Splash'
Calibrachoa 'Callie Rose'	*Limonium* (Statice) 'Soiree Mix'	*Pelargonium* (Geranium-Zonal) 'Eclipse Velvet Red'
Calibrachoa 'Callie Scarlet Red 08'	*Limonium* (Statice) 'Supreme Extra Pastel Mix'	*Pelargonium* (Geranium-Exotic) 'Graffiti Double Red'
Canna 'Tropical Sunrise'	*Lobelia* 'Techno Heat Dark Blue'	*Pelargonium* (Geranium-Exotic) 'Graffiti Double Salmon'
Capsicum (Ornamental Pepper) 'Calico'	*Lobelia* 'Techno Heat Electric Blue'	*Pelargonium* (Geranium-Zonal) 'Orange Appeal'
Capsicum (Ornamental Pepper) 'Variegated'	*Lobelia* 'Techno Heat Upright Light Blue'	*Pelargonium* (Geranium-Zonal) 'Orbit Appleblossom'
Catharanthus (Vinca) 'Nirvana Red'	*Mirabilis* (Four-O-Clocks) 'Broken Colors'	*Pelargonium* (Geranium-Zonal) 'Orbit Deep Salmon'
Catharanthus (Vinca) 'Pacifica Burgundy Halo'	*Mirabilis* (Four-O-Clocks) 'Limelight'	*Pelargonium* (Geranium-Zonal) 'Orbit Pink'
Catharanthus (Vinca) 'Pacifica Magenta Halo XP'	*Nolana* 'Sun Belle Mix'	*Pelargonium* (Geranium-Zonal) 'Orbit Red'

Fargo Top Performers-2008

Top performers received *, **, or *** during **either** evaluation time as seen in the evaluations for each site (pp.17-48). Plants are listed in alphabetical order by genus.

July 29 (cont.)

Pelargonium (Geranium-Zonal) 'Orbit Rose'	*Petunia* (Large-flowered Trailing) 'Jamboree Blue'	*Rudbeckia* (Black-eyed Susan) 'Tiger Eye Gold'
Pelargonium (Geranium-Zonal) 'Orbit Scarlet'	*Petunia* (Large-flowered Trailing) 'Jamboree Burgundy'	*Salvia farinacea* 'Evolution'
Pelargonium (Geranium-Zonal) 'Orbit Violet'	*Petunia* (Large-flowered Trailing) 'Jamboree Lavender II'	*Salvia farinacea* 'Fahrenheit Violet'
Pelargonium (Geranium-Zonal) 'Orbit White Improved'	*Petunia* (Large-flowered Trailing) 'Jamboree Light Blue'	*Salvia farinacea* 'Victoria'
Pelargonium (Geranium-Zonal) 'Rocky Mountain Coral'	*Petunia* (Spreading) 'Lavender Wave'	*Salvia splendens* 'Flare'
Pelargonium (Geranium-Zonal) 'Rocky Mountain Dark Red'	*Petunia* (Grandiflora) 'Limbo Violet'	*Salvia splendens* 'Vista Rose'
Pelargonium (Geranium-Zonal) 'Rocky Mountain Deep Rose 09'	*Petunia* (Spreading) 'LoGro White'	*Stipa* 'Ponytails'
Pelargonium (Geranium-Zonal) 'Rocky Mountain Magenta'	*Petunia* (Spreading) 'LoGro Yellow'	*Tagetes erecta* (Marigold) 'Inca Gold'
Pelargonium (Geranium-Zonal) 'Rocky Mountain Salmon 08'	*Petunia* (Floribunda) 'Madness Plum Crazy Improved'	*Tagetes erecta* (Marigold) 'Inca Orange'
Pelargonium (Geranium-Zonal) 'Rocky Mountain Violet'	*Petunia* (Floribunda) 'Madness Red Improved'	*Tagetes erecta* (Marigold) 'Inca Primrose'
Pelargonium (Geranium-Zonal) 'Tango Coral'	*Petunia* (Floribunda) 'Madness Yellow'	*Tagetes erecta* (Marigold) 'Inca Yellow'
Pelargonium (Geranium-Zonal) 'Tango Red 09'	*Petunia* (Multiflora) 'Merlin Blue Morn'	*Tagetes erecta* (Marigold) 'Moonstruck Orange'
Pelargonium interspecific (Geranium-Hybrid) 'Caliente Coral'	*Petunia* (Spreading) 'Misty Lilac Wave'	*Tagetes erecta* (Marigold) 'Parks Whopper Gold'
Pelargonium interspecific (Geranium-Hybrid) 'Caliente Lavender'	*Petunia* (Trailing grandiflora) 'Opera Supreme Lilac Ice'	*Tagetes erecta* (Marigold) 'Park's Whopper Orange'
Pelargonium interspecific (Geranium-Hybrid) 'Caliente Rose'	*Petunia* (Spreading) 'Opera Supreme Pink Morn'	*Tagetes erecta* (Marigold) 'Park's Whopper Yellow'
Pelargonium peltatum (Ivy Geranium) 'Acapulco Compact Cascade'	*Petunia* (Spreading) 'Pink Wave'	*Tagetes erecta* (Marigold) 'Vanilla'
Pelargonium peltatum (Ivy Geranium) 'Beach'	*Petunia* (Spreading) 'Purple Wave'	*Tagetes patula x erecta* (Hybrid Marigold) 'Daisy Orange-Red'
Pelargonium peltatum (Ivy Geranium) 'Blizzard Pink'	*Petunia* (Spreading) 'Shock Wave Ivory'	*Tagetes patula x erecta* (Hybrid Marigold) 'Sunburst Orange'
Pelargonium peltatum (Ivy Geranium) 'Compact Burgundy'	*Petunia* (Spreading) 'Shock Wave Pink Vein'	*Tagetes patula x erecta* (Hybrid Marigold) 'Zenith Red'
Pennisetum (Fountain Grass)	*Petunia* (Spreading) 'Shock Wave Purple'	*Talinum* 'Limon'
Petunia (Spreading) 'Baby Duck Yellow'	*Petunia* (Spreading) 'Shock Wave Rose'	*Thunbergia* (Black-eyed Susan Vine) 'Mix'
Petunia (Spreading) 'Blue Wave'	*Petunia* (Hedgiflora) 'Tidal Wave Silver'	*Thymophylla* (Dahlberg Daisy)
Petunia (Multiflora) 'Carpet Pink Improved'	*Petunia* (Grandiflora) 'Ultra Crimson Star'	*Tropaeolum* (Nasturtium) 'Alaska Gold'
Petunia (Floribunda) 'Celebrity Blue Improved'	*Petunia* (Supertunia) 'Vista Bubblegum'	*Verbena bonariensis*
Petunia (Grandiflora) 'Dreams Fuchsia'	*Petunia* (Mini-flowered Trailing) 'Whispers Blue'	*Verbena x hybrida* 'Escapade Bright Eye'
Petunia (Grandiflora) 'Dreams DayDreams Mix'	*Petunia* (Mini-flowered Trailing) 'Whispers Bright Pink'	*Verbena x hybrida* 'Escapade Pink'
Petunia (Grandiflora) 'Dreams Rose Morn'	*Petunia* (Mini-flowered Trailing) 'Whispers Rose Vein'	*Verbena x hybrida* 'Lanai Blush White'
Petunia (Spreading) 'Easy Wave Mystic Pink'	*Petunia* (Mini-flowered Trailing) 'Whispers White'	*Verbena x hybrida* 'Lanai Bright Pink'
Petunia (Spreading) 'Easy Wave Pink Marble Mix'	*Plectranthus* 'Silver Shield'	*Verbena x hybrida* 'Lanai Lavender Star'
Petunia (Spreading) 'Easy Wave Red'	*Rudbeckia* (Black-eyed Susan) 'Prairie Sun'	*Verbena x hybrida* 'Lanai Peach'
Petunia (Spreading) 'Easy Wave Rosy Dawn'	*Rudbeckia* (Black-eyed Susan) 'Radiance'	*Verbena x hybrida* 'Lanai Royal Purple with Eye'

Fargo Top Performers-2008

Top performers received *, **, or *** during **either** evaluation time as seen in the evaluations for each site (pp.17-48). Plants are listed in alphabetical order by genus.

July 29 (cont.)

Verbena x hybrida 'Lanai Upright Magenta'	*Verbena x hybrida* 'Quartz XP Silver'	*Verbena tenuisecta* 'Imagination'
Verbena x hybrida 'Lanai Upright Violet'	*Verbena x hybrida* 'Quartz XP White'	*Zinnia elegans* 'Magellan Coral'
Verbena x hybrida 'Quartz XP Purple'	*Verbena x hybrida* 'Rapunzel Lilac'	*Zinnia elegans* 'Uproar Rose'
Verbena x hybrida 'Quartz XP Red Eye'	*Verbena x hybrida* 'Rapunzel Violet'	*Zinnia* hybrid 'Profusion Knee-High White'

Fargo Top Performers-2008

Top performers received *, **, or *** during **either** evaluation time as seen in the evaluations for each site (pp.17-48). Plants are listed in alphabetical order by genus.

September 8 & 9

Agastache cana 'Purple Pigmy'	*Dianthus barbatus* 'Amazon Neon Rose Magic'	*Mirabilis* (Four-O-Clocks) 'Broken Colors'
Agastache foeniculum 'Golden Jubilee'	*Dianthus superbus* 'Kawara Pink'	*Mirabilis* (Four-O-Clocks) 'Limelight'
Agastache rupestins	*Diascia* 'Darla Light Pink'	*Osteospermum* 'Asti White'
Ageratum 'Patina Blue'	*Dichondra* 'Silver Falls'	*Osteospermum* 'Tradewinds Deep Purple'
Alcea (Hollyhock) 'Queeny Purple'	*Dorotheanthus* 'Mezoo Trailing Red'	*Osteospermum* 'Tradewinds Pearl White'
Alternanthera 'Royal Tapestry'	*Gaillardia* 'Arizona Sun'	*Osteospermum* 'Tradewinds Yellow Bicolor'
Angelonia 'Serena Lavender'	*Gaillardia* 'Sunburst Burgundy Picotee'	*Pelargonium* (Geranium-Zonal) 'Americana Cherry Rose'
Angelonia 'Serena White'	*Gaillardia* 'Sunburst Scarlet Halo'	*Pelargonium* (Geranium-Zonal) 'Americana Cranberry Red'
Begonia 'BIG Red Green Leaf'	*Gomphrena globosa* 'Purple Gomp'	*Pelargonium* (Geranium-Zonal) 'Americana Pink'
Begonia 'BIG Rose Bronze Leaf'	*Gomphrena haageana* 'Strawberry Fields'	*Pelargonium* (Geranium-Zonal) 'Americana Red'
Bracteantha 'Strawburst Yellow'	*Helenium* 'Goldfield'	*Pelargonium* (Geranium-Zonal) 'Americana Rose Mega Splash'
Calibrachoa 'Callie Peach'	*Ipomoea* (Sweet Potato Vine) 'Margarita'	*Pelargonium* (Geranium-Zonal) 'Americana Salmon 09'
Calibrachoa 'Callie Purple 07'	*Ipomoea* (Sweet Potato Vine) 'Sidekick Black Heart'	*Pelargonium* (Geranium-Zonal) 'Americana Violet'
Calibrachoa 'Callie Rose'	*Ipomoea* (Sweet Potato Vine) 'Sidekick Black Palmate'	*Pelargonium* (Geranium-Zonal) 'Americana White 09'
Canna 'Bengal Tiger'	*Ipomoea* (Sweet Potato Vine) 'Tricolor'	*Pelargonium* (Geranium-Zonal) 'Americana White Splash 09'
Canna 'Lucifer'	*Juncus effusus* 'Spiralis' (Corkscrew Plant)	*Pelargonium* (Geranium-Zonal) 'Avenida Mosaic Red'
Canna 'Tropical Sunrise'	*Juncus inflexus* 'Blue Arrows'	*Pelargonium* (Geranium-Zonal) 'Black Velvet Appleblossom'
Canna 'Wyoming Dwarf'	*Juncus inflexus* 'Hedgehog'	*Pelargonium* (Geranium-Zonal) 'Black Velvet Rose'
Capsicum (Ornamental Pepper) 'Black Pearl'	*Juncus pallidus* 'Javelin'	*Pelargonium* (Geranium-Zonal) 'Black Velvet Salmon'
Capsicum (Ornamental Pepper) 'Calico'	*Juncus tenuis* 'Blue Dart'	*Pelargonium* (Geranium-Zonal) 'Black Velvet Scarlet'
Capsicum (Ornamental Pepper) 'Purple Flash'	*Lablab* (*Dolichos lablab*) (Purple Hyacinth Bean)	*Pelargonium* (Geranium-Zonal) 'Eclipse Light Salmon II'
Capsicum (Ornamental Pepper) 'Variegated'	*Lantana* 'Bandana Cherry'	*Pelargonium* (Geranium-Zonal) 'Eclipse Velvet Red'
Catharanthus (Vinca) 'Nirvana Red'	*Lantana* 'Bandana Pink 07'	*Pelargonium* (Geranium-Exotic) 'Graffiti Double Salmon'
Catharanthus (Vinca) 'Nirvana Violet'	*Lantana* 'Bandana Red'	*Pelargonium* (Geranium-Zonal) 'Orbit Deep Salmon'
Catharanthus (Vinca) 'Pacifica Burgundy Halo'	*Lantana* 'Bandana Rose'	*Pelargonium* (Geranium-Zonal) 'Orbit Red'
Catharanthus (Vinca) 'Pacifica Magenta Halo XP'	*Laurentia* 'Avant-Garde Blue'	*Pelargonium* (Geranium-Zonal) 'Orbit Scarlet'
Catharanthus (Vinca) 'Titan Pure White'	*Laurentia* 'Avant-Garde Pink'	*Pelargonium* (Geranium-Zonal) 'Orbit White Improved'
Celosia plumosa 'Fresh Look Gold'	*Laurentia* 'Avant-Garde White'	*Pelargonium* (Geranium-Zonal) 'Rocky Mountain Coral'
Celosia plumosa 'Fresh Look Red'	*Limonium* (Statice) 'Soiree Mix'	*Pelargonium* (Geranium-Zonal) 'Rocky Mountain Dark Red'
Celosia plumosa 'Fresh Look Yellow'	*Limonium* (Statice) 'Supreme Extra Pastel Mix'	*Pelargonium* (Geranium-Zonal) 'Rocky Mountain Deep Rose 09'
Celosia spicata 'Flamingo Purple'	*Lobelia* 'Techno Heat Upright Light Blue'	*Pelargonium* (Geranium-Zonal) 'Rocky Mountain Magenta'

Fargo Top Performers-2008

Top performers received *, **, or *** during **either** evaluation time as seen in the evaluations for each site (pp.17-48). Plants are listed in alphabetical order by genus.

September 8 & 9 (cont.)

Pelargonium (Geranium-Zonal) 'Rocky Mountain Salmon 08'	*Salvia farinacea* 'Fahrenheit Violet'	*Verbena x hybrida* 'Lanai Peach'
Pelargonium (Geranium-Zonal) 'Rocky Mountain Violet'	*Salvia farinacea* 'Victoria'	*Verbena x hybrida* 'Lanai Purple Star'
Pelargonium (Geranium-Zonal) 'Tango Coral'	*Salvia splendens* 'Whopper Lighthouse'	*Verbena x hybrida* 'Lanai Royal Purple with Eye'
Pennisetum (Fountain Grass)	*Spilanthes* 'Peek-A-Boo'	*Verbena x hybrida* 'Lanai Upright Magenta'
Pentas 'Northern Lights Lavender'	*Stipa* 'Ponytails'	*Verbena x hybrida* 'Lanai Upright Violet'
Petunia (Floribunda) 'Celebrity Blue Improved'	*Tagetes erecta* (Marigold) 'Parks Whopper Gold'	*Verbena x hybrida* 'Rapunzel Lilac'
Petunia (Large-flowered Trailing) 'Jamboree Burgundy'	*Tagetes erecta* (Marigold) 'Park's Whopper Orange'	*Verbena x hybrida* 'Rapunzel Violet'
Petunia (Large-flowered Trailing) 'Jamboree Light Blue'	*Tagetes erecta* (Marigold) 'Vanilla'	*Verbena rigida* 'Rigida Rose'
Petunia (Spreading) 'Lavender Wave'	*Tagetes patula x erecta* (Hybrid Marigold) 'Zenith Red'	*Zinnia elegans* 'Magellan Coral'
Petunia (Hedgiflora) 'Tidal Wave Silver'	*Talinum* 'Limon'	*Zinnia elegans* 'Zowie! Yellow Flame'
Petunia (Supertunia) 'Vista Bubblegum'	*Thunbergia* (Black-eyed Susan Vine) 'Mix'	*Zinnia elegans* 'Uproar Rose'
Petunia (Mini-flowered Trailing) 'Whispers Blue'	*Tropaeolum* (Nasturtium) 'Alaska Gold'	*Zinnia* hybrid 'Profusion Knee-High Red'
Plectranthus 'Silver Shield'	*Verbena bonariensis*	*Zinnia* hybrid 'Profusion Knee-High White'
Rudbeckia (Black-eyed Susan) 'Tiger Eye Gold'	*Verbena x hybrida* 'Escapade Pink'	*Zinnia Marylandica* 'Zahara Coral Rose'
Salvia farinacea 'Evolution'	*Verbena x hybrida* 'Lanai Lavender Star'	*Zinnia Marylandica* 'Zahara Yellow'

Dickinson Top Performers-2008

Top performers received *, **, or *** during **either** evaluation time as seen in the evaluations for each site (pp. 17-48). Plants are listed in alphabetical order by genus.

July 9

Begonia 'BIG Red Bronze Leaf'	*Nicotiana* (Flowering Tobacco) 'Perfume Deep Purple'	*Pelargonium* (Geranium-Zonal) 'Rocky Mountain Deep Rose 09'
Begonia 'BIG Red Green Leaf'	*Osteospermum* 'Tradewinds Deep Purple'	*Pelargonium* (Geranium-Zonal) 'Tango Magenta'
Begonia 'BIG Rose Bronze Leaf'	*Osteospermum* 'Tradewinds Pearl White'	*Pelargonium* (Geranium-Zonal) 'Tango White'
Bidens 'Mexican Gold'	*Osteospermum* 'Tradewinds Purple Bicolor'	*Pelargonium* interspecific (Geranium-Hybrid) 'Caliente Coral'
Bracteantha 'Strawburst Yellow'	*Osteospermum* 'Tradewinds Yellow Bicolor'	*Pelargonium* interspecific (Geranium-Hybrid) 'Caliente Lavender'
Capsicum (Ornamental Pepper) 'Calico'	*Pelargonium* (Geranium-Zonal) 'Americana Cherry Rose'	*Pelargonium* interspecific (Geranium-Hybrid) 'Caliente Rose'
Celosia 'Fresh Look Red'	*Pelargonium* (Geranium-Zonal) 'Americana Cranberry Red'	*Pelargonium peltatum* (Ivy Geranium) 'Acapulco Compact Cascade'
Coreopsis 'Corey Yellow'	*Pelargonium* (Geranium-Zonal) 'Americana Rose Mega Splash'	*Pelargonium peltatum* (Ivy Geranium) 'Blizzard Pink'
Dianthus F1 'Supra Purple'	*Pelargonium* (Geranium-Zonal) 'Americana Salmon 09'	*Pelargonium peltatum* (Ivy Geranium) 'Lambada Hot Pink'
Diascia barberae 'Darla Light Pink'	*Pelargonium* (Geranium-Zonal) 'Americana Violet'	*Petunia* (Large-flowered Trailing) 'Jamboree Lavender II'
Diascia barberae 'Darla Rose 08'	*Pelargonium* (Geranium-Zonal) 'Americana White Splash 09'	*Petunia* (Grandiflora) 'Limbo Violet'
Gaillardia 'Sunburst Burgundy Picotee'	*Pelargonium* (Geranium-Zonal) 'Avenida Mosaic Red'	*Tagetes patula x erecta* (Hybrid Marigold) 'Daisy Orange-Red'
Gaillardia 'Sunburst Scarlet Halo'	*Pelargonium* (Geranium-Zonal) 'Eclipse Dark Red'	*Verbena* 'Lanai Lavender Star'
Juncus 'Blue Dart'	*Pelargonium* (Geranium-Zonal) 'Eclipse Rose Mega Splash'	*Verbena* 'Lanai Royal Purple with Eye'
Lobelia 'Techno Heat Dark Blue'	*Pelargonium* (Geranium-Exotic) 'Graffiti Double Salmon'	*Verbena* 'Lanai Upright Magenta'
Lobelia 'Techno Heat Electric Blue'	*Pelargonium* (Geranium-Zonal) 'Rocky Mountain Coral'	*Zinnia elegans* 'Zowie! Yellow Flame'
Lobelia 'Techno Heat Upright Dark Blue'	*Pelargonium* (Geranium-Zonal) 'Rocky Mountain Dark Red'	*Zinnia Marylandica* 'Zahara Yellow'
Lobelia 'Techno Heat Upright Light Blue'		

Dickinson Top Performers-2008

Top performers received *, **, or *** during **either** evaluation time as seen in the evaluations for each site (pp. 17-48). Plants are listed in alphabetical order by genus.

September 4

Ageratum 'Patina Blue'	*Osteospermum* 'Tradewinds Pearl White'	*Petunia* (Spreading) 'LoGro Yellow'
Begonia 'BIG Red Bronze Leaf'	*Osteospermum* 'Tradewinds Purple Bicolor'	*Petunia* (Spreading) 'Opera Supreme Pink Morn'
Begonia 'BIG Red Green Leaf'	*Pelargonium* (Geranium-Zonal) 'Americana Cherry Rose'	*Petunia* (Mini-flowered Trailing) 'Whispers Blue'
Begonia 'BIG Rose Bronze Leaf'	*Pelargonium* (Geranium-Zonal) 'Americana Rose Mega Splash'	*Petunia* (Mini-flowered Trailing) 'Whispers Rose Vein'
Bidens 'Mexican Gold'	*Pelargonium* (Geranium-Zonal) 'Americana Trailing Dark Red'	*Salvia farinacea* 'Evolution'
Capsicum (Ornamental Pepper) 'Black Pearl'	*Pelargonium* (Geranium-Zonal) 'Avenida Mosaic Red'	*Salvia farinacea* 'Fahrenheit Violet'
Capsicum (Ornamental Pepper) 'Calico'	*Pelargonium* (Geranium-Zonal) 'Eclipse Dark Red'	*Verbena x hybrida* 'Escapade Bright Eye'
Catharanthus (Vinca) 'First Kiss Blueberry'	*Pelargonium* (Geranium-Zonal) 'Eclipse Velvet Red'	*Verbena x hybrida* 'Escapade Pink'
Catharanthus (Vinca) 'Nirvana Pink Blush'	*Pelargonium* (Geranium-Exotic) 'Graffiti Double Red'	*Verbena x hybrida* 'Lanai Blush White'
Catharanthus (Vinca) 'Nirvana Violet'	*Pelargonium* (Geranium-Exotic) 'Graffiti Double Salmon'	*Verbena x hybrida* 'Lanai Bright Pink'
Catharanthus (Vinca) 'Pacifica Magenta Halo XP'	*Pelargonium* (Geranium-Zonal) 'Rocky Mountain Dark Red'	*Verbena x hybrida* 'Lanai Lavender Star'
Catharanthus (Vinca) 'Pacifica White XP'	*Pelargonium* (Geranium-Zonal) 'Rocky Mountain Salmon 08'	*Verbena x hybrida* 'Lanai Peach'
Celosia 'Fresh Look Gold'	*Pelargonium x hortorum* (Geranium-Zonal) 'Tango Red 09'	*Verbena x hybrida* 'Lanai Purple Star'
Celosia 'Fresh Look Red'	*Pelargonium* interspecific (Geranium-Hybrid) 'Caliente Coral'	*Verbena x hybrida* 'Lanai Royal Purple with Eye'
Celosia 'Fresh Look Yellow'	*Pelargonium* interspecific (Geranium-Hybrid) 'Caliente Lavender'	*Verbena x hybrida* 'Lanai Upright Magenta'
Gaillardia 'Arizona Sun'	*Pelargonium* interspecific (Geranium-Hybrid) 'Caliente Rose'	*Verbena x hybrida* 'Lanai Upright Violet'
Gaillardia 'Sunburst Burgundy Picotee'	*Pelargonium peltatum* (Ivy Geranium) 'Acapulco Compact Cascade'	*Verbena x hybrida* 'Rapunzel Lilac'
Ipomoea (Sweet Potato Vine) 'Sidekick Black Heart'	*Pelargonium peltatum* (Ivy Geranium) 'Beach'	*Verbena x hybrida* 'Rapunzel Violet'
Ipomoea (Sweet Potato Vine) 'Sidekick Black Palmate'	*Pelargonium peltatum* (Ivy Geranium) 'Blizzard Pink'	*Verbena rigida* 'Rigida Rose'
Juncus 'Blue Dart'	*Pentas* 'Northern Lights Lavender'	*Zinnia elegans* 'Magellan Coral'
Lantana 'Bandana Rose'	*Petunia* (Large-flowered Trailing) 'Jamboree Blue'	*Zinnia elegans* 'Zowie! Yellow Flame'
Lobelia 'Techno Heat Electric Blue'	*Petunia* (Large-flowered Trailing) 'Jamboree Burgundy'	*Zinnia Marylandica* 'Zahara Coral Rose'
Lobelia 'Techno Heat Upright Light Blue'	*Petunia* (Large-flowered Trailing) 'Jamboree Lavender II'	*Zinnia Marylandica* 'Zahara Scarlet'
Nicotiana (Flowering Tobacco) 'Perfume Deep Purple'	*Petunia* (Large-flowered Trailing) 'Jamboree Light Blue'	*Zinnia Marylandica* 'Zahara White'
Osteospermum 'Tradewinds Deep Purple'	*Petunia* (Grandiflora) 'Limbo Violet'	*Zinnia Marylandica* 'Zahara Yellow'

Williston Top Performers-2008

Top performers received *, **, or *** during **either** evaluation time as seen in the evaluations for each site (pp. 17-48). Plants are listed in alphabetical order by genus.

July 10

Achillea 'Gypsy White'	*Pelargonium* (Geranium-Zonal) 'Americana Cranberry Red'	*Petunia* (Large-flowered Trailing) 'Jamboree Blue'
Ageratum 'Patina Blue'	*Pelargonium* (Geranium-Zonal) 'Americana Pink'	*Petunia* (Large-flowered Trailing) 'Jamboree Burgundy'
Begonia 'BIG Red Bronze Leaf'	*Pelargonium* (Geranium-Zonal) 'Americana Rose Mega Splash'	*Petunia* (Large-flowered Trailing) 'Jamboree Lavender II'
Begonia 'BIG Red Green Leaf'	*Pelargonium* (Geranium-Zonal) 'Americana Salmon 09'	*Petunia* (Large-flowered Trailing) 'Jamboree Light Blue'
Begonia 'BIG Rose Bronze Leaf'	*Pelargonium* (Geranium-Zonal) 'Americana Trailing Dark Red'	*Petunia* (Grandiflora) 'Limbo Violet'
Bidens 'Mexican Gold'	*Pelargonium* (Geranium-Zonal) 'Americana Violet'	*Petunia* (Spreading) 'LoGro Yellow'
Calibrachoa 'Callie Painted Coral'	*Pelargonium* (Geranium-Zonal) 'Americana White Splash'	*Petunia* (Spreading) 'Opera Supreme Pink Morn'
Capsicum (Ornamental Pepper) 'Calico'	*Pelargonium* (Geranium-Zonal) 'Avenida Mosaic Red'	*Petunia* (Mini-flowered Trailing) 'Whispers Blue'
Coreopsis 'Corey Yellow'	*Pelargonium* (Geranium-Zonal) 'Eclipse Dark Red'	*Petunia* (Mini-flowered Trailing) 'Whispers Bright Pink'
Diascia 'Darla Light Pink'	*Pelargonium* (Geranium-Zonal) 'Eclipse Light Salmon II'	*Petunia* (Mini-flowered Trailing) 'Whispers Rose Vein'
Diascia 'Darla Rose 08'	*Pelargonium* (Geranium-Zonal) 'Eclipse Rose Mega Splash'	*Petunia* (Mini-flowered Trailing) 'Whispers White'
Diascia 'Diamonte Coral Rose'	*Pelargonium* (Geranium-Zonal) 'Eclipse Velvet Red'	*Tagetes patula x erecta* (Hybrid Marigold) 'Daisy Orange-Red'
Gaillardia 'Sunburst Burgundy Picotee'	*Pelargonium* (Geranium-Exotic) 'Graffiti Double Red'	*Verbena* 'Escapade Bright Eye'
Gaillardia 'Sunburst Scarlet Halo'	*Pelargonium* (Geranium-Exotic) 'Graffiti Double Salmon'	*Verbena* 'Escapade Pink'
Gypsophila (Baby's Breath) 'Gypsy Deep Rose'	*Pelargonium* (Geranium-Zonal) 'Rocky Mountain Coral'	*Verbena* 'Lanai Blush White'
Ipomoea (Sweet Potato Vine) 'Sidekick Black Heart'	*Pelargonium* (Geranium-Zonal) 'Rocky Mountain Dark Red'	*Verbena* 'Lanai Bright Pink'
Juncus 'Blue Dart'	*Pelargonium* (Geranium-Zonal) 'Rocky Mountain Deep Rose 09'	*Verbena* 'Lanai Lavender Star'
Lobelia 'Techno Heat Dark Blue'	*Pelargonium* (Geranium-Zonal) 'Rocky Mountain Magenta'	*Verbena* 'Lanai Royal Purple with Eye'
Lobelia 'Techno Heat Electric Blue'	*Pelargonium* (Geranium-Zonal) 'Rocky Mountain Salmon 08'	*Verbena* 'Lanai Upright Magenta'
Lobelia 'Techno Heat Upright Dark Blue'	*Pelargonium* (Geranium-Zonal) 'Rocky Mountain Violet'	*Verbena* 'Lanai Upright Violet'
Lobelia 'Techno Heat Upright Light Blue'	*Pelargonium* (Geranium-Zonal) 'Tango Coral'	*Verbena* 'Rapunzel Lilac'
Osteospermum 'Tradewinds Deep Purple'	*Pelargonium* interspecific (Geranium-Hybrid) 'Caliente Coral'	*Verbena* 'Rapunzel Violet'
Osteospermum 'Tradewinds Pearl White'	*Pelargonium* interspecific (Geranium-Hybrid) 'Caliente Lavender'	*Viola* F1 'Skippy XL Plum-Gold'
Osteospermum 'Tradewinds Purple Bicolor'	*Pelargonium peltatum* (Ivy Geranium) 'Acapulco Compact Cascade'	*Viola* F1 'Skippy XL Red-Gold'
Osteospermum 'Tradewinds Yellow Bicolor'	*Pelargonium peltatum* (Ivy Geranium) 'Blizzard Pink'	*Viola* F1 'Rain Blue and Purple'
Pelargonium (Geranium-Zonal) 'Americana Cherry Rose'		

Williston Top Performers-2008

Top performers received *, **, or *** during **either** evaluation time as seen in the evaluations for each site (pp. 17-48). Plants are listed in alphabetical order by genus.

September 3

Alcea (Hollyhock) 'Queeny Purple'	*Lantana* 'Bandana Rose'	*Petunia* (Spreading) 'LoGro Yellow'
Begonia 'BIG Red Bronze Leaf'	*Lobelia* 'Techno Heat Upright Light Blue'	*Petunia* (Spreading) 'Opera Supreme Pink Morn'
Begonia 'BIG Red Green Leaf'	*Nicotiana* 'Perfume Deep Purple'	*Petunia* (Mini-flowered Trailing) 'Whispers Blue'
Begonia 'BIG Rose Bronze Leaf'	*Osteospermum* 'Tradewinds Deep Purple'	*Petunia* (Mini-flowered Trailing) 'Whispers Rose Vein'
Bidens 'Mexican Gold'	*Osteospermum* 'Tradewinds Purple Bicolor'	*Petunia* (Mini-flowered Trailing) 'Whispers White'
Bracteantha 'Strawburst Yellow'	*Pelargonium* (Geranium-Zonal) 'Americana Rose Mega Splash'	*Salvia farinacea* 'Evolution'
Capsicum (Ornamental Pepper) 'Black Pearl'	*Pelargonium* (Geranium-Zonal) 'Americana White 09'	*Salvia farinacea* 'Fahrenheit Violet'
Capsicum (Ornamental Pepper) 'Calico'	*Pelargonium* (Geranium-Zonal) 'Avenida Mosaic Red'	*Tagetes patula x erecta* (Hybrid Marigold) 'Daisy Orange-Red'
Catharanthus (Vinca) 'Nirvana Red'	*Pelargonium* (Geranium-Zonal) 'Eclipse Light Salmon II'	*Verbena* 'Escapade Pink'
Catharanthus (Vinca) 'Nirvana Violet'	*Pelargonium* (Geranium-Zonal) 'Eclipse Velvet Red'	*Verbena* 'Lanai Blush White'
Catharanthus (Vinca) 'Nirvana White'	*Pelargonium* (Geranium-Exotic) 'Graffiti Double Salmon'	*Verbena* 'Lanai Bright Pink'
Catharanthus (Vinca) 'Pacifica Burgundy Halo'	*Pelargonium* (Geranium-Zonal) 'Rocky Mountain Deep Rose 09'	*Verbena* 'Lanai Lavender Star'
Catharanthus (Vinca) 'Pacifica Magenta Halo XP'	*Pelargonium* (Geranium-Zonal) 'Rocky Mountain Salmon 08'	*Verbena* 'Lanai Royal Purple with Eye'
Celosia 'Fresh Look Gold'	*Pelargonium* interspecific (Geranium-Hybrid) 'Caliente Coral'	*Verbena* 'Lanai Upright Magenta'
Celosia 'Fresh Look Red'	*Pelargonium* interspecific (Geranium-Hybrid) 'Caliente Lavender'	*Verbena* 'Lanai Upright Violet'
Celosia 'Fresh Look Yellow'	*Pelargonium* interspecific (Geranium-Hybrid) 'Caliente Rose"	*Verbena* 'Rapunzel Lilac'
Coreopsis 'Corey Yellow'	*Pelargonium peltatum* (Ivy Geranium) 'Acapulco Compact Cascade'	*Verbena* 'Rapunzel Violet'
Diascia 'Darla Light Pink'	*Pelargonium peltatum* (Ivy Geranium) 'Beach'	*Zinnia* 'Magellan Coral'
Diascia 'Darla Rose 08'	*Pelargonium peltatum* (Ivy Geranium) 'Blizzard Pink'	*Zinnia* 'Zowie! Yellow Flame'
Diascia 'Diamonte Coral Rose'	*Petunia* (Large-flowered Trailing) 'Jamboree Blue'	*Zinnia* 'Zahara Coral'
Dorotheanthus 'Mezoo Trailing Red'	*Petunia* (Large-flowered Trailing) 'Jamboree Burgundy'	*Zinnia* 'Zahara Scarlet'
Gaillardia 'Sunburst Burgundy Picotee'	*Petunia hybrida* (Large-flowered Trailing) 'Jamboree Lavender II'	*Zinnia* 'Zahara White'
Ipomoea (Sweet Potato Vine) 'Sidekick Black Heart'	*Petunia* (Large-flowered Trailing) 'Jamboree Light Blue'	*Zinnia* 'Zahara Yellow'
Ipomoea (Sweet Potato Vine) 'Sidekick Black Palmate'	*Petunia* (Grandiflora) 'Limbo Violet'	

2008 Star Performers

Star performers received *, **, or *** during **both** evaluation times as seen on the evaluation sheets for each site (pp. 17-48). Plants are listed in alphabetical order by genus.

Fargo

Agastache foeniculum 'Golden Jubilee'
Agastache rupestins
Ageratum 'Patina Blue'
Alternanthera 'Royal Tapestry'
Angelonia 'Serena White'
Begonia 'BIG Red Green Leaf'
Begonia 'BIG Rose Bronze Leaf'
Bracteantha 'Strawburst Yellow'
Calibrachoa 'Callie Peach'
Calibrachoa 'Callie Purple 07'
Calibrachoa 'Callie Rose'
Canna 'Tropical Sunrise'
Capsicum (Ornamental Pepper) 'Calico'
Capsicum (Ornamental Pepper) 'Variegated'
Catharanthus (Vinca) 'Nirvana Red'
Catharanthus (Vinca) 'Pacifica Burgundy Halo'
Catharanthu (Vinca) 'Pacifica Magenta Halo XP'
Dianthus 'Amazon Neon Rose Magic'
Diascia 'Darla Light Pink'
Dorotheanthus 'Mezoo Trailing Red'
Gaillardia 'Sunburst Burgundy Picotee'
Gaillardia 'Sunburst Scarlet Halo'
Ipomoea (Sweet Potato Vine) 'Margarita'
Ipomoea (Sweet Potato Vine) 'Sidekick Black Heart'
Ipomoea (Sweet Potato Vine) 'Sidekick Black Palmate'
Ipomoea (Sweet Potato Vine) 'Tricolor'
Juncus inflexus 'Blue Arrows'
Juncus tenuis 'Blue Dart'
Lablab (*Dolichos lablab*) (Purple Hyacinth Bean)
Laurentia 'Avant-Garde Blue'
Laurentia 'Avant-Garde Pink'
Limonium (Statice) 'Soiree Mix'
Limonium (Statice) 'Supreme Extra Pastel Mix'
Lobelia 'Techno Heat Upright Light Blue'
Mirabilis (Four-O-Clocks) 'Broken Colors'
Mirabilis (Four-O-Clocks) 'Limelight'
Osteospermum 'Asti White'
Osteospermum 'Tradewinds Deep Purple'
Osteospermum 'Tradewinds Pearl White'
Osteospermum 'Tradewinds Yellow Bicolor'
Pelargonium (Geranium-Zonal) 'Americana Cherry Rose'
Pelargonium (Geranium-Zonal) 'Americana Cranberry Red'
Pelargonium (Geranium-Zonal) 'Americana Pink'
Pelargonium (Geranium-Zonal) 'Americana Red'
Pelargonium (Geranium-Zonal) 'Americana Rose Mega Splash'
Pelargonium (Geranium-Zonal) 'Americana Salmon 09'
Pelargonium (Geranium-Zonal) 'Americana Violet'
Pelargonium (Geranium-Zonal) 'Americana White 09'
Pelargonium (Geranium-Zonal) 'Americana White Splash 09'
Pelargonium (Geranium-Zonal) 'Avenida Mosaic Red'
Pelargonium (Geranium-Zonal) 'Black Velvet Appleblossom'
Pelargonium (Geranium-Zonal) 'Black Velvet Rose'
Pelargonium (Geranium-Zonal) 'Black Velvet Salmon'
Pelargonium (Geranium-Zonal) 'Black Velvet Scarlet'
Pelargonium (Geranium-Zonal) 'Eclipse Light Salmon II'
Pelargonium (Geranium-Zonal) 'Eclipse Velvet Red'
Pelargonium (Geranium-Exotic) 'Graffiti Double Salmon'
Pelargonium (Geranium-Zonal) 'Orbit Deep Salmon'
Pelargonium (Geranium-Zonal) 'Orbit Red'
Pelargonium (Geranium-Zonal) 'Orbit Scarlet'
Pelargonium (Geranium-Zonal) 'Orbit White Improved'
Pelargonium (Geranium-Zonal) 'Rocky Mountain Coral'
Pelargonium (Geranium-Zonal) 'Rocky Mountain Dark Red'
Pelargonium (Geranium-Zonal) 'Rocky Mountain Deep Rose 09'
Pelargonium (Geranium-Zonal) 'Rocky Mountain Magenta'
Pelargonium (Geranium-Zonal) 'Rocky Mountain Salmon 08'
Pelargonium (Geranium-Zonal) 'Rocky Mountain Violet'
Pelargonium (Geranium-Zonal) 'Tango Coral'
Pennisetum (Fountain Grass)
Petunia (Floribunda) 'Celebrity Blue Improved'
Petunia (Large-flowered Trailing) 'Jamboree Burgundy'
Petunia (Large-flowered Trailing) 'Jamboree Light Blue'
Petunia (Spreading) 'Lavender Wave'
Petunia (Hedgiflora) 'Tidal Wave Silver'
Petunia (Supertunia) 'Vista Bubblegum'
Petunia (Mini-flowered Trailing) 'Whispers Blue'
Plectranthus 'Silver Shield'
Rudbeckia (Black-eyed Susan) 'Tiger Eye Gold'
Salvia 'Evolution'
Salvia 'Fahrenheit Violet'
Salvia 'Victoria'
Stipa 'Ponytails'
Tagetes erecta (Marigold) 'Parks Whopper Gold'
Tagetes erecta (Marigold) 'Park's Whopper Orange'
Tagetes erecta (Marigold) 'Vanilla'
Tagetes patula x erecta (Hybrid Marigold) 'Zenith Red'
Talinum 'Limon'
Thunbergia (Black-eyed Susan Vine) 'Mix'
Tropaeolum (Nasturtium) 'Alaska Gold'
Verbena bonariensis
Verbena 'Escapade Pink'
Verbena 'Lanai Lavender Star'
Verbena 'Lanai Peach'
Verbena 'Lanai Royal Purple with Eye'
Verbena 'Lanai Upright Magenta'
Verbena 'Lanai Upright Violet'
Verbena 'Rapunzel Lilac'
Verbena 'Rapunzel Violet'
Zinnia elegans 'Magellan Coral'
Zinnia elegans 'Uproar Rose'
Zinnia hybrid 'Profusion Knee-High White'

2008 Star Performers

Star performers received *, **, or *** during **both** evaluation times as seen on the evaluation sheets for each site (pp.17-48). Plants are listed in alphabetical order by genus.

Dickinson	Williston	
Begonia 'BIG Red Bronze Leaf'	*Begonia* 'BIG Red Bronze Leaf'	*Petunia* (Mini-flowered Trailing) 'Whispers Blue'
Begonia 'BIG Red Green Leaf'	*Begonia* 'BIG Red Green Leaf'	*Petunia* (Mini-flowered Trailing) 'Whispers Rose Vein'
Begonia 'BIG Rose Bronze Leaf'	*Begonia* 'BIG Rose Bronze Leaf'	*Petunia* (Mini-flowered Trailing) 'Whispers White'
Bidens 'Mexican Gold'	*Bidens* 'Mexican Gold'	*Tagetes patula x erecta* (Hybrid Marigold) 'Daisy Orange-Red'
Capsicum (Ornamental Pepper) 'Calico'	*Capsicum* (Ornamental Pepper) 'Calico'	*Verbena* 'Escapade Pink'
Celosia 'Fresh Look Red'	*Coreopsis* 'Corey Yellow'	*Verbena* 'Lanai Blush White'
Gaillardia 'Sunburst Burgundy Picotee'	*Diascia* 'Darla Light Pink'	*Verbena* 'Lanai Bright Pink'
Juncus 'Blue Dart'	*Diascia* 'Darla Rose 08'	*Verbena* 'Lanai Lavender Star'
Lobelia 'Techno Heat Electric Blue'	*Diascia* 'Diamonte Coral Rose'	*Verbena* 'Lanai Royal Purple with Eye'
Lobelia 'Techno Heat Upright Light Blue'	*Gaillardia* 'Sunburst Burgundy Picotee'	*Verbena* 'Lanai Upright Magenta'
Nicotiana (Flowering Tobacco) 'Perfume Deep Purple'	*Ipomoea* (Sweet Potato Vine) 'Sidekick Black Heart'	*Verbena* 'Lanai Upright Violet'
Osteospermum 'Tradewinds Deep Purple'	*Lobelia* 'Techno Heat Upright Light Blue'	*Verbena* 'Rapunzel Lilac'
Osteospermum 'Tradewinds Pearl White'	*Osteospermum* 'Tradewinds Deep Purple'	*Verbena* 'Rapunzel Violet'
Osteospermu 'Tradewinds Purple Bicolor'	*Osteospermum* 'Tradewinds Purple Bicolor'	
Pelargonium (Geranium-Zonal) 'Americana Cherry Rose'	*Pelargonium* (Geranium-Zonal) 'Americana Rose Mega Splash'	
Pelargonium (Geranium-Zonal) 'Americana Rose Mega Splash'	*Pelargonium* (Geranium-Zonal) 'Avenida Mosaic Red'	
Pelargonium (Geranium-Zonal) 'Avenida Mosaic Red'	*Pelargonium* (Geranium-Zonal) 'Eclipse Light Salmon II'	
Pelargonium (Geranium-Zonal) 'Eclipse Dark Red'	*Pelargonium* (Geranium-Zonal) 'Eclipse Velvet Red'	
Pelargonium (Geranium-Exotic) 'Graffiti Double Salmon'	*Pelargonium* (Geranium-Exotic) 'Graffiti Double Salmon'	
Pelargonium (Geranium-Zonal) 'Rocky Mountain Dark Red'	*Pelargonium* (Geranium-Zonal) 'Rocky Mountain Deep Rose 09'	
Pelargonium interspecific (Geranium-Hybrid) 'Caliente Coral'	*Pelargonium* (Geranium-Zonal) 'Rocky Mountain Salmon 08'	
Pelargonium interspecific (Geranium-Hybrid) 'Caliente Lavender'	*Pelargonium* interspecific (Geranium-Hybrid) 'Caliente Coral'	
Pelargonium interspecific (Geranium-Hybrid) 'Caliente Rose'	*Pelargonium* interspecific (Geranium-Hybrid) 'Caliente Lavender'	
Pelargonium peltatum (Ivy Geranium) 'Acapulco Compact Cascade'	*Pelargonium peltatum* (Ivy Geranium) 'Acapulco Compact Cascade'	
Pelargonium peltatum (Ivy Geranium) 'Blizzard Pink'	*Pelargonium peltatum* (Ivy Geranium) 'Blizzard Pink'	
Petunia (Large-flowered Trailing) 'Jamboree Lavender II'	*Petunia* (Large-flowered Trailing) 'Jamboree Blue'	
Petunia (Grandiflora) 'Limbo Violet'	*Petunia* (Large-flowered Trailing) 'Jamboree Burgundy'	
Verbena 'Lanai Lavender Star'	*Petunia* (Large-flowered Trailing) 'Jamboree Lavender II'	
Verbena 'Lanai Royal Purple with Eye'	*Petunia* (Large-flowered Trailing) 'Jamboree Light Blue'	
Verbena 'Lanai Upright Magenta'	*Petunia* (Grandiflora) 'Limbo Violet'	
Zinnia elegans 'Zowie! Yellow Flame'	*Petunia* (Spreading) 'LoGro Yellow'	
Zinnia Marylandica 'Zahara Yellow'	*Petunia* (Spreading) 'Opera Supreme Pink Morn'	

2008 Site Evaluations and Measurements-Fargo, ND

Note-An * preceding a cultivar measurement indicates good performance but lacking somewhat in size uniformity or bloom time; ** indicates a top performer with good bloom, vigor and uniformity; *** indicates outstanding performance. All measurements are in inches except where noted and ( ) indicates missing data. Seed/plant source list is on the last page of the report.

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	Seed/Plant	July 29			September 8 and 9		
Genus species 'Cultivar'	Source	Height	Spread	Comments	Height	Spread	Comments
Achillea ptarmica 'Gypsy White'	Syn	***9-10	***14-17	Very, very nice!	7-8	16-19	Some are dying but some are nice.
Acroclinium 'Best Mix'	Pk	*12-19	*10-15	Good bloom but not uniform in size.	10-18	10-14	Plants are dying and flowers are faded.
Agastache cana 'Purple Pigmy'	Pk	16-20	9-12	Just starting to bloom but good vigor.	**20-26	**22-24	Nice!
Agastache foeniculum 'Golden Jubilee'	Pk, AAS '03	*13-15	*10-14	Good vigor but just starting to bloom.	**25-27	**22-25	Good vigor and nice bloom.
Agastache rupestins	Pk	**17-22	**14-16	Good bloom and vigor.	**27-32	**28-30	Good bloom and vigor.
Ageratum houstonianum 'Leilani Blue'	Pk	9-13	8-17	Not uniform in size but good bloom.	15-19	22-24	Dead heads detract from appearance.
Ageratum houstonianum 'Patina Blue'	Syn	*5-7	*5-9	Nice little plants with good bloom but spread isn't uniform.	**7-9	**12-15	Nice bloom!
Alcea rosea (Hollyhock) 'Queeny Purple'	AAS '04	15-20	13-16	Good vigor but blooms hidden under foliage.	**25-31	**17-24	Lots of bloom and good vigor.
Alternanthera dentata 'Purple Knight'	Pk	3-5	10-14	Doing alright but not as vigorous as *Alternanthera* 'Royal Tapestry'.	3-5	8-12	No vigor and some are dying.
Alternanthera dentata 'Royal Tapestry'	PAS	***4-6	***20-24	Nice ground cover.	**7-9	**20-25	Good vigor; nice ground cover.
Angelonia angustifolia 'Serena Lavender'	Pk	7-10	4-12	Not uniform in size or bloom.	**13-15	**18-20	Very nice!
Angelonia angustifolia 'Serena Lavender Pink'	Pk	5-9	2-10	Not uniform in size or bloom.	11-13	13-15	Only 3 plants out of 6 left; not as floriferous as the others.
Angelonia angustifolia 'Serena White'	Pk	**8-9	**9-11	Nicest of the three *Angelonia* right now.	**11-14	**15-18	Best of the *Angelonia* right now.
Antirrhinum majus (Snapdragon) 'Frosted Sunset'	Pk	**10-12	**9-11	Good bloom and nice color.	11-13	10-12	Past peak bloom but healthy and vigorous.
Antirrhinum majus (Snapdragon) 'Rocket Mix'	Pk	**18-25	**10-15	Really good bloom right now.	25-31	13-16	Past peak bloom but healthy and vigorous.
Antirrhinum majus (Snapdragon) 'Speedy Sonnet Rose'	Ball	**14-16	**15-16	Really good bloom and size uniformity right now.	18-20	16-20	Past peak bloom but healthy and vigorous.
Antirrhinum majus (Snapdragon) 'Speedy Sonnet White'	Ball	*11-15	*8-10	Not as floriferous as *Antirrhinum* 'Speedy Sonnet Rose'.	18-20	15-18	Past peak bloom but healthy and vigorous.
Begonia benariensis 'BIG Red Bronze Leaf'	Ben	**7-10	**9-13	Good vigor and bloom.	9-11	10-20	Nice but not as full as the other two 'BIG' begonias.
Begonia benariensis 'BIG Red Green Leaf'	Ben	**6-9	**9-12	Good vigor and bloom.	**9-11	**16-18	Good vigor and bloom.

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Genus species 'Cultivar'	Seed/Plant Source	July 29 Height	July 29 Spread	July 29 Comments	September 8 and 9 Height	September 8 and 9 Spread	September 8 and 9 Comments
Begonia benariensis 'BIG Rose Bronze Leaf'	Ben	**8-10	**10-15	Good vigor and bloom.	**12-14	**16-18	Good vigor and bloom.
Bidens pelfi 'Mexican Gold'	Syn	***9-11	***18-20	Nice show of yellow.	12-15	18-20	Good vigor but lull in bloom right now.
Bracteantha bracteata 'Strawburst Yellow'	Syn	*7-10	*8-12	Really good bloom but not uniform in size.	*9-13	*8-12	Getting crowded by statice; not uniform in size but good bloom.
Calibrachoa x hybrida 'Callie Coral Pink'	Syn	**3-5	**12-13	Good vigor and bloom.	5-8	18-20	Some disease showing up.
Calibrachoa x hybrida 'Callie Deep Yellow'	Syn	**5-7	**11-13	Good vigor and bloom.	8-10	18-20	Some disease-possibly Aster Yellows.
Calibrachoa x hybrida 'Callie Gold with Red Eye'	Syn	**5-7	**12-14	Good vigor and bloom.	7-9	16-18	A bit crowded by neighboring *Calibrachoa* .
Calibrachoa x hybrida 'Callie Light Blue'	Syn	**5-6	**13-15	Looks good.	5-7	12-14	Chlorotic.
Calibrachoa x hybrida 'Callie Orange 08'	Syn	3-6	8-14	Not uniform in size or bloom.	4-6	14-18	Disease present.
Calibrachoa x hybrida 'Callie Painted Coral'	Syn	**7-8	**12-13	Good vigor and bloom.	10-11	14-16	Doing alright.
Calibrachoa x hybrida 'Callie Peach'	Syn	**3-4	**10-12	Good vigor and bloom.	*4-7	*18-20	Doing alright but a bit of chlorosis.
Calibrachoa x hybrida 'Callie Purple 07'	Syn	**3-5	**12-14	Looks good.	**4-6	**18-20	One of the better *Calibrachoa* right now.
Calibrachoa x hybrida 'Callie Rose'	Syn	**3-5	**10-12	Good vigor and bloom.	**4-6	**18-20	One of the better *Calibrachoa* right now.
Calibrachoa x hybrida 'Callie Scarlet Red 08'	Syn	**5-6	**10-13	Good vigor and bloom.	4-7	18-20	Some disease showing up.
Canna x generalis 'Australia'	Pk	13-30	10-18	A few blooms but not uniform in height.	40-42	36-40	Good vigor but flowers a bit weather beaten.
Canna x generalis 'Bengal Tiger'	Pk	18-22	15-18	No bloom right now.	**38-40	**24-27	Nice show!
Canna x generalis 'Lucifer'	Pk	22-24	25-26	Just starting to bloom but good vigor.	**40-42	**24-26	Nice!
Canna x generalis 'Tropical Red'	Pk	10-14	19-20	Just starting to bloom but good vigor.	21-24	21-23	Doing alright.
Canna x generalis 'Tropical Sunrise'	Pk	*20-22	*20-25	Just starting to bloom but good vigor and fairly uniform in size.	**42-45	**36-38	Good bloom and vigor.
Canna x generalis 'Tropical White'	Pk	12-16	13-17	Best bloom right now of the *Cannas* .	24-26	17-19	Needs dead heading.
Canna x generalis 'Tropical Yellow'	Pk	12-18	11-14	Just starting to bloom.	24-29	17-20	Needs dead heading.
Canna x generalis 'Wyoming Dwarf'	Pk	30-33	30-33	No bloom but vigorous.	**52-60	**to 36	Not very dwarf!

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Genus species 'Cultivar'	Seed/Plant Source	July 29 Height	July 29 Spread	July 29 Comments	September 8 and 9 Height	September 8 and 9 Spread	September 8 and 9 Comments
Capsicum annuum (Ornamental Pepper) 'Black Pearl'	AAS '06	5-12	6-12	Not uniform in size.	**9-12	**10-13	Good vigor and pepper production.
Capsicum annuum (Ornamental Pepper) 'Calico'	PAS	**9-11	**9-11	Good vigor and variegated foliage is unique.	**9-12	**12-14	Red peppers contrast nicely with variegated foliage.
Capsicum annuum (Ornamental Pepper) 'Purple Flash'	PAS	6-8	4-9	Not uniform in spread.	*7-11	*7-12	Good vigor but not uniform in size.
Capsicum annuum (Ornamental Pepper) 'Variegated'	Pk	**12-13	**12-14	Looks good.	**13-15	**18-22	Looks good!
Catharanthus roseus (Vinca) 'First Kiss Blueberry'	AAS '05	6	8	Only one plant; not too vigorous yet.	10	15	Only one plant there-it's doing alright.
Catharanthus roseus (Vinca) 'Nirvana Pink Blush'	Syn	3-8	3-10	Not uniform in size, vigor or bloom.	9-11	6-12	Not uniform in size and a bit smaller than other 'Nirvana' vinca.
Catharanthus roseus (Vinca) 'Nirvana Red'	Syn	**6-9	**6-10	Good vigor and bloom.	**11-13	**13-15	Nice!
Catharanthus roseus (Vinca) 'Nirvana Violet'	Syn	4-10	5-11	Lost 7 of 12; good bloom on remaining plants.	**11-14	**13-15	Good bloom and vigor.
Catharanthus roseus (Vinca) 'Nirvana White'	Syn	2-8	2-10	Lost 4 of 12; not uniform in size.	8-13	6-14	Not uniform in size but bloom alright.
Catharanthus roseus (Vinca) 'Pacifica Burgundy Halo'	AAS '07	*6-9	*5-9	Not uniform in size but bloom good.	**11-13	**13-15	Good vigor and bloom.
Catharanthus roseus (Vinca) 'Pacifica Magenta Halo XP'	PAS	*5-9	*5-11	Good bloom but not uniform in spread.	*9-11	*10-12	Good vigor but not as many blooms as some other vinca.
Catharanthus roseus (Vinca) 'Pacifica Mix Halo'	PAS	6-9	4-9	Not uniform in size.	9-11	11-13	Not uniform in bloom but good vigor.
Catharanthus roseus (Vinca) 'Pacifica White XP'	PAS	4-9	3-8	Not uniform in size.	7-11	12-15	Not uniform in size but bloom alright.
Catharanthus roseus (Vinca) 'Titan Pure White'	Ball	5-8	6-10	Not uniform in size but bloom alright.	**11-13	**13-16	Good vigor and show.
Celosia cristata 'Amigo Mix'	Pk	3-4	4-5	Not too vigorous.	3-4	3-4	Poor; no vigor.
Celosia plumosa 'Fresh Look Gold'	AAS '07	8-10	2-10	Not uniform in size or bloom and not much vigor.	**14-18	**14-16	Good vigor and bloom.
Celosia plumosa 'Fresh Look Red'	AAS '04	8-10	5-12	Not uniform in size or bloom and not much vigor, yet.	**15-19	**13-16	Good vigor and bloom.
Celosia plumosa 'Fresh Look Yellow'	AAS '04	4-10	2-12	Not uniform in size or bloom and not much vigor, yet.	**13-19	**14-16	Good vigor and bloom.
Celosia plumosa 'Rainbow Sherbet'	Pk	4-8	3-7	Not uniform in size or bloom and not much vigor, yet.	6-8	3-12	Poor-not uniform in size, vigor or bloom.
Celosia spicata 'China Town'	Pk	11-12	3-10	Not uniform in size or vigor.	19-20	13-15	Nice show of red.
Celosia spicata 'Flamingo Purple'	Pk	11-21	2-12	Four really nice plants but two are small with no vigor.	**31-38	**33-36	Nice!

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Genus species 'Cultivar'	Seed/Plant Source	July 29 Height	July 29 Spread	July 29 Comments	September 8 and 9 Height	September 8 and 9 Spread	September 8 and 9 Comments
Cobaea scandens 'Royal Plum'	Pk	**Vining to 4'		Good vigor but no flowers, yet.	vining 3-4'		Being over-run by Purple Hyacinth Bean and Black-eyed Susan vine.
Coreopsis grandiflora 'Corey Yellow'	Syn	***16-18	***14-16	Great bloom and vigor; nice show.	19-20	11-14	Past peak bloom and *Gaillardia* 'Sundance Bicolor' crowding it.
Coreopsis tinctoria 'Sunfire'	Pk	9-12	7-11	Small but good bloom.	10-12	11-13	Past peak bloom but healthy.
Craspedia chrysantha 'Drumstick'	Pk	5-7	5-8	Not too vigorous and no flowers yet.	12-15	8-10	Just starting to bloom and statice is crowding it.
Dahlia variabilis 'Cactus Hybrids Mix'	TM	28-32	33-36	Good vigor; lots of buds but few flowers, yet.	up to 48	36-40	Very vigorous but some plants splitting apart.
Dianthus F1 'Supra Purple'	AAS '06	7-9	9-11	Alright but not uniform in bloom.	8-9	13-15	Needs deadheading.
Dianthus barbatus 'Amazon Neon Duo'	Pk	**11-14	**8-10	Huge flowers!	12-17	13-16	Good bloom but not as vigorous as *Dianthus* 'Amazon Neon Rose Magic'.
Dianthus barbatus 'Amazon Neon Rose Magic'	Pk	**11-13	**8-10	Huge flowers!	**11-14	**10-15	Good bloom and fuller than *Dianthus* 'Amazon Neon Duo'.
Dianthus caryophyllus 'Can Can Scarlet'	AAS '03	11-13	11-14	Just starting to bloom.	12-13	12-16	Not uniform in bloom and needs deadheading.
Dianthus chinensis 'Baby Doll'	Pk	7-9	9-12	Pretty flowers but not uniform in size or bloom.	8-10	15-17	Not uniform in size.
Dianthus chinensis 'Ideal Violet'	AAS '92	5-6	6-9	Very good bloom but plants are very small.	6-8	6-9	Not uniform in bloom and needs deadheading.
Dianthus superbus 'Kawara Pink'	Pk	15-18	9-11	Not very full.	**15-17	**17-19	Good bloom, vigor and uniformity.
Diascia barberae 'Darla Light Pink'	Syn	**8-10	**9-13	Good bloom and vigor.	**13-15	**18-22	Most floriferous of the *Diascia* right now.
Diascia barberae 'Darla Rose 08'	Syn	**9-13	**9-13	Good bloom and vigor.	13-15	18-22	Lull in bloom right now but vigor is good.
Diascia barberae 'Diamonte Coral Rose'	AAS '06	**9-11	**13-15	Looks good.	13-15	18-22	Good vigor but lull in bloom right now.
Dichondra argentea 'Silver Falls'	Pk	1-2	12-14	Just starting to spread.	*1	*20-22	Nice ground cover but not as vigorous as in the past.
Dorotheanthus bellidiformis 'Mezoo Trailing Red'	Syn	**1-2	**14-17	Good vigor but few flowers.	**5-6	**22-24	Very vigorous but few flowers; nice ground cover.
Eustoma grandiflorum (Lisianthus) 'Cinderella Blue'	Pk	10-17	6-8	Nice bloom but one plant of six died.	12-16	6-8	Lull in bloom right now.
Eustoma grandiflorum (Lisianthus) 'Cinderella Pink'	Pk	9-13	4-6	Not uniform in bloom.	7-14	7-9	Not too vigorous or floriferous.
Eustoma grandiflorum (Lisianthus) 'Cinderella Yellow'	Pk	11-13	6-8	Not uniform in bloom and 2 of 6 plants died.	9-14	7-9	Falling over and sickly.
Eustoma grandiflorum (Lisianthus) 'Echo Mix'	Pk	11-13	6-8	Lots of pink and white; not uniform in bloom.	12-14	7-9	Sickly; only light pink and white colors.

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Genus species 'Cultivar'	Seed/Plant Source	July 29 Height	July 29 Spread	July 29 Comments	September 8 and 9 Height	September 8 and 9 Spread	September 8 and 9 Comments
Eustoma grandiflorum (Lisianthus) 'Florida Mix'	Pk	4-6	4-6	Only 3 of 7 plants still there.	10	8-9	Only 2 plants left; good bloom.
Gaillardia aristata 'Arizona Sun'	AAS '05	7-10	7-14	Not uniform in size or bloom.	**10-12	**13-17	Past peak bloom but seed heads attractive.
Gaillardia aristata 'Sunburst Burgundy Picotee'	Syn	**11-13	**12-14	Good bloom and vigor.	**13-15	**18-20	Good bloom and vigor but a few dying plants.
Gaillardia aristata 'Sunburst Scarlet Halo'	Syn	**8-10	**8-13	Not uniform in spread but good bloom.	**10-12	**15-20	Nice; looks very similar to *Gaillardia* 'Arizona Sun'.
Gaillardia pulchella 'Sundance Bicolor'	AAS '03	10-17	12-19	Not uniform in size but bloom and vigor good.	20-24	20-25	Past peak bloom but healthy and vigorous.
Gazania rigens 'Daybreak Mix'	Pk	3-6	5-9	Not uniform in size but bloom good.	7-9	8-13	Not uniform in size; flowers not open right now.
Gazania rigens 'Dynastar Vanilla Ice'	Pk	6-10	8-13	Not uniform in size or bloom.	6-11	12-18	One dying plant; flowers not open right now.
Gomphrena globosa 'All Around Purple'	Pk	10-12	7-9	Only 3 plants of 6 there; small but uniform with good bloom.	11-13	15-17	Good bloom but one plant dying.
Gomphrena globosa 'Purple Gomp'	Gri	6-12	4-10	Only 3 plants there of 6 planted; not uniform in size.	**11-13	**15-18	Looks good!
Gomphrena haageana 'Strawberry Fields'	Pk	8-10	3-12	Not too vigorous and not uniform in size.	**12-18	**20-28	Nice bloom!
Gypsophila muralis (Baby's Breath) 'Gypsy Deep Rose'	AAS '04	3-4	4-6	Not much vigor.	2-3	4-6	Poor, no vigor.
Helenium amarum 'Goldfield'	Pk	6-11	7-12	Good bloom but not uniform in size.	*9-14	*11-16	Good bloom but not uniform in size.
Helichrysum petiolare 'Silver Mist'	Pk	5-7	10-14	Just starting to grow well.	7-9	15-17	Doing alright.
Hibiscus moscheutos 'Luna Rose'	PAS	12-16	6-12	Nice little plants but no flowers.	20-23	20-24	Huge flowers!
Impatiens hawkerii (New Guinea Impatiens) 'Sonic Deep Red 08'	Syn	3-4	5-6	Small; not a lot of bloom.	4-6	5-9	Not uniform in size or bloom.
Impatiens hawkerii (New Guinea Impatiens) 'Sonic Lilac'	Syn	3-4	5-6	Small; not a lot of bloom.	4-6	5-9	Not uniform in size or bloom.
Impatiens hawkerii (New Guinea Impatiens) 'Sonic Mango'	Syn	3-4	6-7	Small; not a lot of bloom.	4-5	6-8	Not uniform in bloom.
Impatiens hawkerii (New Guinea Impatiens) 'Sonic Orange 08'	Syn	4-5	6-7	Small; not a lot of bloom.	5-7	5-10	Not uniform in size or bloom.
Impatiens hawkerii (New Guinea Impatiens) 'Sonic Scarlet 09'	Syn	3-4	5-6	Small; not a lot of bloom.	4-5	6-7	Not uniform in bloom but size uniformity alright.
Impatiens hawkerii (New Guinea Impatiens) 'Sonic Sweet Orange 09'	Syn	3-4	5-7	Small; not a lot of bloom.	3-4	5-6	Small; not much bloom.
Impatiens hawkerii (New Guinea Impatiens) 'Super Sonic Lavender 08'	Syn	3-4	6-7	Small; not a lot of bloom.	4-5	6-9	Not uniform in size or bloom.

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Genus species 'Cultivar'	Seed/Plant Source	July 29 Height	July 29 Spread	July 29 Comments	September 8 and 9 Height	September 8 and 9 Spread	September 8 and 9 Comments
Impatiens hawkerii (New Guinea Impatiens) 'Super Sonic Lilac 09'	Syn	3-5	5-8	Small; not a lot of bloom.	4-6	4-11	Not uniform in size or bloom.
Impatiens hawkerii (New Guinea Impatiens) 'Super Sonic Magenta 08'	Syn	4-5	5-8	Small; not a lot of bloom.	6-8	10-13	Best of the New Guinea impatiens here; it has the most bloom and vigor.
Impatiens hawkerii (New Guinea Impatiens) 'Super Sonic Pastel Pink'	Syn	3-4	5-6	Small; not a lot of bloom.	4-5	4-6	Small and not much bloom.
Impatiens hawkerii (New Guinea Impatiens) 'Super Sonic Red 08'	Syn	3-4	5-6	Small; not a lot of bloom.	4-5	6-8	Small and not much bloom.
Impatiens hawkerii (New Guinea Impatiens) 'Super Sonic Cherry Cream'	Syn	3-4	4-7	Small; not a lot of bloom.	5-6	5-9	Small; not much bloom.
Impatiens walleriana (Double Impatiens) 'Silhouette Cherry Red 09'	Syn	3-4	7-12	Bloom alright but plants small.	3-4	9-16	Bloom alright but plants not as vigorous as they should be.
Impatiens walleriana (Double Impatiens) 'Silhouette Orange Star'	Syn	3-5	8-10	Bloom alright but plants small.	4-6	11-15	Bloom alright but plants not as vigorous as they should be.
Impatiens walleriana (Double Impatiens) 'Silhouette Purple'	Syn	3-4	7-10	Bloom alright but plants small.	3-5	11-13	Bloom alright but plants not as vigorous as they should be.
Impatiens walleriana (Double Impatiens) 'Silhouette Salmon 09'	Syn	3-4	8-10	Bloom alright but plants small.	3-4	11-15	Bloom alright but plants not as vigorous as they should be.
Impatiens walleriana (Double Impatiens) 'Silhouette White'	Syn	2-3	7-10	Bloom alright but plants small.	3-4	9-11	Bloom alright but plants not as vigorous as they should be.
Ipomoea batata (Sweet Potato Vine) 'Blackie'	Unk	***6-8	***28-32	Very nice!	7-9	12-15	Least vigorous and most liked by bugs.
Ipomoea batata (Sweet Potato Vine) 'Margarita'	Shot	***7-8	***to 36	Very nice!	***to 11	***to 4'	Very, very vigorous.
Ipomoea batata (Sweet Potato Vine) 'Sidekick Black Heart'	Syn	***11-12	***30-33	Very vigorous and uniform in size.	***to 16	***to 40	Very nice and vigorous.
Ipomoea batata (Sweet Potato Vine) 'Sidekick Black Palmate'	Syn	***11-12	***20-22	Very vigorous and uniform in size.	***to 14	***to 40	Very nice and vigorous.
Ipomoea batata (Sweet Potato Vine) 'Tricolor'	Shot	***7-8	***to 40	Very nice!	**7-9	**to 36	Nice!
Ipomoea imperialis 'Tie Dye Blue'	Pk	8-10	to 24	Good vigor and some flowers.	Vining 4-5'		Vigorous but not many blooms right now.
Ipomoea imperialis 'Tie Dye Pink'	Pk	8-10	to 24	No flowers but vigor good.	Vining 4-5'		Vigorous but not many blooms right now.
Ipomoea x multifida (Cardinal Climber)	Pk	**Vining to 4'		Good vigor and bloom.	Vining to 6'		Very vigorous but few blooms.
Ipomoea purpurea 'Scarlet O'Hara'	TM	Vining to 3'		Not as vigorous as *Ipomoea* 'Star of Yelta' and few flowers.	Vining to 6'		Very vigorous but few blooms.
Ipomoea purpurea 'Star of Yelta'	Pk	**Vining to 4'		Good vigor but few flowers.	Vining to 6'		Trellis fell over; very vigorous.
Isolepsis cernua 'Live Wire'	Pk	2-3	4-5	Small, no vigor.	2-3	3-4	Poor-no vigor.

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Juncus effusus 'Spiralis' (Corkscrew Plant)	Pk	10-12	12-15	Interesting but foliage yellowing.	**10-13	**14-16	A bit overshadowed by Fountain Grass next to it.
Juncus inflexus 'Blue Arrows'	PAS	**14-16	**15-17	Good vigor and unique look.	**20-22	**22-24	Nice!
Juncus inflexus 'Hedgehog'	Pk	8-9	8-9	Doing alright.	**10-11	**11-13	Interesting but pokey!
Juncus pallidus 'Javelin'	PAS	20-24	19-30	Looks good.	**36-38	**38-40	Looks nice!
Juncus tenuis 'Blue Dart'	PAS	**10-12	**8-10	Nice.	**13-15	**11-14	Looks good!
Koeleria glauca 'Blue Sprite'	PAS	4-6	4-8	Small.	4-5	7-9	Small; one plant with a flower head.
Lablab purpureus (*Dolichos lablab*) (Purple Hyacinth Bean)	Pk	**Vining to 4-5'		Good vigor but no flowers, yet.	***Vining 5-6'		Great bloom and vigor.
Lantana camara 'Bandana Cherry'	Syn	5-8	5-10	Doing alright.	**9-11	**15-17	Good vigor and bloom.
Lantana camara 'Bandana Pink 07'	Syn	2-7	3-9	Not uniform in size or bloom.	*6-11	*10-15	Not as uniform in size as other *Lantana* .
Lantana camara 'Bandana Red'	Syn	4-7	6-9	Doing alright.	**7-10	**11-15	Good bloom and vigor.
Lantana camara 'Bandana Rose'	Syn	7-8	7-10	Nice little plants; most vigorous of the *Lantana* .	**10-13	**10-14	Nicest of *Lantana* right now; good vigor and bloom.
Lathyrus odoratus (Sweet Pea) 'Mammoth Scarlet'	SGS	**Vining to 3-4'		Good bloom and vigor.	Vining 2-3'		Decline in bloom.
Laurentia hybrida 'Avant-Garde Blue'	Pk	*6-9	*6-15	A few smaller plants.	**10-11	**16-20	Nice, little plants with lots of flowers.
Laurentia hybrida 'Avant-Garde Pink'	Pk	**7-9	**10-13	Nice little plants.	**9-10	**19-20	Nice, little plants with lots of flowers.
Laurentia hybrida 'Avant-Garde White'	Pk	6-9	6-15	2 of 6 died; not uniform in size.	**9-10	**16-25	Nice, little plants with lots of flowers.
Lavandula angustifolia 'Potpourri Dark Purple'	Ball	10-15	6-9	Doing alright.	11-18	10-14	Doing alright.
Limonium sinuatum (Statice) 'Soiree Mix'	Pk	*19-30	*16-20	Good vigor but just starting to bloom.	**26-33	**26-28	Great bloom and vigor.
Limonium sinuatum (Statice) 'Supreme Extra Pastel Mix'	Pk	**25-29	**15-20	Good vigor and bloom.	**24-30	**to 28	Great bloom and vigor.
Lobelia erinus 'Fountain Blue'	Pk	3-4	6-8	No vigor; 3 of 6 died.	3-7	8-12	Not very vigorous.
Lobelia erinus 'Fountain Crimson'	Pk	3-4	5-7	No vigor; 3 of 6 died.	3-7	8-11	No vigor.
Lobelia erinus 'Fountain White'	Pk	2-3	6-8	No vigor; 2 of 6 died.	4-6	8-12	Not very vigorous or uniform in size.

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Lobelia erinus 'Techno Heat Dark Blue'	Syn	*6-8	*9-12	Good bloom but not uniform in spread.	6-8	14-18	Not as floriferous as earlier but doing alright.
Lobelia erinus 'Techno Heat Electric Blue'	Syn	*5-7	*9-12	Good bloom but not uniform in spread.	6-8	18-20	Not as floriferous as earlier but doing alright.
Lobelia erinus 'Techno Heat Upright Dark Blue'	Syn	4-6	5-9	Lost 4 of 12; not much vigor right now.	5-7	7-16	Not as vigorous as other *Lobelia* and not uniform in size.
Lobelia erinus 'Techno Heat Upright Light Blue'	Syn	**7-8	**9-11	Best bloom and vigor of the *Lobelia* right now.	**8-10	**12-14	Has done great all season!
Lobularia maritima (Sweet Alyssum) 'Pastel Carpet'	Pk	3-10	2-5	Not uniform in size or bloom.	2-6	6-17	Not uniform in size or bloom.
Lobularia maritima (Sweet Alyssum) 'Snow Crystals'	Pk	3-5	4-12	Not uniform in size or bloom.	5-6	10-17	Not uniform in size or bloom.
Melampodium paludosum 'Derby'	Pk	6-9	5-10	Good bloom but not uniform in size.	10-18	9-15	Not uniform in size but great bloom.
Melampodium paludosum 'Melanie'	Pk	5-12	5-12	Good bloom but not uniform in size.	12-18	12-23	Not uniform in size but great bloom.
Mirabilis jalapa (Four-O-Clocks) 'Broken Colors'	Pk	*18-21	*23-26	Just starting to bloom but very good vigor.	**23-30	**29-30	Good vigor and bloom.
Mirabilis jalapa (Four-O-Clocks) 'Limelight'	Pk	**12-15	**20-24	Good vigor; nice bright color.	**20-24	**28-30	Good vigor and bloom.
Nicotiana x sanderae (Flowering Tobacco) 'Perfume Deep Purple'	AAS '06	11-15	8-13	Not uniform in spread but bloom good.	6-18	6-16	Not as vigorous as normal and not uniform in size.
Nolana paradoxa 'Sun Belle Mix'	TM	**7-8	**22-24	Nice ground cover.	3-4	11-13	Dying.
Osteospermum ecklonis 'Asti White'	AAS '08	**13-15	**14-16	Good bloom and size uniformity.	*20-22	*18-20	Good vigor-huge plants!
Osteospermum ecklonis 'Tradewinds Deep Purple'	Syn	**10-11	**14-15	Good bloom, vigor and size uniformity.	**16-18	**15-17	Very nice!
Osteospermum ecklonis 'Tradewinds Pearl White'	Syn	**11-13	**13-14	Good bloom, vigor and size uniformity.	**16-18	**15-17	Nice!
Osteospermum ecklonis 'Tradewinds Purple Bicolor'	Syn	**10-12	**13-14	Good bloom, vigor and size uniformity.	13-16	15-17	Getting crowded by *Osteospermum* 'Tradewinds Pearl White' and 'Tradewinds Yellow Bicolor'.
Osteospermum ecklonis 'Tradewinds Yellow Bicolor'	Syn	**10-11	**11-13	Good bloom, vigor and size uniformity.	*20-21	*17-20	Good vigor but not uniform in bloom.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Cherry Rose'	Syn	***13-14	***13-15	Nice show!	**15-16	**16-18	Good bloom and vigor.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Cranberry Red'	Syn	**10-12	**12-13	Good bloom and vigor.	*13-15	*13-15	Nice but not as vigorous as some other geraniums right now.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Pink'	Syn	**9-12	**10-13	Good bloom and vigor.	**14-15	**13-15	Good bloom and vigor.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Red'	Syn	**13-15	**12-15	Good bloom and vigor.	**17-20	**16-18	Good bloom and vigor.

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		Height	Spread	Comments	Height	Spread	Comments
Pelargonium x hortorum (Geranium-Zonal) 'Americana Rose Mega Splash'	Syn	**9-11	**9-11	Good bloom and vigor.	*14-16	*14-16	Not as bright as earlier but good vigor.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Salmon 09'	Syn	**10-12	**13-15	Good bloom and vigor.	**13-15	**16-18	Good bloom and vigor.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Trailing Dark Red'	Syn	**11-12	**14-16	Good bloom and vigor.	12-13	18-22	Slightly chlorotic but bloom alright.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Violet'	Syn	***11-13	***12-14	A nice show of color!	**16-17	**13-15	Good bloom and vigor.
Pelargonium x hortorum (Geranium-Zonal) 'Americana White 09'	Syn	**11-13	**13-15	Good bloom and vigor.	*18-22	*16-18	Good vigor but browning heads detract from appearance.
Pelargonium x hortorum (Geranium-Zonal) 'Americana White Splash 09'	Syn	**8-10	**9-11	Good bloom and vigor.	*9-11	*10-12	Much smaller than other 'Americana' geraniums; good bloom.
Pelargonium x hortorum (Geranium-Zonal) 'Avenida Mosaic Red'	Syn	**13-15	**13-15	Good bloom and vigor.	**18-20	**18-22	Nice!
Pelargonium x hortorum (Geranium-Zonal) 'Black Velvet Appleblossom'	Pk	**12-13	**14-17	Good bloom and vigor.	*14-18	*19-26	Nice but not as showy as some other 'Black Velvet' geraniums.
Pelargonium x hortorum (Geranium-Zonal) 'Black Velvet Rose'	Pk	**11-14	**12-15	Good bloom and vigor.	**14-16	**19-24	Vigorous and floriferous.
Pelargonium x hortorum (Geranium-Zonal) 'Black Velvet Salmon'	Pk	**13-15	**13-15	Good bloom and vigor.	**16-19	**22-25	Vigorous and floriferous.
Pelargonium x hortorum (Geranium-Zonal) 'Black Velvet Scarlet'	Pk	**13-14	**12-14	Good bloom and vigor.	**13-14	**18-22	Vigorous and floriferous.
Pelargonium x hortorum (Geranium-Zonal) 'Eclipse Dark Red'	Syn	**9-11	**9-12	Good bloom and vigor.	9-11	11-13	Not as vigorous as *Pelargonium* 'Eclipse Velvet Red' or 'Eclipse Light Salmon II'.
Pelargonium x hortorum (Geranium-Zonal) 'Eclipse Light Salmon II'	Syn	**12-14	**12-15	Good bloom and vigor.	**16-18	**15-17	Good bloom and vigor.
Pelargonium x hortorum (Geranium-Zonal) 'Eclipse Rose Mega Splash'	Syn	***8-10	***8-12	Very, very showy!	6-10	11-13	Lull in bloom but good vigor.
Pelargonium x hortorum (Geranium-Zonal) 'Eclipse Velvet Red'	Syn	**10-12	**12-14	Good bloom and vigor.	**12-15	**14-16	Nice!
Pelargonium x hortorum (Geranium-Exotic) 'Graffiti Double Red'	Syn	**9-11	**10-12	Neat 'balls' of flowers.	12-14	11-13	Good vigor but not as floriferous as earlier this summer.
Pelargonium x hortorum (Geranium-Exotic) 'Graffiti Double Salmon'	Syn	**10-11	**9-10	Unique flowers and very uniform in size.	*15-17	*13-16	Nice but not as floriferous as earlier.
Pelargonium x hortorum (Geranium-Zonal) 'Orange Appeal'	Pk	**8-10	**10-12	Looks good!	9-11	9-13	Not quite as nice as earlier.
Pelargonium x hortorum (Geranium-Zonal) 'Orbit Appleblossom'	Pk	**10-11	**10-14	Good bloom and vigor.	13-14	20-21	Good bloom but a bit chlorotic.
Pelargonium x hortorum (Geranium-Zonal) 'Orbit Deep Salmon'	Pk	**10-12	**10-12	Good bloom and vigor.	*13-15	*18-20	Not quite as full or floriferous as *Pelargonium* 'Orbit Red'.
Pelargonium x hortorum (Geranium-Zonal) 'Orbit Pink'	Pk	**10-12	**10-12	Good bloom and vigor.	12-14	16-18	Looks good.

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		Height	Spread	Comments	Height	Spread	Comments
Pelargonium x hortorum (Geranium-Zonal) 'Orbit Red'	Pk	**11-12	**12-14	Very uniform in size.	**17-18	**29-30	Very vigorous and floriferous.
Pelargonium x hortorum (Geranium-Zonal) 'Orbit Rose'	Pk	**10-12	**10-12	Good bloom and vigor.	13-15	18-20	Looks good.
Pelargonium x hortorum (Geranium-Zonal) 'Orbit Scarlet'	Pk	**11-13	**14-16	Good bloom and vigor.	*15-17	*20-22	Nice but not quite as floriferous or full as *Pelargonium* 'Orbit Red'.
Pelargonium x hortorum (Geranium-Zonal) 'Orbit Violet'	Pk	**12-13	**12-14	Good bloom and vigor.	13-16	12-17	Not as nice as earlier.
Pelargonium x hortorum (Geranium-Zonal) 'Orbit White Improved'	Pk	**12-13	**12-14	Good bloom and vigor.	*16-17	*20-22	Nice but not as floriferous as *Pelargonium* 'Orbit Red'.
Pelargonium x hortorum (Geranium-Zonal) 'Rocky Mountain Coral'	Syn	**11-13	**11-13	Looks good.	**14-16	**11-13	Nice!
Pelargonium x hortorum (Geranium-Zonal) 'Rocky Mountain Dark Red'	Syn	**10-12	**12-15	Good vigor and bloom.	**12-14	**13-15	Looks good!
Pelargonium x hortorum (Geranium-Zonal) 'Rocky Mountain Deep Rose 09'	Syn	**12-15	**12-14	Good vigor and bloom.	*18-19	*16-18	Good vigor but not quite as floriferous as some others.
Pelargonium x hortorum (Geranium-Zonal) 'Rocky Mountain Magenta'	Syn	**10-12	**10-15	Good vigor and bloom.	**13-15	**13-15	Nice!
Pelargonium x hortorum (Geranium-Zonal) 'Rocky Mountain Salmon 08'	Syn	**12-14	**12-14	Good bloom and vigor.	**17-19	**16-18	Good bloom and vigor.
Pelargonium x hortorum (Geranium-Zonal) 'Rocky Mountain Violet'	Syn	**11-13	**12-14	Good bloom and vigor.	**13-17	**15-17	Good bloom and vigor.
Pelargonium x hortorum (Geranium-Zonal) 'Tango Coral'	Syn	**11-14	**11-14	Good bloom and vigor.	**14-17	**15-17	Good bloom and vigor.
Pelargonium x hortorum (Geranium-Zonal) 'Tango Magenta'	Syn	9-13	8-12	Not quite as vigorous or showy as many other geraniums.	9-13	11-14	Nice but not as vigorous or floriferous as some other geraniums.
Pelargonium x hortorum (Geranium-Zonal) 'Tango Red 09'	Syn	**9-12	**12-14	Good bloom and vigor.	12-15	10-14	Not as floriferous as others right now.
Pelargonium x hortorum (Geranium-Zonal) 'Tango White'	Syn	9-11	8-12	Not quite as vigorous or showy as many other geraniums.	8-11	7-11	Not uniform in size and not as vigorous as other 'Tango' geraniums.
Pelargonium interspecific (Geranium-Hybrid) 'Caliente Coral'	Syn	***10-11	***13-15	Great!	17-18	18-20	Good vigor but lull in bloom right now.
Pelargonium interspecific (Geranium-Hybrid) 'Caliente Lavender'	Syn	***10-11	***13-15	Great!	13-15	14-16	Not as floriferous as earlier this summer.
Pelargonium interspecific (Geranium-Hybrid) 'Caliente Rose'	Syn	***10-11	***13-15	Great!	12-14	14-16	Not as floriferous as earlier this summer.
Pelargonium peltatum (Ivy Geranium) 'Acapulco Compact Cascade'	Syn	**7-9	**14-16	Nice!	9-11	13-15	Good vigor but not many blooms.
Pelargonium peltatum (Ivy Geranium) 'Beach'	Syn	**11-13	**12-15	Good bloom and vigor.	11-17	18-22	Good vigor but not many blooms.
Pelargonium peltatum (Ivy Geranium) 'Blizzard Pink'	Syn	**8-10	**12-15	Good bloom and vigor.	7-9	12-14	Not as floriferous as earlier.

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Pelargonium peltatum (Ivy Geranium) 'Compact Burgundy'	Syn	**8-10	**14-16	Good bloom and vigor.	7-9	12-15	Hardly any flowers right now.
Pelargonium peltatum (Ivy Geranium) 'Lambada Hot Pink'	Syn	7-9	9-12	Not quite as full or vigorous as the other ivy geraniums.	6-7	11-13	Least vigorous of the ivy geraniums right now.
Pennisetum glaucum 'Jester'	Pk	18-24	8-13	Not looking very nice right now.	18-26	8-16	Poor; no vigor.
Pennisetum setaceum (Fountain Grass)	Pk	***28-30	***28-30	Very nice!	***to 46	***36-38	Nice, as usual.
Pentas lanceolata 'Graffiti Bright Red'	Ben	3-4	4-5	Small, not very nice.	5-6	7-9	Small but good bloom.
Pentas lanceolata 'Northern Lights Lavender'	Ben	6-9	4-9	Not uniform in bloom or size but some plants really nice.	**11-13	**11-15	Looks good!
Petunia hybrida (Spreading) 'Baby Duck Yellow'	PAS	**to 12	**to 40	Very nice!	11-13+	42+	Over-took *Petunia* 'LoGro White'.
Petunia hybrida (Spreading) 'Blue Wave'	AAS '03	**9-10	**to 40	Good bloom and vigor.	8-10	24-30	Good vigor.
Petunia hybrida (Multiflora) 'Carpet Pink Improved'	PAS	**12-14	**22-24	Good bloom and vigor.	14-15	18-20	Being crowded by *Petunia* 'Tidal Wave Silver'.
Petunia hybrida (Floribunda) 'Celebrity Blue Improved'	Pk	**13-15	**18-20	Good bloom and vigor.	**11-13	**24-26	Good vigor and bloom.
Petunia hybrida (Grandiflora) 'Dreams Fuchsia'	PAS	**12-14	**20-22	Good bloom and vigor.	13-15	22-24	Not blooming all that great right now.
Petunia hybrida (Grandiflora) 'Dreams DayDreams Mix'	PAS	**12-14	**15-18	Good bloom and vigor.	13-14	20-22	Not blooming all that great right now.
Petunia hybrida (Grandiflora) 'Dreams Rose Morn'	PAS	**13-15	**20-22	Good bloom and vigor.	13-15	22-24	Not that great right now.
Petunia hybrida (Spreading) 'Easy Wave Mystic Pink'	PAS	**9-12	**30-36	Nice!	14-16	to 36	Not as nice as earlier.
Petunia hybrida (Spreading) 'Easy Wave Pink Marble Mix'	PAS	**12-15	**18-24	Good bloom and vigor.	10-13	20-24	Not as nice as earlier.
Petunia hybrida (Spreading) 'Easy Wave Red'	Pk	**11-12	**33-36	Good bloom and vigor.	13-15	24-30	Doing alright.
Petunia hybrida (Spreading) 'Easy Wave Rosy Dawn'	Pk	**6-8	**26-30	Good bloom and vigor.	10-13	24-38	Being over-run by *Petunia* 'Easy Wave Red' and 'Easy Wave Misty Pink'.
Petunia hybrida (Large-flowered Trailing) 'Jamboree Blue'	Syn	***12-14	***to 36	Great!	13-15	22-24	Crowded by *Petunia* 'Lavender Wave' and 'Jamboree Light Blue'.
Petunia hybrida (Large-flowered Trailing) 'Jamboree Burgundy'	Syn	***12-15	***to 40	Great!	**14-16	**to 36	Very vigorous.
Petunia hybrida (Large-flowered Trailing) 'Jamboree Lavender II'	Syn	***11-13	***to 40	Great!	15-17	to 24	Crowded by *Petunia* 'Jamboree Burgundy' and 'Jamboree Light Blue'.
Petunia hybrida (Large-flowered Trailing) 'Jamboree Light Blue'	Syn	***11-13	***to 40	Great!	**14-16	**22-24	Nice!

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Petunia hybrida (Spreading) 'Lavender Wave'	AAS '02	***6-8	***to 40	Very, very nice!	**6-8	**to 36	Good vigor and bloom.
Petunia hybrida (Grandiflora) 'Limbo Violet'	AAS '04	**8-10	**15-17	Good bloom and vigor.	8-9	22-24	Not as nice as earlier.
Petunia hybrida (Spreading) 'LoGro White'	Gri	**6-7	**10-12	Good bloom and vigor.	( )	( )	*Petunia* 'Baby Duck Yellow' over-ran this one.
Petunia hybrida (Spreading) 'LoGro Yellow'	Gri	***to 10	***to 38	Tons of flowers!	15-17	33-36	Good vigor but not as floriferous as before.
Petunia hybrida (Floribunda) 'Madness Plum Crazy Improved'	Ball	**( )	**( )	Good bloom and vigor.	12-16	28-30	Doing alright.
Petunia hybrida (Floribunda) 'Madness Red Improved'	Ball	**10-11	**14-16	Good bloom and vigor.	11-13	24-26	Doing alright.
Petunia hybrida (Floribunda) 'Madness Yellow'	Ball	**9-11	**12-22	Good bloom and vigor.	13-15	22-25	Doing alright.
Petunia hybrida (Multiflora) 'Merlin Blue Morn'	AAS '03	**12-14	**20-22	Good bloom and vigor.	9-10	18-20	Not as showy as earlier.
Petunia hybrida (Spreading) 'Misty Lilac Wave'	Pk	***10-12	***to 42	Nice!	9-11	36+	Good vigor but blossoms look sick.
Petunia hybrida (Trailing grandiflora) 'Opera Supreme Lilac Ice'	Pk	**8-10	**to 36	Nice!	5-7	to 24	Decline in bloom from earlier this summer.
Petunia hybrida (Spreading) 'Opera Supreme Pink Morn'	AAS '07	**7-9	**33-36	Nice!	10-12	24-30	Being crowded by *Petunia* 'Vista Bubblegum'.
Petunia hybrida (Spreading) 'Pink Wave'	Pk	***5-6	***to 36	Very nice!	5-7	18-20	Looks like some Aster Yellows.
Petunia hybrida (Spreading) 'Purple Wave'	AAS '95	**8-10	**to 36	Good bloom and vigor.	5-7	to 36	Alright but not as nice as earlier this summer.
Petunia hybrida (Spreading) 'Shock Wave Ivory'	PAS	***9-10	***28-30	Tons of flowers!	15-17	28-36	Nice but a bit of yellowing foliage.
Petunia hybrida (Spreading) 'Shock Wave Pink Vein'	PAS	**8-9	**12-16	Nice but being over-run by *Petunia* 'Tidal Wave Silver'.	( )	( )	Totally swallowed up by *Petunia* 'Tidal Wave Silver'.
Petunia hybrida (Spreading) 'Shock Wave Purple'	PAS	**to 16	**to 36	Good bloom and vigor.	11-13	28-26	A bit of disease present.
Petunia hybrida (Spreading) 'Shock Wave Rose'	PAS	***4-6	***28-30	Solid mass of pink.	11-13	28-30	A bit of disease present.
Petunia hybrida (Hedgiflora) 'Tidal Wave Silver'	AAS '02	***to 13	***to 48	Very, very vigorous and showy!	**13-16	**to 48	Very vigorous!
Petunia hybrida (Grandiflora) 'Ultra Crimson Star'	AAS '88	**10-11	**18-20	Good bloom and vigor.	13-15	24-26	Not as nice as earlier.
Petunia hybrida (Supertunia) 'Vista Bubblegum'	Unk	***to 18	***to 38	Great!	**14-17	**36+	Very nice and vigorous.
Petunia hybrida (Mini-flowered Trailing) 'Whispers Blue'	Syn	***12-14	***to 40	Nice!	**12-14	**to 36	Nice!

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Genus species 'Cultivar'	Seed/Plant Source	July 29 Height	July 29 Spread	July 29 Comments	September 8 and 9 Height	September 8 and 9 Spread	September 8 and 9 Comments
Petunia hybrida (Mini-flowered Trailing) 'Whispers Bright Pink'	Syn	***8-9	***23	Very uniform but some yellowing foliage.	4-6	10-12	No vigor and sickly.
Petunia hybrida (Mini-flowered Trailing) 'Whispers Rose Vein'	Syn	***12-14	***to 40	Nice!	6-8	22-24	Sickly and yellowing.
Petunia hybrida (Mini-flowered Trailing) 'Whispers White'	Syn	***12-14	***to 40	Nice!	6-8	22-24	Sickly and yellowing.
Plectranthus argentatus 'Silver Shield'	Pk	**8-10	**10-16	Good vigor and show.	**15-18	**22-30	Nice but not as vigorous as in years past.
Portulaca grandiflora (Moss Rose) 'Margarita Fruit Splash Hybrid'	Pk	5-7	10-14	All dark pink except one coral.	6-7	8-14	Best of the moss roses but still a lot of disease.
Portulaca grandiflora (Moss Rose) 'Margarita Pastel Mix'	Pk	3-6	6-13	Not much of a color mix-all white and creamy yellow; not uniform in size.	4-7	7-14	Disease present and plants dying.
Portulaca grandiflora (Moss Rose) 'Margarita Mix'	Pk	4-6	8-13	Good bloom and color mix.	3-7	9-14	Disease present.
Rudbeckia hirta (Black-eyed Susan) 'Corona'	Ben	4-11	6-9	Good bloom but not uniform in size.	6-10	6-8	Poor.
Rudbeckia hirta (Black-eyed Susan) 'Prairie Sun'	AAS '03	**18-21	**15-18	Nice!	22-24	28-32	Good bloom but powdery mildew present.
Rudbeckia hirta (Black-eyed Susan) 'Radiance'	Ball	*11-13	*7-12	Neat 'quill' petals; good bloom but not uniform in spread.	13-18	14-17	Nice flowers but lots of powdery mildew.
Rudbeckia hirta (Black-eyed Susan) 'Tiger Eye Gold'	Ball	**12-15	**14-18	Very good bloom.	**12-16	**16-20	Great bloom on clean plants.
Salvia farinacea 'Evolution'	AAS '06	**18-20	**12-14	Looks good.	**24-26	**18-20	Good bloom and vigor.
Salvia farinacea 'Fahrenheit Violet'	Gri	**19-20	**13-15	Nice!	**24-26	**18-20	Good bloom and vigor.
Salvia farinacea 'Victoria'	Pk	**19-20	**12-15	Looks good.	**24-26	**18-20	Good bloom and vigor.
Salvia splendens 'Flare'	Pk	**12-14	**11-13	Good vigor and bloom.	18-19	15-17	Bit of a decline in bloom right now.
Salvia splendens 'Hotline Mix'	Pk	6-12	8-14	Not uniform in size but good bloom.	11-18	13-16	Good vigor but needs deadheading.
Salvia splendens 'Vista Rose'	PAS	**8-9	**9-13	Great bloom and good size uniformity.	11-12	10-15	Good vigor but needs deadheading.
Salvia splendens 'Whopper Lighthouse'	Pk	16-18	14-15	Not as much bloom as the others.	**26-28	**20-22	Nice show of red.
Scaveola 'Bombay Blue'	Syn	5-9	12-14	Much more vigor than 'Bombay Pink'.	3-4	18-22	Still much nicer than *Scaveola* 'Bombay Pink'; some being over-run by *Alternanthera* 'Royal Tapestry'.
Scaveola 'Bombay Pink'	Syn	4-6	9-13	Not very vigorous.	2-3	10-12	Poor; no vigor.
Solenostemon scuttelerioides (Coleus) 'Chocolate Mint'	PAS	6-8	7-8	Doing alright.	9-10	8-10	Not much vigor.

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Genus species 'Cultivar'	Seed/Plant Source	July 29 Height	July 29 Spread	July 29 Comments	September 8 and 9 Height	September 8 and 9 Spread	September 8 and 9 Comments
Solenostemon scuttelerioides (Coleus) 'Dark Chocolate'	PAS	3	3	Only 1 of 6 left; something ate the rest.	4	5	Small; no vigor.
Solenostemon scuttelerioides (Coleus) 'Aureole'	Pk	5-6	6-7	Only 3 plants there.	10-14	5-10	Not much vigor.
Solenostemon scuttelerioides (Coleus) 'Limelight'	Pk	6-9	6-10	Doing alright.	15-18	8-20	Not uniform in size.
Solenostemon scuttelerioides (Coleus) 'Palisandra'	Pk	6-10	5	Only 2 of 6 plants still there.	13-14	8-9	Not much vigor.
Spilanthes oleracea 'Peek-A-Boo'	Pk	4-5	9-18	Not uniform in spread and just starting to bloom.	**7-9	**18-20	Good bloom and vigor.
Stipa tenuissima 'Ponytails'	Pk	**18-20	**14-16	Good vigor.	**24-26	**30-36	Nice!
Sutera cordata (Bacopa) 'Calypso Jumbo White'	Syn	3-4	8-10	Lost 4 of 12; not very healthy-foliage looks burned.	1-3	10-16	About half died; survivors look alright.
Tagetes erecta (Marigold) 'Inca Gold'	Pk	**12-15	**16-19	Very nice!	18-20	22-25	Doing alright.
Tagetes erecta (Marigold) 'Inca Orange'	Pk	**11-13	**15-18	Nice!	19-22	22-25	Some Aster Yellows, otherwise alright.
Tagetes erecta (Marigold) 'Inca Primrose'	Pk	**14-15	**17-19	Looks good.	18-20	20-24	Dead heads detract from appearance and some Aster Yellows present.
Tagetes erecta (Marigold) 'Inca Yellow'	Pk	*11-16	*12-17	Not uniform in height but good bloom.	15-17	20-22	Doing alright but dead heads detract a bit.
Tagetes erecta (Marigold) 'Mumsy Mix'	Pk	8-18	8-16	Good bloom but not uniform in height.	13-18	18-22	A bit past peak bloom and some Aster Yellows present.
Tagetes erecta (Marigold) 'Moonstruck Orange'	Pk	*9-11	*11-14	Nice but not uniform in size.	16-18	13-15	Alright.
Tagetes erecta (Marigold) 'Parks Whopper Gold'	Pk	*13-17	*15-19	Looks good.	**22-26	**20-22	Good bloom and vigor.
Tagetes erecta (Marigold) 'Park's Whopper Orange'	Pk	*13-16	*14-17	Good bloom.	**18-22	**20-23	Nice and bright.
Tagetes erecta (Marigold) 'Park's Whopper Yellow'	Pk	**15-18	**15-17	Good bloom and size uniformity.	20-22	20-24	One plant split apart.
Tagetes erecta (Marigold) 'Vanilla'	PAS	*18-20	*16-20	Doing alright.	**20-25	**25-30	Falling over into *Tagetes* 'Moonstruck Orange'; but good bloom and vigor.
Tagetes patula x erecta (Hybrid Marigold) 'Daisy Orange-Red'	Gri	*14-23	*17-20	One plant that is taller than the rest; otherwise good bloom and vigor.	16-20	18-22	Some Aster Yellows but good bloom and vigor.
Tagetes patula x erecta (Hybrid Marigold) 'Sunburst Orange'	Pk	**11-17	**19-20	Good vigor, bloom, and size uniformity.	18-20	20-22	Doing alright.
Tagetes patula x erecta (Hybrid Marigold) 'Zenith Red'	Pk	**14-16	**18-20	Good bloom and vigor.	**15-17	**22-24	Good bloom!
Talinum paniculata 'Limon'	PAS	**17-20	**20-23	Good vigor.	**36-38	**38-40	Good vigor-nice!

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Genus species 'Cultivar'	Seed/Plant Source	July 29 Height	July 29 Spread	July 29 Comments	September 8 and 9 Height	September 8 and 9 Spread	September 8 and 9 Comments
Thunbergia alata (Black-eyed Susan Vine) 'Mix'	Pk	**Vining 3-4'		Good bloom and vigor.	**vining 5-6 feet		Very nice!
Thymophylla tenuiloba (Dahlberg Daisy)	Pk	**7-8	**12-14	Nice show of yellow.	6-7	15-17	Dahlia crowding it; two plants dying.
Tropaeolum majus (Nasturtium) 'Alaska Gold'	Pk	*8-12	*10-15	Not uniform in size but good vigor and lots of flowers.	*12-15	*24-28	Very vigorous but few flowers.
Verbena bonariensis	Pk	**38-40	**36-38	Neat!	**38-40	**38-40	There is some powdery mildew but otherwise vigorous and floriferous.
Verbena x hybrida 'Escapade Bright Eye'	Syn	***10-11	***18-24	Most vigorous of the *Verbena* right now; nice!	9-10	24-26	Very vigorous but few flowers right now.
Verbena x hybrida 'Escapade Pink'	Syn	***6-8	***18-20	Nice carpet of pink!	**9-10	**24-26	Vigorous and floriferous.
Verbena x hybrida 'Lanai Blush White'	Syn	**6-9	**15-20	Good bloom and vigor.	7-9	24-26	Very vigorous but few flowers.
Verbena x hybrida 'Lanai Bright Pink'	Syn	**4-5	**18-22	Good bloom and vigor.	4-6	24-26	Good vigor but not many blooms right now.
Verbena x hybrida 'Lanai Lavender Star'	Syn	***8-9	***18-20	Solid mass of purple.	**11-12	**17-18	Good bloom and vigor.
Verbena x hybrida 'Lanai Peach'	Syn	**4-7	**16-20	Good bloom and vigor.	*4-7	*16-18	Good vigor but not as floriferous as *Verbena* 'Lanai Lavender Star'.
Verbena x hybrida 'Lanai Purple Star'	Syn	3-4	10-15	Not as floriferous, full or vigorous as other *Verbena* .	*6-8	*16-18	Nice but not quite as floriferous as some other *Verbena* right now.
Verbena x hybrida 'Lanai Royal Purple with Eye'	Syn	***7-8	***18-20	Great bloom!	*11-12	*18-20	Very good vigor but only about half the plants are blooming.
Verbena x hybrida 'Lanai Upright Magenta'	Syn	**11-13	**12-15	Nice!	**12-13	**16-18	Very good vigor and bloom.
Verbena x hybrida 'Lanai Upright Violet'	Syn	**6-7	**10-12	One plant without any blooms; otherwise very nice and vigorous.	**7-8	**12-14	Very good vigor and bloom.
Verbena x hybrida 'Quartz XP Purple'	PAS	**6-7	**12-15	Good bloom and vigor.	6-7	15-18	Some powdery mildew and spider mites.
Verbena x hybrida 'Quartz XP Red Eye'	PAS	**6-8	**12-15	Good bloom and vigor.	5-7	15-18	Dying; powdery mildew and spider mites.
Verbena x hybrida 'Quartz XP Scarlet'	PAS	5-8	8-17	Not uniform in spread.	7-10	12-19	Some powdery mildew and spider mites.
Verbena x hybrida 'Quartz XP Silver'	PAS	**7-9	**12-15	Good bloom and vigor.	6-8	24-25	Decline in bloom.
Verbena x hybrida 'Quartz XP White'	PAS	**6-8	**10-14	Good bloom and vigor.	8-10	17-19	Doing alright.
Verbena x hybrida 'Rapunzel Lilac'	Syn	**6-7	**14-16	Nice!	**6-7	**16-20	Very good vigor and bloom.
Verbena x hybrida 'Rapunzel Violet'	Syn	**5-6	**12-16	Nice!	**6-7	**16-18	Very good vigor and bloom.

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Genus species 'Cultivar'	Seed/Plant Source	July 29			September 8 and 9		
		Height	Spread	Comments	Height	Spread	Comments
Verbena rigida 'Rigida Rose'	Gri	10-12	14-16	Just starting to bloom.	**15-17	**13-16	Nice!
Verbena tenuisecta 'Imagination'	Pk	**12-16	**30-36	Good bloom but size uniformity could be better.	13-15	36-40	Good vigor but flowers on outside edges only.
Viola F1 'Skippy XL Plum-Gold'	AAS '08	4-5	8-10	Doing alright; not being eaten by rabbits.	3-5	7-10	Not too vigorous and some powdery mildew.
Viola F1 'Skippy XL Red-Gold'	AAS '06	5-6	8-10	Doing alright; not being eaten by rabbits.	3-5	7-10	Not too vigorous and some powdery mildew.
Viola F1 'Rain Blue and Purple'	AAS '09	4-5	8-9	Doing alright; not being eaten by rabbits.	3-5	7-10	Not too vigorous and some powdery mildew.
Zinnia angustifolia 'Crystal Orange'	Pk	6-9	6-12	Good bloom but size not uniform.	14-16	10-20	Not uniform in size but good bloom.
Zinnia elegans 'Magellan Coral'	AAS '05	**7-8	**8-10	Nice; uniform in size and bloom.	**12-16	**15-18	Nice!
Zinnia elegans 'Magellan Mix'	Pk	4-11	7-13	Lost 6 of 12 plants; size not uniform.	8-18	13-18	Not uniform in height but bloom good.
Zinnia elegans 'Zowie! Yellow Flame'	AAS '06	10-12	6-12	Spread not uniform.	**23-26	**18-20	Good bloom and vigor.
Zinnia elegans 'Uproar Rose'	Pk	**20-22	**20-26	Nice; bright color!	*24-26	*33-36	Good bloom but some stems falling over.
Zinnia hybrid 'Profusion Knee-High Red'	Ball	8-11	9-15	Small but bloom good.	**18-20	**26-28	Very vigorous and nice.
Zinnia hybrid 'Profusion Knee-High White'	Ball	*10-12	*8-16	One plant really small; bloom good.	**18-20	**28-30	Very vigorous and nice.
Zinnia Marylandica 'Zahara Coral Rose'	PAS	8-12	8-14	Most vigorous of the 'Zahara' zinnias; fairly good bloom.	**16-18	**18-20	Best of the 'Zahara' zinnias right now.
Zinnia Marylandica 'Zahara Scarlet'	PAS	6-11	4-9	Not uniform in size but fairly good bloom.	11-13	18-20	Good bloom but not uniform in vigor; one plant splitting apart.
Zinnia Marylandica 'Zahara White'	PAS	8-10	8-10	Better size uniformity but flowers not as showy as *Zinnia* 'Zahara Scarlet' or 'Zahara Yellow'.	9-16	8-25	One really small plant; others doing alright.
Zinnia Marylandica 'Zahara Yellow'	PAS	5-10	6-9	Doing alright but not uniform in size.	*11-13	*15-18	Lost two plants; nice, clear yellow color.

2008 Site Evaluations and Measurements-Dickinson, ND

Note-An * preceding a cultivar measurement indicates good performance but lacking somewhat in size uniformity or bloom time; ** indicates a top performer with good bloom, vigor and uniformity; *** indicates outstanding performance. All measurements are in inches except where noted and ( ) indicates missing data. Seed/plant source list is on the last page of the report.

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Genus species 'Cultivar'	Seed/Plant Source	July 9 Height	July 9 Spread	July 9 Comments	September 4 Height	September 4 Spread	September 4 Comments
Achillea ptarmica 'Gypsy White'	Syn	1-2	2-3	No vigor or blooms; looks like it's being eaten by bunnies or gophers.	7-10	12-16	Not uniform in bloom.
Ageratum houstonianum 'Patina Blue'	Syn	3-5	3-7	Not uniform in bloom or vigor.	**6-7	**11-13	Very good bloom.
Alcea rosea (Hollyhock) 'Queeny Purple'	AAS '04	3-8	3-10	Not uniform in size and no blooms; critters eating?	9-28	11-18	Good but looks heat stressed; one really small plant.
Begonia benariensis 'BIG Red Bronze Leaf'	Ben	*5-9	*5-9	Nice but not uniform in size.	*10-18	*10-17	Not uniform in height but good bloom.
Begonia benariensis 'BIG Red Green Leaf'	Ben	**5-9	**7-9	Nice with good bloom and vigor.	**11-14	**12-13	Good bloom, vigor and uniformity.
Begonia benariensis 'BIG Rose Bronze Leaf'	Ben	**8-10	**7-10	Nice with good bloom and vigor.	**14-17	**13-14	Nice!
Bidens pelfi 'Mexican Gold'	Syn	**6-8	**13-14	Good bloom and vigor.	**9-12	**25-27	Nice show of yellow.
Bracteantha bracteata 'Strawburst Yellow'	Syn	**7-10	**8-11	Good bloom and vigor.	12-16	15-17	Outer petals are dark brown-why? Plants look healthy.
Calibrachoa x hybrida 'Callie Coral Pink'	Syn	2-3	7-9	Yellowing foliage; no vigor.	---	---	Poor; most dead or dying.
Calibrachoa x hybrida 'Callie Deep Yellow'	Syn	2-4	6-8	Poor; foliage very yellow.	---	---	Poor; most dead or dying.
Calibrachoa x hybrida 'Callie Gold with Red Eye'	Syn	2-4	6-8	Yellowing foliage; no vigor.	---	---	Poor; most dead or dying.
Calibrachoa x hybrida 'Callie Light Blue'	Syn	2-3	8-10	Foliage is also yellowing but not as bad as on some others.	---	---	Poor; most dead or dying.
Calibrachoa x hybrida 'Callie Orange 08'	Syn	2-4	6-8	Poor; foliage very yellow.	---	---	Poor; most dead or dying.
Calibrachoa x hybrida 'Callie Painted Coral'	Syn	4-6	7-10	Most vigorous *Calibrachoa* but there is some yellowing foliage.	---	---	Poor; most dead or dying.
Calibrachoa x hybrida 'Callie Peach'	Syn	2-4	6-8	Very poor with very yellow foliage.	---	---	Poor; most dead or dying.
Calibrachoa x hybrida 'Callie Purple 07'	Syn	2-3	10-12	Best of the group; no yellowing foliage and bloom alright.	---	---	Poor; most dead or dying.
Calibrachoa x hybrida 'Callie Rose'	Syn	2-3	6-8	Not as much yellowing on this foliage.	---	---	Poor; most dead or dying.
Calibrachoa x hybrida 'Callie Scarlet Red 08'	Syn	2-4	6-8	Very poor with very yellow foliage.	---	---	Poor; most dead or dying.
Capsicum annuum (Ornamental Pepper) 'Black Pearl'	AAS '06	3-7	3-7	Only 3 plants here; not uniform in size and few blooms.	**17-21	**17-20	Good vigor and show.

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Genus species 'Cultivar'	Seed/Plant Source	July 9 Height	July 9 Spread	July 9 Comments	September 4 Height	September 4 Spread	September 4 Comments
Capsicum annuum (Ornamental Pepper) 'Calico'	PAS	**7-8	**7-8	Most vigor of the group; unique, variegated foliage.	*10-17	*15-20	Neat variegated foliage; not uniform in size but better than *Capsicum* 'Purple Flash'.
Capsicum annuum (Ornamental Pepper) 'Purple Flash'	PAS	3-6	3-4	Uniform in size but no vigor and few blooms.	4-12	6-17	Interesting foliage; not uniform in size.
Catharanthus roseus (Vinca) 'First Kiss Blueberry'	AAS '05	3	3-4	Poor with no vigor.	**9-11	**12-13	Good bloom, vigor and uniformity.
Catharanthus roseus (Vinca) 'Nirvana Pink Blush'	Syn	2-3	3-4	Poor with no vigor.	**9-11	**11-13	Good bloom and vigor.
Catharanthus roseus (Vinca) 'Nirvana Red'	Syn	3-4	3-4	Poor with no vigor.	9-11	11-17	Not uniform in size.
Catharanthus roseus (Vinca) 'Nirvana Violet'	Syn	3-4	4-5	Poor with no vigor.	**9-11	**13-14	Nice!
Catharanthus roseus (Vinca) 'Nirvana White'	Syn	1-2	1-2	Poor with no vigor.	7-9	11-13	Only 2 plants here; those are doing alright.
Catharanthus roseus (Vinca) 'Pacifica Burgundy Halo'	AAS '07	3	3-4	Poor with no vigor.	9-13	12-15	Some Aster Yellows present.
Catharanthus roseus (Vinca) 'Pacifica Magenta Halo XP'	PAS	4-5	4-5	Best of the vinca but still not much vigor.	**9-11	**12-14	Nice!
Catharanthus roseus (Vinca) 'Pacifica White XP'	PAS	4-5	3-4	Poor with no vigor.	**7-9	**11-13	Nice!
Celosia plumosa 'Fresh Look Gold'	AAS '07	3-4	4-5	Really small plants.	**10-15	**8-12	Very good bloom but not uniform in size.
Celosia plumosa 'Fresh Look Red'	AAS '04	*6-7	*5-6	Small but good bloom and vigor.	***17-20	***12-14	Very, very nice!
Celosia plumosa 'Fresh Look Yellow'	AAS '04	4-6	4-5	Small plants.	*11-20	*9-16	Good bloom but not uniform in size.
Coreopsis grandiflora 'Corey Yellow'	Syn	**8-9	**7-10	Good bloom; very nice.	11-20	11-23	Not uniform in size but nice, bright color.
Dianthus F1 'Supra Purple'	AAS '06	*7-8	*6-8	Not uniform in bloom but flowers are nice and vigor is good.	9-12	9-11	Lull in bloom right now.
Diascia barberae 'Darla Light Pink'	Syn	*7-8	*6-12	Good bloom but not uniform in spread.	9-14	18-20	Good vigor but lull in bloom.
Diascia barberae 'Darla Rose 08'	Syn	*7-8	*8-12	Good bloom but not uniform in spread.	10-14	18-20	Good vigor but lull in bloom.
Diascia barberae 'Diamonte Coral Rose'	AAS '06	4-8	4-11	Not uniform in size.	12-15	18-23	Good vigor but lull in bloom.
Dorotheanthus bellidiformis 'Mezoo Trailing Red'	Syn	1	6-12	Not uniform in size and no blooms.	1-5	6-28	Neat foliage but not uniform in size.
Gaillardia aristata 'Arizona Sun'	AAS '05	6-7	10-11	Good vigor and uniformity but not much bloom, yet.	*6-16	*6-22	One really small plant; others are nice with good bloom.
Gaillardia aristata 'Sunburst Burgundy Picotee'	Syn	**9-11	**12-13	Older blossoms a bit faded but otherwise good bloom and vigor.	**14-16	**18-22	Nice!

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Genus species 'Cultivar'	Seed/Plant Source	July 9 Height	July 9 Spread	July 9 Comments	September 4 Height	September 4 Spread	September 4 Comments
Gaillardia aristata 'Sunburst Scarlet Halo'	Syn	**6-9	**9-10	Good vigor and bloom.	8-14	8-18	One with Aster Yellows, others are alright.
Gypsophila muralis (Baby's Breath) 'Gypsy Deep Rose'	AAS '04	1-3	4-6	Nice little plants but not too vigorous, yet.	3-4	4-5	Poor; dying.
Impatiens hawkerii (New Guinea Impatiens) 'Sonic Deep Red 08'	Syn	3-4	4-5	No vigor and few blooms.	3-5	7-9	Small but doing alright.
Impatiens hawkerii (New Guinea Impatiens) 'Sonic Lilac'	Syn	3-4	4-5	No vigor and few blooms.	3-5	6-8	Small but vigorous.
Impatiens hawkerii (New Guinea Impatiens) 'Sonic Mango'	Syn	3-4	4-5	No vigor and few blooms.	3-4	8-9	Small but vigorous.
Impatiens hawkerii (New Guinea Impatiens) 'Sonic Orange 08'	Syn	3-4	4-5	Not many blooms.	4-6	8-9	One of the better bloomers here.
Impatiens hawkerii (New Guinea Impatiens) 'Sonic Scarlet 09'	Syn	3-4	3-4	Good bloom on small plants.	3-5	6-8	Few blooms.
Impatiens hawkerii (New Guinea Impatiens) 'Sonic Sweet Orange 09'	Syn	3-4	4-5	No vigor and few blooms.	3-5	6-8	Doing alright.
Impatiens hawkerii (New Guinea Impatiens) 'Super Sonic Lavender 08'	Syn	3-4	4-5	No vigor and few blooms.	4-6	7-9	Small but vigorous.
Impatiens hawkerii (New Guinea Impatiens) 'Super Sonic Lilac 09'	Syn	3-4	4-5	No vigor and few blooms.	4-5	6-9	Small-similar to others.
Impatiens hawkerii (New Guinea Impatiens) 'Super Sonic Magenta 08'	Syn	3-4	4-5	No vigor and few blooms.	5-6	7-10	A bit more vigorous than some others.
Impatiens hawkerii (New Guinea Impatiens) 'Super Sonic Pastel Pink'	Syn	3-4	4-5	No vigor and few blooms.	3-5	5-9	Doing alright.
Impatiens hawkerii (New Guinea Impatiens) 'Super Sonic Red 08'	Syn	3-4	4-5	No vigor and few blooms.	3-4	6-8	Small but vigor is alright.
Impatiens hawkerii (New Guinea Impatiens) 'Super Sonic Cherry Cream'	Syn	3-4	4-5	No vigor and few blooms.	3-5	7-9	Small but vigorous.
Impatiens walleriana (Double Impatiens) 'Silhouette Cherry Red 09'	Syn	1-2	3-6	Poor; no blooms.	3-5	6-10	Only 2 plants and few blooms.
Impatiens walleriana (Double Impatiens) 'Silhouette Orange Star'	Syn	1	2-3	Poor; no blooms.	1-2	3-5	Only two plants; small with few blooms.
Impatiens walleriana (Double Impatiens) 'Silhouette Purple'	Syn	1-3	2-5	Best of the group but still poor.	2-4	6-8	Small with few blooms.
Impatiens walleriana (Double Impatiens) 'Silhouette Salmon 09'	Syn	2-3	3-4	No vigor and few blooms.	1-2	3-5	Poor; no blooms.
Impatiens walleriana (Double Impatiens) 'Silhouette White'	Syn	---	---	Gone.	---	---	Gone.
Ipomoea batata (Sweet Potato Vine) 'Sidekick Black Heart'	Syn	5-6	6-9	Not too vigorous, yet.	**15-17	**to 3'	Very vigorous and nice.
Ipomoea batata (Sweet Potato Vine) 'Sidekick Black Palmate'	Syn	5-6	6-10	Not too vigorous, yet.	**14-18	**28-30	Very vigorous and nice.

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Genus species 'Cultivar'	Seed/Plant Source	July 9 Height	July 9 Spread	July 9 Comments	September 4 Height	September 4 Spread	September 4 Comments
Juncus tenuis 'Blue Dart'	PAS	**10-12	**7-9	Nice form and color; unique.	*10-16	*8-16	Not uniform in size but neat texture.
Lantana camara 'Bandana Cherry'	Syn	2-3	3-5	Small and not much bloom.	9-12	9-19	Not uniform in size but good vigor.
Lantana camara 'Bandana Pink 07'	Syn	2-3	3-5	Small and not much bloom.	5-9	8-11	Least vigorous of the *Lantana* .
Lantana camara 'Bandana Red'	Syn	2-3	3-5	Small and not much bloom.	7-9	9-12	Small but uniform.
Lantana camara 'Bandana Rose'	Syn	2-3	3-5	Small and not much bloom.	**11-14	**12-14	Best of the *Lantana* here with good vigor and bloom.
Lobelia erinus 'Techno Heat Dark Blue'	Syn	**7-8	**11-12	Good bloom, size uniformity and vigor.	9-11	11-20	Not uniform in vigor.
Lobelia erinus 'Techno Heat Electric Blue'	Syn	**6-7	**12-13	Good bloom, size uniformity and vigor.	*9-11	*13-17	Not too bad.
Lobelia erinus 'Techno Heat Upright Dark Blue'	Syn	**7-8	**9-10	Good bloom, size uniformity and vigor.	9-11	10-15	Not as vigorous as *Lobelia* 'Techno Heat Upright Light Blue'.
Lobelia erinus 'Techno Heat Upright Light Blue'	Syn	**7-8	**11-12	Most vigorous of the *Lobelia* with good bloom, size uniformity and vigor.	**12-14	**20-22	Best *Lobelia* here right now.
Nicotiana x sanderae (Flowering Tobacco) 'Perfume Deep Purple'	AAS '06	*10-13	*8-12	Just starting to look good.	**19-22	**24-26	Good vigor and bloom.
Osteospermum ecklonis 'Asti White'	AAS '08	8-11	7-10	Not uniform in bloom or height; not blooming as good as some other *Osteospermum* .	12-16	28-30	Good vigor but bloom not great.
Osteospermum ecklonis 'Tradewinds Deep Purple'	Syn	**9	**10-11	Good bloom, uniformity and vigor.	**15-16	**30-33	Good bloom, vigor and uniformity.
Osteospermum ecklonis 'Tradewinds Pearl White'	Syn	**9-11	**10-12	Good bloom, uniformity and vigor.	**14-17	**18-21	Nice!
Osteospermum ecklonis 'Tradewinds Purple Bicolor'	Syn	***8	***11	Very nice!	**14-15	**28-30	Nice!
Osteospermum ecklonis 'Tradewinds Yellow Bicolor'	Syn	**10-12	**10-12	Nice!	12-15	20-24	Good vigor but bloom not great.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Cherry Rose'	Syn	**7-9	**9-11	Good bloom and bright color.	**11-13	**12-14	Good vigor and bloom.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Cranberry Red'	Syn	*6-8	*8-10	Good bloom and fairly uniform in size.	9-13	11-14	Not as uniform or floriferous as *Pelargonium* 'Americana Trailing Dark Red' or 'Americana Cherry Rose'.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Pink'	Syn	4-9	4-10	One really small plant; otherwise looks alright.	9-12	10-17	Doing alright.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Red'	Syn	7-9	7-11	Not uniform in spread but bloom alright.	6-16	12-20	Not uniform in size.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Rose Mega Splash'	Syn	*6-7	*8-11	Similar to *Pelargonium* 'Americana White Splash'.	**10-13	**16-18	Looks good.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Salmon 09'	Syn	**7-9	**7-9	Looks great with good bloom.	8-12	12-16	Good vigor.

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Genus species 'Cultivar'	Seed/Plant Source	July 9 Height	July 9 Spread	July 9 Comments	September 4 Height	September 4 Spread	September 4 Comments
Pelargonium x hortorum (Geranium-Zonal) 'Americana Trailing Dark Red'	Syn	7-9	8-11	Not uniform in bloom; other geraniums much better.	**11-13	**20-22	Very good vigor and fairly uniform in size and bloom.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Violet'	Syn	**7-9	**8-10	Good vigor and bloom.	8-12	9-14	Not uniform in size.
Pelargonium x hortorum (Geranium-Zonal) 'Americana White 09'	Syn	6-8	7-9	Doing alright but others have more flowers and vigor.	5-10	9-13	One really small plant; otherwise they are doing alright.
Pelargonium x hortorum (Geranium-Zonal) 'Americana White Splash 09'	Syn	*6-7	*8-11	Pretty flowers.	7-10	13-15	Looks good.
Pelargonium x hortorum (Geranium-Zonal) 'Avenida Mosaic Red'	Syn	**7-10	**8-12	Good vigor and bloom.	*9-16	*13-20	Good vigor and bloom but not uniform in size.
Pelargonium x hortorum (Geranium-Zonal) 'Eclipse Dark Red'	Syn	*7-9	*7-10	Good bloom.	*9-14	*10-19	Good bloom but not uniform in size.
Pelargonium x hortorum (Geranium-Zonal) 'Eclipse Light Salmon II'	Syn	5-8	6-10	Not uniform in size but bloom alright.	9-13	10-13	Doing alright.
Pelargonium x hortorum (Geranium-Zonal) 'Eclipse Rose Mega Splash'	Syn	*5-6	*7-9	Showy flowers and bloom good.	7-10	8-12	Looks good.
Pelargonium x hortorum (Geranium-Zonal) 'Eclipse Velvet Red'	Syn	5-8	7-9	Bloom not as uniform or good as *Pelargonium* 'Eclipse Rose Mega Splash'.	**12-14	**14-16	Good vigor and bloom.
Pelargonium x hortorum (Geranium-Exotic) 'Graffiti Double Red'	Syn	7-9	5-10	Not uniform in size or bloom.	**11-12	**14-16	Nice!
Pelargonium x hortorum (Geranium-Exotic) 'Graffiti Double Salmon'	Syn	*8-10	*7-10	More bloom and vigor than *Pelargonium* 'Graffiti Double Red'.	**13-15	**18-20	A bit more vigorous than *Pelargonium* 'Graffiti Double Red'.
Pelargonium x hortorum (Geranium-Zonal) 'Rocky Mountain Coral'	Syn	*6-8	*9-12	Vigor good; bloom good compared to some other geraniums.	9-13	13-18	Good vigor.
Pelargonium x hortorum (Geranium-Zonal) 'Rocky Mountain Dark Red'	Syn	*7-8	*10-12	Good vigor.	**9-13	**12-15	Good vigor and better bloom than *Pelargonium* 'Rocky Mt. Coral'.
Pelargonium x hortorum (Geranium-Zonal) 'Rocky Mountain Deep Rose 09'	Syn	**6-8	**7-9	Uniform in size and good bloom.	10-12	12-15	Doing alright.
Pelargonium x hortorum (Geranium-Zonal) 'Rocky Mountain Magenta'	Syn	6-9	5-9	Not uniform in size but bloom alright.	9-11	11-13	Doing alright.
Pelargonium x hortorum (Geranium-Zonal) 'Rocky Mountain Salmon 08'	Syn	5-9	7-10	Not uniform in size or bloom time.	**13-15	**18-20	Good vigor and bloom.
Pelargonium x hortorum (Geranium-Zonal) 'Rocky Mountain Violet'	Syn	6-9	5-9	Not uniform in size but bloom alright.	9-13	8-13	Doing alright but one really small plant.
Pelargonium x hortorum (Geranium-Zonal) 'Tango Coral'	Syn	6-9	5-9	Not as uniform in size as *Pelargonium* 'Tango Magenta' or 'Tango White'.	9-13	10-12	Doing alright.
Pelargonium x hortorum (Geranium-Zonal) 'Tango Magenta'	Syn	**6-8	**6-8	Good bloom on small plants; uniform in size and bloom.	8-10	8-10	Small but uniform in size and bloom.
Pelargonium x hortorum (Geranium-Zonal) 'Tango Red 09'	Syn	5-8	7-9	Not as uniform in bloom as *Pelargonium* 'Tango Magenta' or 'Tango White'.	**9-11	**10-12	Most vigorous and floriferous 'Tango' geranium here.
Pelargonium x hortorum (Geranium-Zonal) 'Tango White'	Syn	**5-7	**6-8	Good bloom on small plants; uniform in size and bloom.	7-10	9-12	Doing alright.

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Genus species 'Cultivar'	Seed/Plant Source	July 9 Height	July 9 Spread	July 9 Comments	September 4 Height	September 4 Spread	September 4 Comments
Pelargonium interspecific (Geranium-Hybrid) 'Caliente Coral'	Syn	*6-8	*9-12	Good vigor but bloom could be better.	**13-15	**28-30	Looks good.
Pelargonium interspecific (Geranium-Hybrid) 'Caliente Lavender'	Syn	*7-9	*10-12	Good vigor but bloom could be better.	**13-15	**26-28	Good bloom, vigor and uniformity.
Pelargonium interspecific (Geranium-Hybrid) 'Caliente Rose'	Syn	*6-8	*9-12	Good vigor but bloom could be better.	**13-15	**26-28	Nice!
Pelargonium peltatum (Ivy Geranium) 'Acapulco Compact Cascade'	Syn	**5-6	**11-13	Good bloom and vigor-nice.	**9-11	**20-22	Nice!
Pelargonium peltatum (Ivy Geranium) 'Beach'	Syn	6-8	10-12	Good vigor but bloom not as nice as some others.	**9-11	**22-24	Vigorous and floriferous.
Pelargonium peltatum (Ivy Geranium) 'Blizzard Pink'	Syn	*6-7	*7-12	Not uniform in spread but bloom nice and pink flowers are showy.	**7-11	**22-24	Nice!
Pelargonium peltatum (Ivy Geranium) 'Compact Burgundy'	Syn	6-7	5-14	Color unique but not showy; not uniform in spread.	9-11	18-20	Not as floriferous or vigorous as *Pelargonium* 'Blizzard Pink'.
Pelargonium peltatum (Ivy Geranium) 'Lambada Hot Pink'	Syn	*6-7	*7-9	Nice, bright color.	7-10	14-16	A bit crowded by *Pelargonium* 'Caliente Lavender'.
Pentas lanceolata 'Northern Lights Lavender'	Ben	6-8	5-6	Not much vigor or many blooms, yet.	*10-13	*11-18	Good vigor and bloom but not uniform in size.
Petunia hybrida (Large-flowered Trailing) 'Jamboree Blue'	Syn	2-4	7-14	Not uniform in spread or bloom.	**7-9	**18-20	Good bloom and vigor.
Petunia hybrida (Large-flowered Trailing) 'Jamboree Burgundy'	Syn	3-5	10-14	Not uniform in bloom.	***9-11	***to 36	Very, very nice and vigorous.
Petunia hybrida (Large-flowered Trailing) 'Jamboree Lavender II'	Syn	*4-6	*12-14	One of the best petunias here.	**9-11	**to 20	Nice!
Petunia hybrida (Large-flowered Trailing) 'Jamboree Light Blue'	Syn	3-5	8-15	Not uniform in spread or bloom.	***9-11	***to 24	Very, very vigorous and nice.
Petunia hybrida (Grandiflora) 'Limbo Violet'	AAS '04	**5-6	**9-10	Good vigor and bloom.	**7-8	**10-12	Good bloom and vigor.
Petunia hybrida (Spreading) 'LoGro Yellow'	Gri	2-4	6-12	Doing alright.	**8-14	**18-20	Nice!
Petunia hybrida (Spreading) 'Opera Supreme Pink Morn'	AAS '07	1-3	5-14	Not uniform in spread.	**9-10	**18-20	Nice!
Petunia hybrida (Mini-flowered Trailing) 'Whispers Blue'	Syn	2-3	12-14	Doing better than *Petunia* 'Whispers Bright Pink'.	***9-10	***20-22	Good show of blue.
Petunia hybrida (Mini-flowered Trailing) 'Whispers Bright Pink'	Syn	1	2	Poor.	1	2-3	Small with no vigor.
Petunia hybrida (Mini-flowered Trailing) 'Whispers Rose Vein'	Syn	2-3	5-14	Not uniform in spread or bloom.	***12-14	***20-22	Very nice!
Petunia hybrida (Mini-flowered Trailing) 'Whispers White'	Syn	2-3	3-9	Not uniform in spread or bloom.	2-5	5-18	No vigor compared to other two 'Whispers' petunias.
Salvia farinacea 'Evolution'	AAS '06	8-12	7-8	More vigor than *Salvia* 'Fahrenheit Violet' but not uniform in height or bloom.	**17-22	**20-24	Nice!

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Genus species 'Cultivar'	Seed/Plant Source	July 9 Height	July 9 Spread	July 9 Comments	September 4 Height	September 4 Spread	September 4 Comments
Salvia farinacea 'Fahrenheit Violet'	Gri	3-7	3-7	Not uniform in size or bloom.	**16-22	**16-19	Looks good.
Scaveola 'Bombay Blue'	Syn	2-4	12-15	Not uniform in spread or vigor.	6-8	20-26	Looks good.
Scaveola 'Bombay Pink'	Syn	1-2	10-14	Not uniform in spread or vigor.	---	---	Poor; most dead or dying.
Solenostemon scuttelerioides (Coleus) 'Dark Chocolate'	PAS	4	4	No vigor.	13-16	9-11	Only two plants here.
Sutera cordata (Bacopa) 'Calypso Jumbo White'	Syn	1	6-12	No vigor and few blooms; one plant yellowing.	2-3	6-14	Not uniform in vigor.
Tagetes patula x erecta (Hybrid Marigold) 'Daisy Orange-Red'	Gri	*9-13	*11-15	One plant not blooming; otherwise they look good.	13-18	18-25	Not uniform in size but good bloom.
Verbena x hybrida 'Escapade Bright Eye'	Syn	1-2	14-16	Good vigor but not much bloom, yet.	*7-8	*36-38	Most vigorous *Verbena* but bloom the worst.
Verbena x hybrida 'Escapade Pink'	Syn	1-2	10-13	Nice, bright color.	**4-6	**28-30	Nice!
Verbena x hybrida 'Lanai Blush White'	Syn	2-5	10-13	Good vigor but not much bloom, yet.	**4-5	**28-30	Good vigor and bloom.
Verbena x hybrida 'Lanai Bright Pink'	Syn	1-2	12-14	Not much bloom, yet.	**4-5	**26-28	A bit crowded by *Verbena* 'Lanai Lavender Star' and 'Lanai Blush White'; otherwise good bloom and vigor.
Verbena x hybrida 'Lanai Lavender Star'	Syn	**5-7	**11-13	Good vigor and bloom.	**5-7	**28-30	Nice!
Verbena x hybrida 'Lanai Peach'	Syn	1	8-10	Not much bloom, yet.	**5-6	**28-30	Nice!
Verbena x hybrida 'Lanai Purple Star'	Syn	1	8-10	Not much bloom, yet.	*5-6	*20-23	Doing alright but not as vigorous as some others.
Verbena x hybrida 'Lanai Royal Purple with Eye'	Syn	**3-4	**12-14	Good bloom and vigor.	*6-7	*28-30	Good vigor but lull in bloom.
Verbena x hybrida 'Lanai Upright Magenta'	Syn	**5-8	**5-9	Nice, bright color; uniform in size and bloom.	**11-13	**18-20	Very nice!
Verbena x hybrida 'Lanai Upright Violet'	Syn	4-5	6-8	Small but ok.	**9-10	**15-18	Nice!
Verbena x hybrida 'Rapunzel Lilac'	Syn	1-2	8-10	Good bloom.	**3-4	**28-30	Good vigor and bloom.
Verbena x hybrida 'Rapunzel Violet'	Syn	1-2	8-12	Alright.	*3-5	*22-24	Lull in bloom but good vigor.
Verbena rigida 'Rigida Rose'	Gri	7-9	5-6	Not much bloom or vigor, yet.	**11-13	**22-24	Looks good.
Viola F1 'Skippy XL Plum-Gold'	AAS '08	1	2-3	Poor; being eaten by bunnies?	---	---	Died.
Viola F1 'Rain Blue and Purple'	AAS '09	1	2-3	Poor; being eaten by bunnies?	---	---	Died.

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Genus species 'Cultivar'	Seed/Plant Source	July 9 Height	July 9 Spread	July 9 Comments	September 4 Height	September 4 Spread	September 4 Comments
Zinnia elegans 'Magellan Coral'	AAS '05	7-8	7-8	Good vigor and size uniformity but just starting to bloom.	**11-13	**12-15	Looks good.
Zinnia elegans 'Zowie! Yellow Flame'	AAS '06	*11-12	*8-9	Good vigor and size uniformity; just starting to bloom.	**18-22	**18-24	Nice!
Zinnia Marylandica 'Zahara Coral Rose'	PAS	7-8	6-9	Fairly uniform in size but just starting to bloom.	**14-16	**17-22	Size a little less uniform here than in other 'Zahara' zinnias.
Zinnia Marylandica 'Zahara Scarlet'	PAS	6-7	5-7	Good size uniformity; bloom alright.	**11-13	**17-18	Very nice!
Zinnia Marylandica 'Zahara White'	PAS	7-8	7-9	Not much bloom yet but vigor good.	**14-15	**18-20	Nice!
Zinnia Marylandica 'Zahara Yellow'	PAS	*6-8	*6-10	Nice, clear, yellow color; most bloom and vigor of the 'Zahara' zinnias.	**14-15	**20-22	Good vigor and bloom.

2008 Site Evaluations and Measurements-Williston, ND

Note-An * preceding a cultivar measurement indicates good performance but lacking somewhat in size uniformity or bloom time; ** indicates a top performer with good bloom, vigor and uniformity; *** indicates outstanding performance. All measurements are in inches except where noted and ( ) indicates missing data. Seed/plant source list is on the last page of the report.

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Genus species 'Cultivar'	Seed/Plant Source	July 10 Height	July 10 Spread	July 10 Comments	September 3 Height	September 3 Spread	September 3 Comments
Achillea ptarmica 'Gypsy White'	Syn	**9	**12-14	Good bloom and vigor.	8-10	16-20	Needs deadheading; past peak bloom but good vigor.
Ageratum houstonianum 'Patina Blue'	Syn	*5-7	*6-9	Good bloom on small plants.	6-8	9-14	Good bloom but not uniform in spread.
Alcea rosea (Hollyhock) 'Queeny Purple'	AAS '04	9-10	12-14	No blooms but plants vigorous.	**30-33	**16-18	Good bloom and vigor.
Begonia benariensis 'BIG Red Bronze Leaf'	Ben	**4-9	**5-8	Only 2 with bronze leaves; bloom and vigor good.	**10-12	**11-13	See July comment.
Begonia benariensis 'BIG Red Green Leaf'	Ben	**6-7	**7-9	Looks nice!	**9-11	**11-13	Nice!
Begonia benariensis 'BIG Rose Bronze Leaf'	Ben	**7-8	**7-9	Good bloom and vigor.	**10-12	**12-14	Nice!
Bidens pelfi 'Mexican Gold'	Syn	**6-7	**12-14	Good bloom.	**10-11	**12-18	Nice show of yellow.
Bracteantha bracteata 'Strawburst Yellow'	Syn	5-8	6-11	Not uniform in spread or bloom.	**13-15	**13-17	Nice!
Calibrachoa x hybrida 'Callie Coral Pink'	Syn	2-3	6-8	Doing alright.	2-3	8-10	Doing alright.
Calibrachoa x hybrida 'Callie Deep Yellow'	Syn	2-3	6-8	Doing alright.	3-4	16-18	Brightest of the *Calibrachoa* right now.
Calibrachoa x hybrida 'Callie Gold with Red Eye'	Syn	2-3	8-11	Looks good.	3-4	15-18	Good vigor.
Calibrachoa x hybrida 'Callie Light Blue'	Syn	2-3	8-10	Alright.	3-4	9-12	Doing alright.
Calibrachoa x hybrida 'Callie Orange 08'	Syn	2-3	8-12	Not uniform in spread.	3-4	15-18	Doing alright.
Calibrachoa x hybrida 'Callie Painted Coral'	Syn	**3-4	**11-12	Good size uniformity and bloom.	6-8	18-20	Looks good.
Calibrachoa x hybrida 'Callie Peach'	Syn	2-3	8-12	Not uniform in spread.	2-3	16-18	Doing alright.
Calibrachoa x hybrida 'Callie Purple 07'	Syn	2-3	6-10	One of the smallest *Calibrachoa* here.	2-3	20-22	Looks good.
Calibrachoa x hybrida 'Callie Rose'	Syn	2-3	8-12	Good bloom.	3-4	14-24	Bright color but not uniform in spread.
Calibrachoa x hybrida 'Callie Scarlet Red 08'	Syn	2-3	6-12	Not uniform in size-one really small plant; good bloom.	6-7	15-18	Good vigor.
Capsicum annuum (Ornamental Pepper) 'Black Pearl'	AAS '06	5-7	4-6	Not much vigor, yet.	**13-15	**12-14	Nice show!

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Genus species 'Cultivar'	Seed/Plant Source	July 10 Height	July 10 Spread	July 10 Comments	September 3 Height	September 3 Spread	September 3 Comments
Capsicum annuum (Ornamental Pepper) 'Calico'	PAS	*5-6	*4-5	Good size uniformity but vigor could be better.	**5-8	**9-12	Vigorous and variegated foliage is neat.
Capsicum annuum (Ornamental Pepper) 'Purple Flash'	PAS	2-5	2-5	Not much vigor, yet.	4-9	5-13	Not uniform in size.
Catharanthus roseus (Vinca) 'First Kiss Blueberry'	AAS '05	3	3	Only 2 small plants here.	8-9	10-12	Only two plants there; they are doing alright.
Catharanthus roseus (Vinca) 'Nirvana Pink Blush'	Syn	3-4	3-5	Only 3 plants here.	9-11	12-14	Only 3 plants here; look alright.
Catharanthus roseus (Vinca) 'Nirvana Red'	Syn	3-5	2-5	Doing alright.	*7-11	*8-12	Bloom good but not uniform in height.
Catharanthus roseus (Vinca) 'Nirvana Violet'	Syn	3-5	3-6	Bloom alright; only 4 plants.	**9-10	**12-13	Good bloom and vigor.
Catharanthus roseus (Vinca) 'Nirvana White'	Syn	3-5	3-5	Bloom alright.	*8-10	*10-14	Not as uniform in size as other vinca.
Catharanthus roseus (Vinca) 'Pacifica Burgundy Halo'	AAS '07	4-5	2-4	Not uniform in bloom and small plants.	**9-11	**12-14	Good bloom and vigor.
Catharanthus roseus (Vinca) 'Pacifica Magenta Halo XP'	PAS	4-5	3-5	Doing alright.	**10-11	**13-14	Good bloom and vigor.
Catharanthus roseus (Vinca) 'Pacifica White XP'	PAS	2-4	2-4	Small plants.	5-8	9-12	Not as vigorous or floriferous as *Catharanthus* 'Pacifica Magenta Halo XP'.
Celosia plumosa 'Fresh Look Gold'	AAS '07	5-6	3-4	Not too vigorous, yet.	**11-14	**10-12	Good vigor and bloom.
Celosia plumosa 'Fresh Look Red'	AAS '04	6-7	4-5	Not too vigorous, yet.	**14-16	**12-14	Nice!
Celosia plumosa 'Fresh Look Yellow'	AAS '04	6-7	3-4	Not too vigorous, yet.	*11-15	*9-13	Not uniform in size and blooms a bit 'dirty' looking.
Coreopsis grandiflora 'Corey Yellow'	Syn	***12-14	***10-12	Very, very nice.	***15-17	***16-22	Great!
Dianthus F1 'Supra Purple'	AAS '06	6-8	5-9	Not uniform in bloom.	8-12	7-9	Vigor good but needs deadheading.
Diascia barberae 'Darla Light Pink'	Syn	**8-10	**10-12	Really good bloom.	**12-14	**26-28	Nice!
Diascia barberae 'Darla Rose 08'	Syn	**10-11	**10-12	Nice!	**13-15	**28-36	Nice!
Diascia barberae 'Diamonte Coral Rose'	AAS '06	**8-9	**10-12	Good bloom and vigor.	**13-15	**24-27	Good bloom and vigor.
Dorotheanthus bellidiformis 'Mezoo Trailing Red'	Syn	1	12-15	Not too full and few flowers.	**2-3	**18-20	Good vigor but not many blooms.
Gaillardia aristata 'Sunburst Burgundy Picotee'	Syn	**10-11	**8-10	Good bloom and vigor.	**11-13	**13-15	Good bloom and vigor.
Gaillardia aristata 'Sunburst Scarlet Halo'	Syn	*8-9	*6-9	Not as vigorous as *Gaillardia* 'Sunburst Burgundy Picotee'.	10-12	11-13	Some plants falling over.

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Genus species 'Cultivar'	Seed/Plant Source	July 10 Height	July 10 Spread	July 10 Comments	September 3 Height	September 3 Spread	September 3 Comments
Gypsophila muralis (Baby's Breath) 'Gypsy Deep Rose'	AAS '04	*3-4	*6-8	Small but good bloom.	3-4	5-6	Poor.
Impatiens hawkerii (New Guinea Impatiens) 'Sonic Deep Red 08'	Syn	2-3	3-4	No vigor.	2-4	5-8	Poor; few blooms.
Impatiens hawkerii (New Guinea Impatiens) 'Sonic Lilac'	Syn	2-3	3-4	No vigor.	2-4	5-8	Poor; few blooms.
Impatiens hawkerii (New Guinea Impatiens) 'Sonic Mango'	Syn	2-3	3-4	No vigor.	2-4	5-8	Poor; few blooms.
Impatiens hawkerii (New Guinea Impatiens) 'Sonic Orange 08'	Syn	2-3	3-4	No vigor.	2-4	5-8	Poor; few blooms.
Impatiens hawkerii (New Guinea Impatiens) 'Sonic Scarlet 09'	Syn	2-3	3-4	No vigor.	2-4	5-8	Poor; few blooms.
Impatiens hawkerii (New Guinea Impatiens) 'Sonic Sweet Orange 09'	Syn	2-3	3-4	No vigor.	2-4	5-8	Poor; few blooms.
Impatiens hawkerii (New Guinea Impatiens) 'Super Sonic Lavender 08'	Syn	2-3	3-4	No vigor.	2-4	5-8	Poor; few blooms.
Impatiens hawkerii (New Guinea Impatiens) 'Super Sonic Lilac 09'	Syn	2-3	3-4	No vigor.	2-4	5-8	Poor; few blooms.
Impatiens hawkerii (New Guinea Impatiens) 'Super Sonic Magenta 08'	Syn	2-3	3-4	No vigor.	2-4	5-8	Poor; few blooms.
Impatiens hawkerii (New Guinea Impatiens) 'Super Sonic Pastel Pink'	Syn	2-3	3-4	No vigor.	2-4	5-8	Poor; few blooms.
Impatiens hawkerii (New Guinea Impatiens) 'Super Sonic Red 08'	Syn	2-3	3-4	No vigor.	2-4	5-8	Poor; few blooms.
Impatiens hawkerii (New Guinea Impatiens) 'Super Sonic Cherry Cream'	Syn	2-3	3-4	No vigor.	2-4	5-8	Poor; few blooms.
Impatiens walleriana (Double Impatiens) 'Silhouette Cherry Red 09'	Syn	2-3	4-6	Probably the best bloom.	4-6	9-12	Best of the double impatiens but still not that great.
Impatiens walleriana (Double Impatiens) 'Silhouette Orange Star'	Syn	2-3	4-6	Small but bloom is alright.	4-5	9-11	Not too vigorous.
Impatiens walleriana (Double Impatiens) 'Silhouette Purple'	Syn	2-3	4-6	Small but bloom is alright.	3-4	8-12	Not too vigorous.
Impatiens walleriana (Double Impatiens) 'Silhouette Salmon 09'	Syn	2-3	4-6	Small but bloom is alright.	2-3	7-9	Not that vigorous.
Impatiens walleriana (Double Impatiens) 'Silhouette White'	Syn	2-3	4-6	Small but bloom is alright.	2-3	7-9	Not too vigorous.
Ipomoea batata (Sweet Potato Vine) 'Sidekick Black Heart'	Syn	**5-7	**10-12	Good vigor.	***13-15	***22-26	Very vigorous and nice.
Ipomoea batata (Sweet Potato Vine) 'Sidekick Black Palmate'	Syn	5-6	8-10	Not as vigorous as *Ipomoea* 'Sidekick Black Heart'.	***12-13	***18-20	Good vigor!
Juncus tenuis 'Blue Dart'	PAS	*8-11	*4-6	Unique.	7-12	5-9	Not uniform in size but interesting texture.

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	Seed/Plant	July 10			September 3		
Genus species 'Cultivar'	Source	Height	Spread	Comments	Height	Spread	Comments
Lantana camara 'Bandana Cherry'	Syn	2-3	3-4	Not too vigorous, yet.	6-7	9-11	Doing alright.
Lantana camara 'Bandana Pink 07'	Syn	2-3	3-4	Not too vigorous, yet.	5-7	8-10	Doing alright.
Lantana camara 'Bandana Red'	Syn	3-5	3-5	Not too vigorous, yet.	7-8	9-11	Doing alright.
Lantana camara 'Bandana Rose'	Syn	4-5	4-6	Not too vigorous, yet.	**11-12	**13-15	Nicest of the *Lantana* ; good vigor and bloom.
Lobelia erinus 'Techno Heat Dark Blue'	Syn	**6-7	**10-12	Great bloom!	9-12	11-15	Doing alright.
Lobelia erinus 'Techno Heat Electric Blue'	Syn	**6-7	**10-12	Great bloom!	8-12	14-16	Decline in bloom.
Lobelia erinus 'Techno Heat Upright Dark Blue'	Syn	**7	**8-10	Nice!	9-12	11-14	Decline in bloom.
Lobelia erinus 'Techno Heat Upright Light Blue'	Syn	***7	***10-11	Nicest *Lobelia* .	**11-13	**18-22	Best of the *Lobelia* right now.
Nicotiana x sanderae (Flowering Tobacco) 'Perfume Deep Purple'	AAS '06	7-11	5-8	Not uniform in size or bloom.	*13-18	*12-18	Not uniform in size but good bloom.
Osteospermum ecklonis 'Asti White'	AAS '08	10-12	6-8	Not as floriferous as some other *Osteospermum* .	12-16	15-20	Not uniform in bloom.
Osteospermum ecklonis 'Tradewinds Deep Purple'	Syn	*8-9	*8-10	Nice but bloom not uniform.	**12-13	**17-20	Good vigor; fairly uniform in bloom.
Osteospermum ecklonis 'Tradewinds Pearl White'	Syn	**9	**8-10	Good uniformity in size and bloom.	11-13	15-18	Not as floriferous as *Osteospermum* 'Tradewinds Deep Purple' or 'Tradewinds Purple Bicolor'.
Osteospermum ecklonis 'Tradewinds Purple Bicolor'	Syn	**8	**8-10	Good bloom.	**10-11	**16-18	Good vigor and fairly uniform in bloom.
Osteospermum ecklonis 'Tradewinds Yellow Bicolor'	Syn	*6-8	*10-12	Not as uniform in size or bloom as other *Osteospermum* but still nice.	11-13	15-17	Least bloom of all the *Osteospermum* .
Pelargonium x hortorum (Geranium-Zonal) 'Americana Cherry Rose'	Syn	**7-9	**8-12	Nice!	9-11	10-15	Not quite as floriferous as earlier.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Cranberry Red'	Syn	*7-9	*7-11	Bloom not quite as uniform as others.	10-12	14-16	Nice, deep red.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Pink'	Syn	*8-10	*8-11	Similar to other 'Americana' geraniums.	10-14	10-15	Doing alright.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Red'	Syn	7-9	6-12	Not uniform in size.	11-13	14-15	Not as floriferous as some other geraniums.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Rose Mega Splash'	Syn	**6-8	**8-10	A bit short but good size uniformity and bloom.	**11-13	**12-15	Nice and bright.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Salmon 09'	Syn	*8-9	*9-12	Not as many blooms as some others.	11-13	13-15	Not as floriferous as some other geraniums.
Pelargonium x hortorum (Geranium-Zonal) 'Americana Trailing Dark Red'	Syn	*8-9	*9-12	Not as floriferous as some other geraniums.	10-12	18-20	Not as floriferous as some other geraniums.

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Genus species 'Cultivar'	Seed/Plant Source	July 10			September 3		
		Height	Spread	Comments	Height	Spread	Comments
Pelargonium x hortorum (Geranium-Zonal) 'Americana Violet'	Syn	**8-9	**9-11	Nice, bright color.	11-14	14-16	Alright.
Pelargonium x hortorum (Geranium-Zonal) 'Americana White 09'	Syn	7-10	8-12	Not as uniform in size or as showy as some other geraniums.	*12-14	*20-22	More vigor than others but browning on petals detracts.
Pelargonium x hortorum (Geranium-Zonal) 'Americana White Splash 09'	Syn	**6-8	**8-12	Looks good.	9-11	10-12	Bright!
Pelargonium x hortorum (Geranium-Zonal) 'Avenida Mosaic Red'	Syn	**7-9	**8-12	Good vigor and big blooms.	**13-15	**15-17	Good bloom and vigor.
Pelargonium x hortorum (Geranium-Zonal) 'Eclipse Dark Red'	Syn	*6-7	*6-9	Similar to *Pelargonium* 'Eclipse Velvet Red'.	7-9	9-11	Not as vigorous as other geraniums.
Pelargonium x hortorum (Geranium-Zonal) 'Eclipse Light Salmon II'	Syn	**7-8	**8-11	Good bloom and vigor.	**13-15	**14-16	Good bloom and vigor.
Pelargonium x hortorum (Geranium-Zonal) 'Eclipse Rose Mega Splash'	Syn	*5-6	*6-8	Small plants but good bloom.	6-8	9-11	Not as floriferous as other geraniums.
Pelargonium x hortorum (Geranium-Zonal) 'Eclipse Velvet Red'	Syn	*7-8	*6-10	Smaller plants but bloom held high above foliage.	**12-14	**14-16	Looks great!
Pelargonium x hortorum (Geranium-Exotic) 'Graffiti Double Red'	Syn	**7-8	**8-11	Nice!	11-12	13-15	Not as full or floriferous as *Pelargonium* 'Graffiti Double Salmon'.
Pelargonium x hortorum (Geranium-Exotic) 'Graffiti Double Salmon'	Syn	**8-9	**11-13	Good vigor and bloom.	**12-13	**15-17	Neat flowers.
Pelargonium x hortorum (Geranium-Zonal) 'Rocky Mountain Coral'	Syn	**7-9	**9-12	Nice!	10-13	14-17	Looks good.
Pelargonium x hortorum (Geranium-Zonal) 'Rocky Mountain Dark Red'	Syn	**7-9	**8-12	Good bloom and vigor.	9-11	14-16	Not as floriferous as *Pelargonium* 'Rocky Mountain Deep Rose' or 'Rocky Mountain Salmon 08'.
Pelargonium x hortorum (Geranium-Zonal) 'Rocky Mountain Deep Rose 09'	Syn	**7-8	**7-9	Good bloom and vigor.	**13-15	**15-17	Good bloom and vigor.
Pelargonium x hortorum (Geranium-Zonal) 'Rocky Mountain Magenta'	Syn	**7-8	**7-9	Really big blooms on some plants.	9-11	12-14	Not as floriferous as some other geraniums.
Pelargonium x hortorum (Geranium-Zonal) 'Rocky Mountain Salmon 08'	Syn	*7-9	*9-11	Bloom not quite as good as on some others.	**14-16	**22-24	Bright!
Pelargonium x hortorum (Geranium-Zonal) 'Rocky Mountain Violet'	Syn	**7-9	**10-12	Looks good.	11-14	17-19	Doing alright.
Pelargonium x hortorum (Geranium-Zonal) 'Tango Coral'	Syn	*7-9	*8-12	Most vigorous 'Tango' geranium.	9-15	13-15	Not uniform in size or bloom time.
Pelargonium x hortorum (Geranium-Zonal) 'Tango Magenta'	Syn	6-7	7-9	Big blooms on smaller plants.	6-7	8-9	Small plants.
Pelargonium x hortorum (Geranium-Zonal) 'Tango Red 09'	Syn	6-7	6-11	Not uniform in size.	7-11	7-12	Small plants.
Pelargonium x hortorum (Geranium-Zonal) 'Tango White'	Syn	6-7	7-11	Similar to the other 'Tango' geraniums.	7-10	5-10	Small plants.
Pelargonium interspecific (Geranium-Hybrid) 'Caliente Coral'	Syn	*6-7	*11-13	Doing alright.	***11-12	***20-24	Nicest 'Caliente' geranium.

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Genus species 'Cultivar'	Seed/Plant Source	July 10 Height	July 10 Spread	July 10 Comments	September 3 Height	September 3 Spread	September 3 Comments
Pelargonium interspecific (Geranium-Hybrid) 'Caliente Lavender'	Syn	*6-8	*9-12	Looks good.	**12-13	**15-20	Very good bloom and vigor.
Pelargonium interspecific (Geranium-Hybrid) 'Caliente Rose'	Syn	6-8	8-12	Not uniform in spread.	**9-11	**17-20	Very good bloom and vigor.
Pelargonium peltatum (Ivy Geranium) 'Acapulco Compact Cascade'	Syn	**6-8	**11-13	Good bloom and vigor.	**7-8	**18-20	Nice!
Pelargonium peltatum (Ivy Geranium) 'Beach'	Syn	6-9	8-13	Not uniform in size.	**9-13	**17-20	Nice!
Pelargonium peltatum (Ivy Geranium) 'Blizzard Pink'	Syn	*7-10	*8-12	Nice show of pink but not uniform in spread.	**7-9	**16-18	Good bloom and vigor.
Pelargonium peltatum (Ivy Geranium) 'Compact Burgundy'	Syn	6-8	11-13	Not uniform in bloom but good vigor.	7-10	14-16	Not as showy or full as *Pelargonium* 'Beach'.
Pelargonium peltatum (Ivy Geranium) 'Lambada Hot Pink'	Syn	6-7	8-9	Only 4 plants; not too vigorous, yet.	7-8	10-12	Plants small.
Pentas lanceolata 'Northern Lights Lavender'	Ben	5-7	3-6	Small but uniform and good bloom.	9-11	9-11	Small but bloom is good.
Petunia hybrida (Large-flowered Trailing) 'Jamboree Blue'	Syn	**4-5	**14-16	Good bloom and vigor.	**8-10	**30-36	Good bloom and vigor.
Petunia hybrida (Large-flowered Trailing) 'Jamboree Burgundy'	Syn	**4-5	**12-16	Looks nice!	***10-11	***to 42	Nice!
Petunia hybrida (Large-flowered Trailing) 'Jamboree Lavender II'	Syn	**4-5	**12-14	Good bloom and vigor.	**8-9	**to 36	Good bloom and vigor.
Petunia hybrida (Large-flowered Trailing) 'Jamboree Light Blue'	Syn	**5-7	**14-16	A bit more vigorous than the other 'Jamboree' petunias.	***10-11	***to 36	Nice!
Petunia hybrida (Grandiflora) 'Limbo Violet'	AAS '04	**6-7	**11-12	Nice!	**6-8	**18-20	Nice but being crowded by *Petunia* 'Opera Supreme Pink Morn'.
Petunia hybrida (Spreading) 'LoGro Yellow'	Gri	**5-6	**12-14	Nice!	**10-13	**20-30	Good bloom and vigor.
Petunia hybrida (Spreading) 'Opera Supreme Pink Morn'	AAS '07	**3-4	**14-16	Good bloom and vigor.	***8-10	***to 42	Nice!
Petunia hybrida (Mini-flowered Trailing) 'Whispers Blue'	Syn	**4-5	**12-14	Nice!	**9-10	**to 36	Good bloom and vigor.
Petunia hybrida (Mini-flowered Trailing) 'Whispers Bright Pink'	Syn	**4-5	**10-11	Good bloom and vigor.	5	8	Very crowded by *Petunia* 'Whispers Rose Vein'.
Petunia hybrida (Mini-flowered Trailing) 'Whispers Rose Vein'	Syn	**4-5	**14-16	Looks nice!	***9-10	***33-36	Nice!
Petunia hybrida (Mini-flowered Trailing) 'Whispers White'	Syn	**4-5	**11-12	Very uniform in spread.	**7-9	**18-22	Nice but being crowded by *Petunia* 'Whispers Rose Vein'.
Salvia farinacea 'Evolution'	AAS '06	4-8	6-10	Not uniform in size.	**17-20	**14-19	Good bloom and vigor.
Salvia farinacea 'Fahrenheit Violet'	Gri	6-12	6-8	Not uniform in size.	**15-18	**14-18	Nice!

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Genus species 'Cultivar'	Seed/Plant Source	July 10 Height	July 10 Spread	July 10 Comments	September 3 Height	September 3 Spread	September 3 Comments
Scaveola 'Bombay Blue'	Syn	2-3	8-12	Not too vigorous, yet.	5-7	13-15	Good bloom; nicer here than in Dickinson.
Scaveola 'Bombay Pink'	Syn	2-3	8-12	Not too vigorous, yet.	6-8	14-16	Good bloom; nicer here than in Dickinson.
Sutera cordata (Bacopa) 'Calypso Jumbo White'	Syn	1	7-12	Not uniform in size or bloom.	1-2	12-14	Not too vigorous but better than Fargo or Dickinson.
Tagetes patula x erecta (Hybrid Marigold) 'Daisy Orange-Red'	Gri	**8-9	**12-14	Good vigor and bloom.	*12-14	*16-18	Good bloom but dead heads detract.
Verbena x hybrida 'Escapade Bright Eye'	Syn	**3-5	**12-14	Good vigor and bloom.	5-7	33-36	Vigorous but not a lot of flowers.
Verbena x hybrida 'Escapade Pink'	Syn	**2-3	**12-14	Good vigor and bloom.	*5-7	*22-24	Nice but a bit crowded by *Verbena* 'Escapade Bright Eye'.
Verbena x hybrida 'Lanai Blush White'	Syn	*3-4	*12-14	Alright.	**7-8	**28-30	Good vigor and bloom.
Verbena x hybrida 'Lanai Bright Pink'	Syn	**1-2	**12-14	Looks good.	*4-5	*28-30	Bright but not as floriferous as *Verbena* 'Lanai Lavender Star'.
Verbena x hybrida 'Lanai Lavender Star'	Syn	**4-5	**12-14	Nice!	**7-8	**28-30	Nice!
Verbena x hybrida 'Lanai Peach'	Syn	1-2	12-14	Not as much bloom as other *Verbena* .	4-8	24-28	Not as floriferous as *Verbena* 'Lanai Blush White'.
Verbena x hybrida 'Lanai Purple Star'	Syn	1-2	6-10	Not as vigorous as other *Verbena* .	4-5	22-24	Not as vigorous as other *Verbena* .
Verbena x hybrida 'Lanai Royal Purple with Eye'	Syn	*2-3	*12-14	Bloom not as good as on some other *Verbena* .	*7-8	*33-36	Good vigor but not as floriferous as other *Verbena* .
Verbena x hybrida 'Lanai Upright Magenta'	Syn	*3-7	*4-8	Nice, bright color but not uniform in size.	**9-11	**15-18	Bright!
Verbena x hybrida 'Lanai Upright Violet'	Syn	*4-6	*6-10	Nice, bright color but not uniform in size.	**10-11	**15-18	Nice!
Verbena x hybrida 'Rapunzel Lilac'	Syn	**2-3	**10-12	Good bloom.	*5-6	*24-36	Nice but not as floriferous as some other *Verbena* .
Verbena x hybrida 'Rapunzel Violet'	Syn	**2-3	**12-14	Good bloom and vigor.	*6-7	*20-22	Nice but not as floriferous as some other *Verbena* .
Verbena rigida 'Rigida Rose'	Gri	6-11	6-8	Not much bloom yet.	11-13	18-20	Doing alright.
Viola F1 'Skippy XL Plum-Gold'	AAS '08	**4-6	**6-8	Good bloom and vigor.	4-8	9-11	Looks alright but some spider mite damage.
Viola F1 'Skippy XL Red-Gold'	AAS '06	**4-6	**6-8	Good bloom and vigor.	6-8	10-12	Looks alright but some spider mite damage.
Viola F1 'Rain Blue and Purple'	AAS '09	**4-6	**6-8	Good bloom and vigor.	4-8	9-12	Looks alright but some spider mite damage.
Zinnia elegans 'Magellan Coral'	AAS '05	7-8	6-7	Doing alright.	***9-13	***11-15	Very good bloom and vigor.

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Genus species 'Cultivar'	Seed/Plant Source	July 10 Height	July 10 Spread	July 10 Comments	September 3 Height	September 3 Spread	September 3 Comments
Zinnia elegans 'Zowie! Yellow Flame'	AAS '06	6-10	6-8	Not uniform in height and just starting to bloom.	***16-24	***17-23	Very good bloom and vigor.
Zinnia Marylandica 'Zahara Coral Rose'	PAS	5-9	6-9	Good vigor.	**9-13	**14-17	Nice!
Zinnia Marylandica 'Zahara Scarlet'	PAS	6-8	5-9	Doing alright.	**9-11	**13-16	Good bloom and vigor.
Zinnia Marylandica 'Zahara White'	PAS	7-9	6-8	Good size uniformity.	**10-12	**14-16	Brown spots and brown heads detract a bit from appearance.
Zinnia Marylandica 'Zahara Yellow'	PAS	7-9	6-8	Doing alright.	**7-12	**12-17	One smaller plant; otherwise looks nice.

Seed Source List - 2008

Abbreviation	Company Name and Address	Abbreviation	Company Name and Address	Abbreviation	Company Name and Address
AAS	All-America Selections 311 Butterfield Road Suite 311 Downer's Grove, IL 60515 www.all-americaselections.org	Gri (W)	Grimes Seeds and Plants 11335 Concord Hambden Road Concord, OH 44077 www.grimesseeds.com	Shot (R)	Shotwell Floral Co. 4000 40 St. S Fargo, ND 58104 www.shotwellfloral.com
Ball (W)	Ball Seed Company 622 Town Road West Chicago , IL 60185-2698 www.ballseed.com	PAS (W)	PanAmerican Seed 622 Town Road West Chicago, IL 60185-2698 www.panamseed.com	Syn (W)	Syngenta Flowers 6899 Winchester Circle, Suite 102 Boulder, CO 80301
Ben (W)	Ernst Benary of America, Inc. 1444 Larson Street Sycamore, IL 60178 www.benary.com	Pk (R)	Park Seed P.O. Box 31 Greenwood, SC 29646 www.parkseed.com	TM (R)	Thompson and Morgan Seedsmen P.O. Box 1308 Jackson, NJ 08527-0308 www.thompson-morgan.com
				Unk	Unknown or seed from an old source.

Note: An 'R' after the seed source abbreviation indicates a retail company while a 'W' indicates a wholesale or breeding company.

Beef Systems Grazing Strategies: Effect on Backgrounding and Finishing Net Return

Progress Report

D.G. Landblom[1], K.C. Olson[2], P. Johnson[2], R. Gates[2], M.K. Beutler[2], M. Hubert[2], S.W. Fausti[3], G.A. Perry[3], R.R. Salverson[4], I. Rush[5], S. Furman[5], J. Vasconcelos[5]

[1]Dickinson Research Extension Center, North Dakota State University
[2]West River Agricultural Center, South Dakota State University
[3]Departments of Animal Science and Economics, South Dakota State University
[4]Cooperative Extension Service, South Dakota State University
[5]Panhandle Research Extension Center, University of Nebraska

Abstract: Cow-calf pairs, grazing native range, from the NDSU-Dickinson RE Center and the SDSU-West River Ag Center (n = 159) were used to evaluate weaning date and backgrounding method. Treatments were: 1) Normal Wean (Jun-Nov) - feedlot direct (NW-FLT), 2) Early Wean (Aug) – feedlot direct (EW-FLT), 3) Early Wean (Aug) - grazed dryland unharvested corn (Aug-Nov) - feedlot (EW-CN), and 4) Normal wean (Nov) - grazed dryland unharvested corn (Nov-Dec) - feedlot (NW-CN). Feedlot arrival date for finishing at the UNL-Panhandle RE Center feedlot, Scottsbluff, NE was staggered. Harvest end point was based on ultrasound BF depth. Mean differences were determined using the SAS MIXED procedure. For backgrounding, EW-CN and EW-FLT steer growth was similar and more rapid [(Gain: (P = 0.043) and ADG: (P = 0.004)] than NW-FLT and NW-CN. The EW-CN system COG of $1.05/kg was lowest when compared to $1.31, $3.77, and $1.37/kg for the NW-FLT, NW-CN, and EW-FLT, respectively. Stockpiling corn resulted in excessive crop shrink (P = 0.013) reducing days of grazing by 70%. Backgrounding net returns/steer were $87.50, -$33.38, $104.58, and $69.56 for the NW-FLT, NW-CN, EW-CN and EW-FLT, respectively. The value of backgrounded beef produced per acre from corn grazing when expressed as bushels per acre was 87.5 and 26.2 bu/acre for the EW-CN and NW-CN, respectively. For finishing, EW-FLT steers grew slower (P = 0.0011), consumed less DM/d (P = 0.0001), were more efficient (P = 0.008), and COG was lower (P = 0.0002). Carcass closeout values for HCW, FD, dressing %, and YG did not differ; however, EW-FLT steer carcasses had smaller REA (P = 0.053), greater marbling score (P = 0.0005), and numerically greater % Choice quality grade (P = 0.11). EW-FLT steers placed directly in the feedlot at weaning were associated with lower placement cost, more DOF (P = 0.0001), and higher feed and yardage costs. Net return to finishing of $39.62 per head for the EW-FLT was greater, when compared to $3.11, -$84.06, and $0.16 for the NW-FLT, NW-CN, and EW-CN, respectively. Experimental results suggest that greatest beef systems net return will be obtained when EW steers graze dryland unharvested corn and are sold at the end of backgrounding; however, when held through final harvest, early weaning and direct feedlot placement were associated with greatest net return.

Introduction

Previous research has evaluated forage utilization by early (August - EW) vs normal (November - NW) weaned beef cows and the effect of weaning date on cow and calf performance. These studies show that weaning calves early has a positive impact on growth and efficiency during the backgrounding phase, improves cow body condition score, reduces range forage utilization, and shortens the lifetime feeding period of steers held for retained ownership (Landblom et al., 2006). Economic analysis of retained ownership concluded that early weaning improved feedlot production efficiency by reducing daily and per carcass revenue relative to normal weaning (Fausti et al., 2007). And subsequently, Landblom et al. (2008) documented that significantly altering weaning date can have a positive impact on business profitability in the beef cattle enterprise. The objective of this study was to evaluate the effect of weaning date (August vs November) and backgrounding method on backgrounding and finishing net returns.

Materials and Methods

Spring calving cows (Mar-Apr) originating at the South Dakota State University Antelope Station (ANT), Buffalo, SD, and the North Dakota State University Dickinson Research Extension Center (DREC), Manning, ND were used in a 2 x 2 factorial arrangement comparing weaning date (August vs November) and backgrounding method (feedlot vs grazing dryland unharvested corn). Pen or pasture served as the experimental unit and backgrounding, finishing, and carcass data were analyzed using the

SAS MIXED procedure. The protocols used in this study were approved by the North Dakota State University Animal Care and Use Committee.

Steer calves in the EW system were weaned on August 15 and calves in the NW system were weaned the first week of November. At each weaning date, steers from each research facility were randomly assigned to either feedlot or corn grazing backgrounding treatments. Corn grazing steers were held in drylot and fed hay for two weeks before being put into replicated dryland unharvested corn fields. Early weaned steers began grazing unharvested corn on August 25th and the NW steers began grazing corn on November 21st. For the feedlot treatment, EW and NW steers were shipped by commercial truck to the University of Nebraska Panhandle Research Extension Center feedlot, Scottsbluff, Nebraska where they were finished and harvested at a commercial Abattoir. Steer weight and backfat depth of 12.7 mm were used to determine final harvest endpoint. Measurement for backfat depth was conducted 30 – 45 days before final harvest using a SonoVet ultrasound machine and 3.5 MHz probe. Final harvest date was determined by calculating the required number of DOF to attain 12.7 mm BF.

Systems measurements were: corn forage nutrient change, corn forage utilization, backgrounding performance type and economics, treatment effect on animal health, corn grazing grain equivalent value, finishing performance and economics, and carcass closeout values.

Steers in the systems investigation were vaccinated before spring turnout on native pasture and then were vaccinated 3-4 weeks before each weaning date, and again at weaning with modified live IBR, BVD types I and II, PI_3, BRSV + Mannhiema haemolytica, and an inactivated 7-way Clostridial vaccine + H. somunus. In addition, the calves were poured with a parasiticide. After weaning, the calves were observed closely for the onset of health problems and were treated according to the attending veterinarian's recommendation. The following information is being recorded: body temperature, number of pulls, product used for treatment and cost, percent death loss, and system cost due to death loss.

Results and Discussion

Systems Backgrounding - Considering the results of Fausti et al. (2007) in the previous study, the present investigation was conducted to compare calf growing methods for EW and NW calves after weaning that compared feedlot backgrounding with grazing unharvested dryland corn before finishing based on a high quality grid. Standing peak dryland corn forage nutrient quality was determined mid-September and tracked through to mid-January. Corn forage CP declined from Sep to Nov (9.16 to 8.66) and IVDMD declined from 75.2% to 57.0% (Table 1).

Peak DM corn production for the EW steers averaged 2.20 Ton/acre (Table 2) and peak DM corn production for the NW group was 1.93 Ton/acre (Table 3). Early weaned steers utilized an average 1.46 Ton/acre over the 70 day grazing period and NW steers utilized 0.41 Ton/acre. Field loss in stockpiled corn set aside for grazing after normal weaning was excessive averaging 0.90 Ton/acre. Compared to the EW treatment, the large field loss reduced available days of grazing by 70%.

Comparative systems backgrounding performance is shown in Table 4. Steer weight at EW did not differ (P=0.44), but gain among the NW-CN steers was reduced significantly (P=0.043) due to field crop shrink. Average daily gain for EW and NW steers was similar and greater (p=0.004) than the control steers despite significant crop shrinkage. System backgrounding economics are shown in Table 5 where gain value, input costs, net returns, and cost/kg of gain are summarized. The backgrounding cost/lb. of gain was \$0.5933, \$1.71, \$0.5097, and \$0.6564 for the NW-FLT, NW-CN, EW-CN, and EW-FLT, respectively. Net return/steer among the steers in EW-CN system was 33.5% greater than the EW-FLT system and 16.3% greater than the NW-FLT system. Stockpiling corn for grazing after normal weaning was not successful resulting in a net loss/steer of -\$33.38. The stocking rate for early weaned calves that grazed unharvested dryland corn was calculated to be 0.25 acres/calf/month and the stocking rate for stockpiled corn reserved for unharvested corn gazing after normal weaning was determined to be 0.82 acres/calf/month (Table 6). Following grazing by calves, cows grazed stalk residue. Stalking rate for cows expressed in acres/cow/month is shown in Table 6 for 1,000, 1,200, and 1,400 pound cows. The stocking rate for 1,200 pound cows grazing corn stalk residue previously grazed by EW and NW calves was 0.70 and 0.87 acres/cow/month, respectively.

For the purpose of comparing beef production from corn grazing during backgrounding with grain production, steer net return value per acre after expenses was converted to a corn grain equivalent yield per acre. Comparative values are shown in Table 7 over a range of corn prices per bushel from \$3.00 to \$5.00/bu. At \$4.00/bu, the corn equivalent value of beef produced among the EW steers was equivalent to 87.5 bushels of corn/ac. The corn equivalent value of beef produced among the NW steers was equivalent to 26.2 bushels of corn/ac.

The effect of alternative weaning date and corn grazing on finishing performance is shown in Table

8. Early weaning and corn grazing backgrounding resulted in variable feedlot starting weights (P = 0001), and a large variation in the number of days on feed (P = 0.0001); however, harvest age (P = 0.27) and 4% shrunk harvest weight (P = .409) did not differ. For gain and FE, EW-FLT steers gained at the slowest rate (P = 0.001), were more efficient (P = 0.008), and feed and yardage cost/lb. of gain were lower (P = 0.0002). By contrast, EW-CN steers that were the most profitable at the end of corn grazing backgrounding were less efficient (P = 0.008) and feed and yardage cost/lb. of gain was higher (P = 0.0002) during retained ownership finishing. The NW-CN steers that grazed stockpiled dryland corn were the least efficient (P = 0.008) and had the highest feed and yardage cost/lb. of gain (P = 0.0002).

The primary health issue was bovine respiratory disease, which has been summarized in Table 9. The incidence of BRD among EW steers sent directly to the feedlot after weaning mid-August was markedly greater than for any of the later arriving treatment groups and treatment cost was 3.5 times greater than either the control or treatment groups that grazed corn during backgrounding.

The effect of alternative weaning date and corn grazing on carcass closeout measurements is shown in Table 10. Carcass closeout values for HCW (P = 0.78), dressing percent (P = 0.51), fat depth (P = 0.243), and yield grade (P = 0.23) did not differ. Corn grazing steers had significantly larger ribeye area (p = 0.053). Days on feed, which varied due to management system, directly affected marbling score (P = <0.0001) and the number of carcasses that grading USDA Choice or better (P = 0.10). The number of days on feed and the percent USDA Choice were 141.5/66.7%, 165.7/79.2%, 192.0/81.1%, and 280.8/94.4% for the NW-CN, EW-CN, NW-FLT, and EW-FLT, respectively.

The combined effect of calf placement cost, ingredient cost, treatment cost, freight, and interest cost affected finishing net return and are shown in Table 11. Calf placement cost had the most influence on net return. Closeout net returns were $3.11, -$84.06, $0.16, and $39.62/head for the NW-FLT, NW-CN, EW-CN, and EW-FLT, respectively.

Implications

Results suggest that greatest beef systems net return will be obtained when EW steers graze dryland unharvested corn and are sold at the end of backgrounding; however, when held until final harvest, early weaning and direct feedlot placement were associated with greatest net return.

This project is scheduled to be repeated during the 2008-2009 production year.

Acknowledgement

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Literature Cited

Fausti, S.W., D.G. Landblom, M.A. Beutler, P. Johnson, R. Gates, H. Patterson, S.I. Paisley and R. Salverson. 2007. The effect of early vs normal calf weaning on feedlot performance and herd management. Am. Soc. Farm Managers and Rural Appraisers, Vol. 70, No. 1, pp. 128-132.

Landblom, D.G., S. Paisley, P. Johnson, R. Gates, W. Fausti, and H.H. Patterson. 2006. Effects of weaning date and retained ownership on cattle performance and forage disappearance in spring calving beef systems. Proceedings: Western Section Am. Soc. Anim. Sci. 57:139-142.

Landblom, D.G., S.I. Paisley, K.C. Olson, P.S. Johnson, R.N. Gates, M.K. Beutler, S.W. Fausti, G.A. Perry, A. Smart, R.R. Salverson, H.H. Patterson, I. Rush, and S. Forman. 2008. Beef Systems Research: Effect of Weaning Date, Weaning Method, and Cow Wintering Method on Beef Cow and Calf Performance. In: 2008 Dickinson Research Extension Center Annual Report pp 336-347 www.ag.ndsu.nodak.edu/dickinso/research/2007/tocweb. htm#b.

Table 1.Corn Nutrient Change (Sept. – Jan.)

	C- Prot	*NDF*	*ADF*	*IVDMD%*	*IVOMD*	*Ca*	*P*
	%	%	%	%	%	%	%
Whole Plant/Stalks:							
Sept. 25, 2007	9.16	61.0	30.0	75.2	74.8	0.20	0.16
Nov. 15, 2007	8.66	70.2	40.5	59.0	57.0	0.23	0.12
Jan. 12, 2008(Residue)	4.36	79.8	50.3	43.5	40.9	0.32	0.05
Corn Grain:							
Sept. 25, 2007	14.1	12.2	3.10	90.8	90.4	0.03	0.37
Cobs:							
Sept. 25, 2007	4.33	81.5	39.2	64.1	63.1	0.01	0.12
Litter (trash on ground):							
Jan. 12, 2008	9.57	72.1	36.7	64.7	64.8	0.31	0.11

Table 2. Early Wean Corn Utilization

	Peak	***Calf***	***Cows***
	Production	Utilization	Residual Stalks
	T/Ac	T/Ac	T/Ac
Fields:			
4	2.05	1.11	0.94
6	1.92	1.24	0.68
8	2.64	2.02	0.62
Total Tons	6.61	4.37	2.24
Avg DM, T/Ac	2.20	1.46	0.75

Table 3. Normal Wean Corn Utilization

	Peak Production Sept	***Start Graze Nov***	***Field Loss***	***Calf Utilization***	***Cows Residual Stalks***
	T/Ac	T/Ac	T/Ac	T/Ac	T/Ac
Field					
5	2.11	1.18	0.93	0.54	0.64
7	1.6	0.89	0.71	0.27	0.62
9	2.08	1.02	1.06	0.41	0.61
Total Tons	5.79	3.09	2.70	1.22	1.87
Avg DM, T/Ac	1.93	1.03	0.90	0.41	0.62

Table 4. Alternative Beef System Backgrounding Performance

	NW-Control Pasture	*NW – Corn Grazing*	*EW – Corn Grazing*	*EW – Feedlot*	*SE*	*P-Value*
Weaning Date	Nov 7	Nov 7	Aug 15	Aug 15		
No. Steers	54	24	24	57		
Pre-Unhvsted Corn Grazing (Drylot):						
Days in Drylot[a]	----	13	13	----		
Drylot St. Wt.(Aug 15, Nov 7), lb	----	627	468	----		
Drylot End Wt., lb	----	639	481	----		
Drylot Gain, lb	----	12.0	13.0	----	2.91	0.52
Drylot ADG (Drylot), lb	----	0.923	1.00	----	0.22	0.53
System Days	84	21	70	86		
System Wt at Ely Wean (Aug 15) lb	436	457	468	405	22.1	0.44
System End Wt., lb	600	693	662	611	33.19	0.15
Gain, lb	164[ab]	54[b]	181[a]	206[a]		0.043
ADG, lb	1.95[b]	2.57[a]	2.59[a]	2.40[a]	0.126	0.004

[a]Weaned steers were held in drylot for 13 days before placement in the corn fields to get over weaning.

Table 5. Alternative Beef System Unharvested Corn, Pasture, and Feedlot Economics (2007)

	NW- Ctrl Pasture/ Feedlot	*NW – Corn Grazing*	*EW – Corn Grazing*	*EW – Feedlot*	*SE*	*P-Value*
No. Steers	54	24	24	57		
Gain Value [a,b,c,d]	$9,979	$1,413	$4,724	$10,980		
Input Cost:						
Pasture (Rent @$14.00/ac)[e]	$5,254					
Corn ($164/ac)		$2,214	$2,214			
Feedlot				$7,302		
Backgrounding Net Return	$4,725	-$801	$2,510	$3,678		
Backgrounding Net Return/Head	$87.50	-$33.38	$104.58	$69.56		
Cost/Lb. Gain	$0.5933	$1.71	$0.5097	$0.6564		

[a]NW Control Gain Value (8,910lb@$112/cwt)
[b]NW Corn Grazing Gain Value (4,334lb@$109/cwt)
[c]EW Gain Value (1,296lb@$109/cwt)
[d]Gain Value (9,804lb@$112/cwt)
Pasture Rent Calculation: 2.78 months, 2.5 AUM; = 6.95 Ac/AUM @ $14/Ac; = $97.30 x54 = $5,254.20

Table 6. Steer and Cow Stalking Rate for Unharvested Corn and Stalk Residue Grazing

	Normal Weaned Cows	*Normal Weaned Steers*	*Early Weaned Cows*	*Early Weaned Steers*
Steer Unharvested Corn, Ac/Steer/Month		0.82		0.25
Corn Residue, T/Ac	0.624		0.748	
Stalk Residue Requirement, Ac/Cow/Month				
1,000 Lb Cow	0.73		0.59	
1,200 Lb Cow	0.87		0.70	
1,400 Lb Cow	1.02		0.82	
Residue Value @$40/Ton Hay Equivalent	$337.00		$420.00	

Table 7. Corn Grazing Grain Equivalent, Bu/Acre

	Corn Bushel Price	*Early Wean – Grain Yield Equivalent*	*Normal Wean – Grain Yield Equivalent*
Steer Grazing Gain Value	$3.00	116.6	34.9
	$4.00	87.5	26.2
	$5.00	70.0	20.9
Corn Stalk Residue Grazing (Cows)	$3.00	10.4	8.3
Based on $40/Ton Hay	$4.00	7.8	6.2
	$5.00	6.2	5.0
Combined Steer Gain and Cow	$3.00	127.0	43.2
Stalk Grazing Value	$4.00	95.3	32.4
	$5.00	76.2	25.9

Table 8. Effect of Alternative Weaning Date and Corn Grazing on Steer Finishing Performance

	NW- Control Pasture/F-lot	*NW – Corn Grazing*	*EW – Corn Grazing*	*EW – Feedlot*	*SE*	*P-Value*
Start Wt., lb	600.0[c]	747.7[b]	690.3[d]	404.8[a]	0.00	<0.0001
Shrunk Finished End Wt., lb[a]	1186.9	1224.0	1249.9	1203.1	23.01	0.409
Days on Feed	192[d]	141.5[b]	165.7[c]	280.8[a]	3.44	<0.0001
Kill Age, Days	408.1	415.1	404.6	412.1	3.17	0.270
Gain, lb	586.9[c]	476.3[b]	559.6[d]	798.3[a]	9.46	0.0001
ADG, lb	3.06[b]	3.37[c]	3.38[c]	2.85[a]	0.056	0.0011
Fd/Head/Day (As Fed), lb	29.7[b]	36.0[d]	33.0[c]	27.0[a]	0.749	<0.0001
Fd/Head/Day (Dry Matter), lb	20.2[b]	24.5[d]	22.4[c]	17.8[a]	0.506	<0.0001
DM Feed:Gain, lb	6.60[b]	7.27[c]	6.62[b]	6.27[a]	0.157	0.008
Fd & Yard Cost/Day, $	$2.096[b]	$2.723[d]	$2.383[c]	$1.715[a]	0.053	<0.0001
Fd & Yard Cost/Lb of Gain, $	$0.6850b	$0.8080c	$0.7050b	$0.6017a	0.016	0.0002

[a] 4% Shrink

Table 9. Alternative Production Effect on Health Pulls and Treatment Costs

	NW- Control Pasture/Feedlot	*NW – Corn Grazing*	*EW – Corn Grazing*	*EW – Feedlot*
Pulls: 1	3.7%	3.75%	0.0%	17.5%
2				8.77%
3				3.51%
Avg. Treatment Cost/Head	$1.72	$3.87	$0.0	$9.92

Table 10. Effect of Alternative Weaning Date and Corn Grazing on Carcass Measurements

	NW – Control Pasture/F-Lot	*NW – Corn Grazing*	*EW – Corn Grazing*	*EW – Feedlot*	*SE*	*P-Value*
Hot Carcass Wt., lb	737.8	745.3	762.9	745.5	14.77	0.78
Carc. Dressing Percent, %	62.0	60.6	61.1	60.6	0.72	0.51
Ribeye Area, sq. in.	11.51[b]	12.3[a]	12.3[a]	11.7[b]	0.17	0.053
Fat Depth, in.	0.586	0.547	0.581	0.638	.0304	0.243
Yield Grade[a]	3.46	3.35	3.45	3.59	0.075	0.229
Marbling Score	442[b]	438[b]	453[b]	539[a]	12.75	0.0005
% Choice Carcasses	81.1	66.7	79.2	94.4	6.32	0.109

[a]Yield Grade correlation to percentage of boneless, closely trimmed retail cuts: 1 = 54.6%, 2 = 52.3%, 3 = 5.0%, 4 = 47.7%, and 5 = 45.4%

Table 11. Effect of Alternative Weaning Date and Corn Grazing on Finishing Economics

	NW – Control Pasture/ F-lot	*NW – Corn Grazing*	*EW – Corn Grazing*	*EW – Feedlot*
Expenses:				
Calf Value	$666.00	$783.22	$724.50	$566.72
Feed and Yardage	$402.06	$384.85	$394.52	$480.34
Treatment Cost	$1.72	$3.87	$0.0	$9.92
Freight ($4.5/mile; 425 miles)	$23.90	$29.88	$27.71	$16.20
Interest @ 6.0%	$34.18	$27.55	$30.90	$49.00
Total Expense	$1,127.86	$1,229.37	$1,177.63	$1,122.18
Carcass Value	$1,130.97	$1,145.31	$1,177.79	$1,161.80
Profit (Loss)	$3.11	-$84.06	$0.16	$39.62

Safe-Zone Project: Southwest North Dakota Market Cow Survey

D.G. Landblom[1], K. Ringwall[1], L. Pederson[1], D. Freeman[2]

[1]NDSU-Dickinson Research Extension Center
[2]NDSU-Veterinary and Microbiological Sciences Department

Introduction

Beef producers often consider market cows as "culls" instead of considering them as a significant food source. According to the North Dakota Farm Business Management program (2007), approximately 15% of cows and bulls in the North Dakota program are replaced annually. Sale of these market animals amounts to approximately 17.7% of total returns to the cow-calf business in North Dakota (ND Farm Bus. Mgmt. Program, 2007). This compares closely with national herd replacement sales and total returns of approximately 16% (National Market Cow and Bull Beef Quality Audit, 2007).

The National Market Cow and Bull Beef Quality Audit (C&B-BQA) was established in the early 1990s to assist producers in recognizing and optimizing cattle value, to monitor the health status of the national cow herd, to encourage marketing cattle in a timely and appropriate manner, to demonstrate ways that will prevent quality defects in market animals, and to encourage producers to be proactive in ways that will ensure a that the consuming public has a safe and wholesome beef supply (National Cow and Bull Beef Quality Audit, 2007).

Considering the goals of the National Market Cow and Bull Beef Quality Audit, a sample of market cows from four southwestern ND ranches were gathered and marketed through Long Prairie Packing Company, Long Prairie, Minnesota to document critical market cow management checkpoints to include drug residue surveillance, bruise trim-out, disease condemnation, cow condition, and the relationship of cow condition to carcass closeout values.

Cows committed to the project, which originated from participating ND Beef cattle Improvement Association members, were delivered to Stockmen's Livestock Exchange, Dickinson, ND on November 5 and 13, 2008. Prior to shipment the cows were processed, which included recording individual cow ID, age, weight, body condition score (BCS), sample collection (blood, fecal, and ear notch), and USDA backtag. Samples collected were forwarded to the NDSU Veterinary Diagnostic Laboratory for BVD virus types I and II, Johne's disease (Mycobacterium paratuberculosis), and Bovine Leukemia virus analysis. Additionally, drug residue analysis (penicillin, gentamicin, sulfamethazine, oxytetracycline, and tilmicosin) was conducted at the packing plant during routine surveillance. Data received from the packing plant included hot carcass weight (HCW), grade, trim (light, medium, or heavy), carcass value per hundredweight ($90.00/cwt base price), dressing percent, and carcass value.

Market Cow Results –

Testing for drug residues (penicillin, gentamicin, sulfamethazine, oxytetracycline, and tilmicosin) and viruses were negative for all cows in the survey. Trim due to bruising was minimal; however, trim can be excessive when market cows and bulls are handled roughly, prodded with electric prods, or transported as mixed loads. Market cows are a significant food source and need to be handled as a perishable product.

Laboratory analysis results for BVD virus Types I and II, Johne's disease, and Bovine Leukemia virus were negative for all cows in the survey.

Information obtained from the market cow survey is summarized in Tables 1 and 2. Freight charges for hauling the cows to Long Prairie Packing were $4.17/loaded mile for the first load ($47.24/cow) and $4.41/loaded mile ($44.05/cow) for the second load. The tables were prepared following an initial database sort based on hot carcass weight followed by grouping the cow's into100 pound hot carcass weight categories. In Table 1, cow age, BCS, origination weight, harvest weight, and transit shrink are summarized. With one exception, as cow age increased, BCS, origination weight,

and harvest weight increased also; however, increasing cow age did not appear to influence transit shrinkage which averaged 5.43%.

Table 2 summarizes packing plant closeout values. As cow age and weight increased, hot carcass weight, dressing percent, carcass grade, and total carcass value improved. Young, thin cows with carcass weights less than 500 pounds had very low dressing percent, carcass grade, and carcass values averaged $394.00/cow. In the C&B-BQA 21% of all carcasses were too light (<500 pounds) and 27% were too heavy (>1,000 pounds). Although the southwestern ND survey includes a much smaller number of cows, the array of hot carcass weights was similar. The carcass value differential among cows in the survey ranged from a low of $394.22 to a high of $838.80with a median carcass value of $619.07. Comparing the lightest hot carcass weight group to the median carcass value, there is a difference of $224.85, which is a significant improvement in market cow value. The data in this survey indicates that there is sufficient economic incentive for producers to predetermine the cows they plan to remove from the herd and early wean their calves or put them on feed after weaning. When lactation is terminated by early weaning, cows will regain body condition rapidly while grazing native range. Depending on weaning date, early weaned cows can gain one body condition score (80 pounds) or more depending on the length of the grazing period.

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Literature Cited

Landblom, D.G., S.I. Paisley, K.C. Olson, P.S. Johnson, R.N. Gates, M.K. Beutler, S.W. Fausti, G.A. Perry, A. Smart, R.R. Salverson, and H.H. Patterson. 2008. Beef Systems Research: Effect of weaning date, weaning method, and cow wintering method on beef cow and calf performance. In Dickinson Research Extension Center annual report at www.ag.ndsu.nodak.edu/dickinso/research/2007/tocweb.htm#g

National Market Cow and Bull Beef Quality Audit. 2007. National Cattlemen's Beef Association, Beef Quality Assurance Program, 9110 E. Nichols Ave., Suite 300, Centennial, CO 80112

North Dakota Farm & Ranch Business Management. 2007. Annual Report: www.ndfarmmanagement.com

Table 1. Market Cow Survey Sorted by hot carcass weight: Age, BCS, Weight and Transit Shrink

Carcass Wt. Range	No. Head	Group Pct	Cow Age	Origination BCS	Origination Weight	Harvest Weight	Pct Shrink
Averages			6.47	5.17	1395.3	1319.3	5.43
Total Cows	79						
<499	8	10.1	5.0	4.1	1001.3	944.9	5.63
500-599	25	31.6	6.4	4.6	1184.6	1121.1	5.36
600-699	30	38.0	7.2	5.2	1347.8	1279.1	5.09
700-799	12	15.9	7.0	5.4	1486.3	1404.3	5.52
800-899	3	3.8	8.4	6.3	1631.7	1549.7	5.02
900-999	1	1.27	4.8	5.5	1720.0	1616.9	6.00

Table 2. Market Cow Survey Sorted by Hot Carcass Weight: HCW, Grade, Trim, and Carcass Value

Carcass Wt. Range	No. Head	Cow Age	HCW	Dressing Percent	Carcass Grade	Trim[a]	Carcass Value/CWT	Total Carcass Value
Averages		6.47	687.9	51.61	2.86	0.83	$90.00	$619.07
	79							
<499	8	5.0	438.3	46.5	1.38	1	$89.88	$394.22
500-599	25	6.4	546.1	48.8	2.0	2	$90.14	$492.29
600-699	30	7.2	642.7	50.4	2.6	1	$90.17	$579.47
700-799	12	7.0	726.2	51.8	3.2	0	$90.33	$655.94
800-899	3	8.4	842.0	54.5	4	1	$89.50	$753.69
900-999	1	4.8	932.0	57.6	4	0	$90.00	$838.80

Safe-Zone Project: Cow and Calf Pathogen Survey

D.G. Landblom[1], K. Ringwall[1], L. Pederson[1], M. Khaitsa[2], J. Tofteland[2], B. Nesemeier[2], D. Freeman[2]

[1]NDSU-Dickinson Research Extension Center
[2]NDSU-Veterinary and Microbiological Sciences Department

Project Brief

Foodborne illnesses in the United States (US) are caused by a wide variety of microorganisms and are estimated to cause 76 million illnesses, 325,000 hospitalizations, and 5,000 deaths annually (Mead et al., 1999).

In the United States, *E. coli* O157:H7 is the most common microbial cause of bloody diarrhea and hemolytic uremic syndrome (HUS), which can lead to acute renal failure and death among humans (CDC 2009; Garg et al., 2003). Undercooked or raw ground beef (hamburger) has been implicated in many Center of Disease Control (CDC) documented outbreaks resulting in a substantial health burden in the United States. Cattle feeding practices have been identified as either the main source of infection or indirectly through contaminated irrigation water. Direct contamination of meat occurs when contaminated hides come in contact with carcasses during skinning and illness in humans is frequently associated with consumption of undercooked hamburger. Effective preharvest intervention strategies that will reduce the proportion of cattle carrying pathogenic *E. coli* may reduce human exposure to this pathogen.

Of all food borne pathogens that affect humans, *Salmonella* is widely considered to be one of the most important. A foodNet report estimated *Salmonella* related infections in the US to be 1.4 million illnesses, 15,000 hospitalizations and 400 deaths annually (Voetsch et al., 2004). .

Among the many *Salmonella* serotypes, the most common associated with infection in humans are S. typhimurium and S. enteritidis. *Salmonella* can live in the intestinal tracts of humans, other animals, and birds. Foods of animal origin may be contaminated with *Salmonella*; therefore, eating raw or undercooked eggs, poultry, or meat can cause infection. Foods prepared with raw eggs can be an unrecognizable origin of contamination. Meat from poultry and ground beef are sources of contamination that should be well cooked before consumption.

The ability of Salmonella to become resistant to antimicrobials has hampered efforts in treating illnesses caused by this pathogen and has made the production and tracking of food products, especially those from cattle, more important. Antimicrobial resistance is the ability of microorganisms to evade the effects of antimicrobials through newly developed biological mechanisms (CDC, 2008). The ability of microorganisms to evade or to become resistant to antimicrobials can be acquired through integrons, which are genes that consist of a central variable region that often harbors antibiotic-resistance gene cassettes (Amita et al., 2004).

Using cow-calf pairs located at the Dickinson Research Extension Center, the purpose of this pathogen survey project is to track the prevalence of pathogenic *E. coli* and *Salmonella* serotypes through the production continuum beginning on fall native range and ending at final harvest (steer calves). *Objectives*: (1) Determine seasonal prevalence change for pathogenic *E. coli* that carry shiga toxin genes and *Salmonella* spp., (2) Determine the level of antimicrobial resistance (AMR) and multidrug resistance in Salmonella strains isolated from beef cattle at different stages of production, and (3) Determine the association between the presence of Integron-1and AMR to 15 different antimicrobials (amikacin, amoxicillin/ clavulanic acid, ampicillin, ceftiofur, chloramphenicol, ciprofloxacin, gentamicin, kanamycin, nalidixic acid, streptomycin, sulfizoxazole, and trimethprim-sulfamethoxazole) in isolated *Salmonella* strains.

Fecal grab samples and rectoanal swab samples are being collected beginning before weaning on fall pasture and continuing through weaning, mid-winter (Feb), at spring pasture turnout on improved crested wheat, and on pasture mid-summer. The calves will be sampled on fall pasture, at weaning, at the end of unharvested corn grazing, midway through the finishing period (Feb), and just prior to final harvest. Laboratory isolation and definitive PCR serotype determinations will be conducted under the direction of Dr. Margaret Khaitsa, Veterinary Epidemiologist, NDSU Veterinary and Microbiological Sciences Department.

Expected outcomes include: (1) Establishment of seasonal shedding patterns for shiga toxin producing *E. coli* serotypes and *Salmonella* spp., (2) Establishment of antimicrobial resistance patterns of Salmonella isolated from beef cattle throughout the production continuum, (3) Establish the connection between Integron-1 presence and resistance patterns to the antimicrobials tested.

Information obtained from the survey will be used to develop intervention strategy research originating at the ranch level and carrying over into the feedlot.

When this research brief was prepared, the spring and summer cow samples remained to be collected. For the feedlot steers, fecal grab, rectoanal swab, and mid-line hide samples remain to be collected prior to final harvest. Data will be presented in the next annual report.

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Literature Cited

Amita, C. et al. (2004) Class I Integrons and SXT elements in El Tor strains isolated before and after 1992 *Vibrio cholera* O139 outbreak, Calcutta, India. Available from: URL: http://www.cdc.gov/ncidod/EID/vol9no4/02-0317.htm

Center for Disease Control and Prevention. (2009) Accessed at URL: http://www.cdc.gov/nczved/dfbmd/disease_listing/stec_gi.html

Garg, A.X., et al. (2003) Long-term renal prognosis of diarrhea-associated hemolytic uremic syndrome. JAMA 290:1360-70.

Mead, P.S., et al. (1999). Food-related illness and death in the United States. Emerg. Infect. Dis. 5:607-625.

Voetsch, A.C. et al. (2004). FoodNet estimate of the burden of illness caused by nontyphodial *Salmonella* infections in the United States. Clinical Infectious Diseases. Vol. 38(Suppl 3):S127-34.

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BEEF SYSTEM METHODS IMPACT BACKGROUNDING AND FINISHING NET RETURNS

D.G. Landblom[1], K.C. Olson[2], P. Johnson[2], R. Gates[2], M.K. Beutler[2], M. Hubert[2], S.W. Fausti[3], G.A. Perry[3], R.R. Salverson[4], I. Rush[5], S. Furman[5], J. Vasconcelos[5]

[1]Dickinson Research Extension Center, North Dakota State University
[2]West River Agricultural Center, South Dakota State University
[3]Departments of Animal Science and Economics, South Dakota State University
[4]Cooperative Extension Service, South Dakota State University
[5]Panhandle Research Extension Center, University of Nebraska

Abstract: Cow-calf pairs, grazing native range, from the NDSU-Dickinson RE Center and the SDSU-West River Ag Center (n = 159) were used to evaluate weaning date and backgrounding method. Treatments were: 1) Normal Wean (Jun-Nov) - feedlot direct (NW-FLT), 2) Early Wean (Aug) – feedlot direct (EW-FLT), 3) Early Wean (Aug) - grazed dryland unharvested corn (Aug-Nov) - feedlot (EW-CN), and 4) Normal wean (Nov) - grazed dryland unharvested corn (Nov-Dec) - feedlot (NW-CN). Feedlot arrival date for finishing at the UNL-Panhandle RE Center feedlot, Scottsbluff, NE was staggered. Harvest end point was based on ultrasound BF depth. Mean differences were determined using the SAS MIXED procedure. For backgrounding, EW-CN and EW-FLT steer growth was similar and more rapid [(Gain: (P = 0.043) and ADG: (P = 0.004)] than NW-FLT and NW-CN. The EW-CN system COG of $1.05/kg was lowest when compared to $1.31, $3.77, and $1.37/kg for the NW-FLT, NW-CN, and EW-FLT, respectively. Stockpiling corn resulted in excessive crop shrink (P = 0.013) reducing days of grazing by 70%. Backgrounding net returns/steer were $87.50, -$33.38, $104.58, and $69.56 for the NW-FLT, NW-CN, EW-CN and EW-FLT, respectively. For finishing, EW-FLT steers grew slower (P = 0.0011), consumed less DM/d (P = 0.0001), were more efficient (P = 0.008), and COG was lower (P = 0.0002). Carcass closeout values for HCW, FD, dressing %, and YG did not differ; however, EW-FLT steer carcasses had smaller REA (P = 0.053), greater marbling score (P = 0.0005), and numerically greater % Choice quality grade (P = 0.11). EW-FLT steers placed directly in the feedlot at weaning were associated with lower placement cost, more DOF (P = 0.0001), and higher feed and yardage costs. Net return to finishing of $39.62 per head for the EW-FLT was greater, when compared to $3.11, -$84.06, and $0.16 for the NW-FLT, NW-CN, and EW-CN, respectively. Experimental results suggest that greatest beef systems net return will be obtained when EW steers graze dryland unharvested corn and are sold at the end of backgrounding; however, when held through final harvest, early weaning and direct feedlot placement were associated with greatest net return.
Key Words: Beef Systems, Early Weaning, Corn Grazing

Introduction

Previous research has evaluated forage utilization by early (August - EW) vs normal (November - NW) weaned beef cows and the effect of weaning date on cow and calf performance. These studies show that weaning calves early has a positive impact on growth and efficiency during the backgrounding phase, improves cow body condition score, reduces range forage utilization, and shortens the lifetime feeding period of steers held for retained ownership (Landblom et al., 2006). Economic analysis of retained ownership concluded that early weaning improved feedlot production efficiency by reducing daily and per carcass revenue relative to normal weaning (Fausti et al., 2007). And subsequently, Landblom et al. (2008) documented that significantly altering

weaning date can have a positive impact on business profitability in the beef cattle enterprise. The objective of this study was to evaluate the effect of weaning date (August vs November) and backgrounding method on backgrounding and finishing net returns.

Materials and Methods

Spring calving cows (Mar-Apr) originating at the South Dakota State University Antelope Station (ANT), Buffalo, SD, and the North Dakota State University Dickinson Research Extension Center (DREC), Manning, ND were used in a 2 x 2 factorial arrangement comparing weaning date (August vs November) and backgrounding method (feedlot vs grazing dryland unharvested corn). Pen or pasture served as the experimental unit and backgrounding, finishing, and carcass data were analyzed using the SAS MIXED procedure. The protocols used in this study were approved by the North Dakota State University Animal Care and Use Committee.

Steer calves in the EW system were weaned on August 15 and calves in the NW system were weaned the first week of November. At each weaning date, steers from each research facility were randomly assigned to either feedlot or corn grazing backgrounding treatments. Corn grazing steers were held in drylot and fed hay for two weeks before being put into replicated dryland unharvested corn fields. Early weaned steers began grazing unharvested corn on August 25th and the NW steers began grazing corn on November 21st. For the feedlot treatment, EW and NW steers were shipped by commercial truck to the University of Nebraska Panhandle Research Extension Center feedlot, Scottsbluff, Nebraska where they were finished and harvested at a commercial Abattoir. Steer weight and backfat depth of 12.7 mm were used to determine final harvest endpoint. Measurement for backfat depth was conducted 30 – 45 days before final harvest using a SonoVet ultrasound machine and 3.5 MHz probe. Final harvest date was determined by calculating the required number of DOF to attain 12.7 mm BF.

Systems measurements were: corn forage nutrient change, corn forage utilization, backgrounding performance type and economics, treatment effect on animal health, corn grazing grain equivalent value, finishing performance and economics, and carcass closeout values.

Steers in the systems investigation were vaccinated before spring turnout on native pasture and then were vaccinated 3-4 weeks before each weaning date, and again at weaning with modified live IBR, BVD types I and II, PI_3, BRSV + Mannhiema haemolytica, and an inactivated 7-way Clostridial vaccine + H. somunus. In addition, the calves were poured with a parasiticide. After weaning, the calves were observed closely for the onset of health problems and were treated according to the attending veterinarian's recommendation. The following information is being recorded: body temperature, number of pulls, product used for treatment and cost, percent death loss, and system cost due to death loss.

Results and Discussion

Systems Backgrounding - Considering the results of Fausti et al. (2007) in the previous study, the present investigation was conducted to compare calf growing methods for EW and NW calves after weaning that compared feedlot backgrounding with grazing unharvested dryland corn before finishing based on a high quality grid. Standing peak dryland corn forage nutrient quality was determined mid-September and tracked through to mid-January. Corn forage CP declined from Sep to Nov (9.16 to 8.66) and IVDMD declined from 75.2% to 57.0%.

Peak DM corn production for the EW steers averaged 2.0 MTon/acre and peak DM corn production for the NW group was 1.75 MTon/acre. Early weaned steers utilized an average 1.46 MTon/acre over the 70 day grazing period and NW steers utilized 0.37 MTon/acre. Field loss in stockpiled corn set aside for grazing after normal weaning was excessive averaging 0.82 MTon/acre. Compared to the EW treatment, the large field loss reduced available days of grazing by 70%.

Comparative systems backgrounding performance is shown in Table 1. Steer weight at EW did not differ (P=0.44), but gain among the NW-CN steers was reduced significantly (P=0.043) due to field crop shrink. Average

daily gain for EW and NW steers was similar and greater (p=0.004) than the control steers despite significant crop shrinkage. System backgrounding economics are shown in Table 2 where gain value, input costs, net returns, and cost/kg of gain are summarized. The backgrounding cost/kg of gain was $$1.31, $3.77, $1.05, and $1.37 for the NW-FLT, NW-CN, EW-CN, and EW-FLT, respectively. Net return/steer among the steers in EW-CN system was 33.5% greater than the EW-FLT system and 16.3% greater than the NW-FLT system. Stockpiling corn for grazing after normal weaning was not successful resulting in a net loss/steer of -$33.38. The stocking rate for early weaned calves that graze unharvested dryland corn was calculated to be 0.1012 hectare/weaned calf/month and the stocking rate for stockpiled corn reserved for normal weaned calves in the study was determined to be 0.324 hectare/weaned calf/month.

The effect of alternative weaning date and corn grazing on finishing performance is shown in Table 3. Early weaning and corn grazing backgrounding resulted in staggered feedlot start weight (P = 0001), and a large variation in the number of days on feed (P = 0.0001); however, harvest age (P = 0.27) and 4% shrunk harvest weight (P = .409) did not differ. For gain and FE, EW-FLT steers gained at the slowest rate (P = 0.001), were more efficient (P = 0.008), and feed and yardage cost/kg of gain (P = 0.0002) were lower. By contrast, EW-CN steers that were the most profitable at the end of corn grazing backgrounding were less efficient (P = 0.008) and feed and yardage cost/kg of gain was higher (P = 0.0002). The NW-CN steers that grazed stockpiled dryland corn were the least efficient (P = 0.008) and had the highest feed and yardage cost/kg of gain (P = 0.0002).

Carcass closeout values for HCW (P = 0.78), dressing percent (P = 0.51), fat depth (P = 0.243), and yield grade (P = 0.23) did not differ. Corn grazing steers had significantly larger ribeye area (p = 0.053). Days on feed, which varied due to management system, directly affected marbling score (P = <0.0001) and the number of carcasses that graded USDA Choice or better (P = 0.10).

The combined effect of calf placement cost, ingredient cost, treatment cost, freight, and interest factors affected finishing net return. Calf placement cost had the most influence on net return. Closeout net returns were $3.11, -$84.06, $0.16, and $39.62/head for the NW-FLT, NW-CN, EW-CN, and EW-FLT, respectively.

Implications

Results suggest that greatest beef systems net return will be obtained when EW steers graze dryland unharvested corn and are sold at the end of backgrounding; however, when held until final harvest, early weaning and direct feedlot placement were associated with greatest net return.

Literature Cited

Fausti, S.W., D.G. Landblom, M.A. Beutler, P. Johnson, R. Gates, H. Patterson, S.I. Paisley and R. Salverson. 2007. The effect of early vs normal calf weaning on feedlot performance and herd management. Am. Soc. Farm Managers and Rural Appraisers, Vol. 70, No. 1, pp. 128-132.

Landblom, D.G., S. Paisley, P. Johnson, R. Gates, W. Fausti, and H.H. Patterson. 2006. Effects of weaning date and retained ownership on cattle performance and forage disappearance in spring calving beef systems. Proceedings: Western Section Am. Soc. Anim. Sci. 57:139-142.

Landblom, D.G., S.I. Paisley, K.C. Olson, P.S. Johnson, R.N. Gates, M.K. Beutler, S.W. Fausti, G.A. Perry, A. Smart, R.R. Salverson, H.H. Patterson, I. Rush, and S. Forman. 2008. Beef Systems Research: Effect of Weaning Date, Weaning Method, and Cow Wintering Method on Beef Cow and Calf Performance. In: 2008 Dickinson Research Extension Center Annual Report pp 336-347 www.ag.ndsu.nodak.edu/dickinso/research/2007/tocweb. htm#b.

Table 1. Systems Backgrounding Performance

	NW- Ctrl Pasture/ Feedlot	*NW – Corn Grazing*	*EW – Corn Grazing*	*EW – Feedlot*	*SE*	*P-Value*
Weaning Date	Nov 7	Nov 7	Aug 15	Aug 15		
No. Steers	54	24	24	57		
System Days	84	21	70	86		
System Weaning Wt., kg[a]	197.9	289.8	212.3	183.7	10.02	0.44
System End Wt., kg	272.2	314.3	300.3	277.1	15.05	0.15
Gain, kg	74.5[ab]	24.5[b]	88.0[a]	93.4[a]		0.043
ADG, kg	0.887[b]	1.16[a]	1.26[a]	1.09[a]	0.057	0.004

[a]Weaned steers were held in drylot for 13 days before placement in the corn fields to get over weaning.

Table 2. Alternative Beef System Unharvested Corn, Pasture, and Feedlot Economics

	NW- Ctrl Pasture/ Feedlot	*NW – Corn Grazing*	*EW – Corn Grazing*	*EW – Feedlot*
No. Steers	54	24	24	57
Gain Value [a,b,c,d]	$9,979	$1,413	$4,724	$10,980
Input Cost:				
Pasture (Rent @$14.00/ac)[e]	$5,254			
Corn ($164/ac)		$2,214	$2,214	
Feedlot				$7,302
Backgrounding Net Return	$4,725	-$801	$2,510	$3,678
Backgrounding Net Return/Head	$87.50	-$33.38	$104.58	$69.56
Cost/kg Gain	$1.31	$3.77	$1.05	$1.37

[a]NW Control Gain Value (8,910lb@$112/cwt)
[b]NW Corn Grazing Gain Value (4,334lb@$109/cwt)
[c]EW Gain Value (1,296lb@$109/cwt)
[d]Gain Value (9,804lb@$112/cwt)
[e]Pasture Rent Calculation: 2.78 months, 2.5 AUM; = 6.95 Ac/AUM @ $14/Ac; = $97.30 x54 = $5,254.20

Table 3. Effect of Alternative Weaning Date and Corn Grazing on Steer Finishing Performance

	NW- Ctrl Pasture/ Feedlot	*NW – Corn Grazing*	*EW – Corn Grazing*	*EW – Feedlot*	*SE*	*P-Value*
Start Wt., kg	272.2[c]	339.2[b]	313.1[d]	183.6[a]	37.2	<0.0001
4% Shrunk End Wt., kg[a]	538.4	555.2	566.9	545.7	10.44	0.409
Days on Feed	192[d]	141.5[b]	165.7[c]	280.8[a]	3.44	<0.0001
Kill Age, Days	408.1	415.1	404.6	412.1	3.17	0.270
ADG, kg	1.39[b]	1.53[c]	1.53[c]	1.29[a]	0.025	0.0011
DM Fd/Head/Day, kg	9.12[b]	11.1[d]	10.2[c]	8.07[a]	0.23	<0.0001
DM Feed:Gain, kg	6.56[b]	7.26[c]	6.64[b]	6.26[a]	0.072	0.008
Fd & Yard Cost/Day, $	$2.096[b]	$2.723[d]	$2.383[c]	$1.715[a]	0.053	<0.0001
Fd & Yard Cost/kg of Gain, $	$1.51[b]	$1.78[c]	$1.56[b]	$1.33[a]	0.016	0.0002

Physiography, Soil, and Native Vegetation of the Northern Plains

Llewellyn L. Manske PhD
Range Scientist
North Dakota State University
Dickinson Research Extension Center

Land resources of the Northern Plains are the source of new wealth generated by livestock agriculture. The land natural resources consist of complex ecosystems with several trophic layers of living organisms that have individual biological requirements and nonliving (abiotic) components that have changeable characteristics. Biologically effective management benefits all living and nonliving ecosystem components by meeting the biological requirements of the plants and soil organisms and by fostering the characteristics of the soil resulting in continuation of ecosystem production at potential sustainable levels. The potential productivity of healthy ecosystems are effected by the same environmental and biological factors that cause changes in physiographic landform characteristics, soil characteristics, and native vegetation types. The characteristics and relationships of the physiography, soil, and native vegetation of the Northern Plains are described in this report.

Physiographic Regions

The Northern Plains are part of the North American Interior Plains that extend from the foot of the Rocky Mountains eastward to the Canadian Shield and Appalachian Provinces and extend from the Athabasca River on the Alberta Plateau southward to the Gulf Coastal Plains (Fenneman 1931, 1946; Hunt 1974; Goodin and Northington 1985). The Interior Plains are divided east and west into the Great Plains and the Central Lowland Physiographic Provinces (Fenneman 1931, 1946). The Northern Plains are separated from the Southern Plains by the North Platte-Platte-Missouri River Valleys (Raisz 1957). The portions of the Great Plains and Central Lowland Provinces that exist in the Northern Plains are separated in North and South Dakota and Saskatchewan by an eroded east facing escarpment at the eastern extent of the Tertiary sedimentary deposits of material eroded from the Rocky Mountains that form a fluvial plain overlaying the Cretaceous bedrock (Hunt 1974). The surface landform feature that shows the location of this boundary is the east escarpment of the Missouri Coteau (Finneman 1931). In eastern Nebraska, the separation of the Great Plains and Central Lowland Provinces is the western limit of older pre-Wisconsin glacial drift which has a mantle of loess (wind deposited silt) (Fenneman 1931).

Great Plains Province

The Missouri Plateau Section and the northern portion of the High Plains Section of the Great Plains Province are separated in southern and eastern South Dakota by the north facing Pine Ridge Escarpment and the southern bluffs of the Missouri River Valley (Fenneman 1931). The portion of the High Plains that extends into the Northern Plains is divided into Pine Ridge, Sand Hills region, Loess Plain, and Goshen Hole Lowland landscape features. The Missouri Plateau, including the Alberta Plain, is divided into three sections: Glaciated, Unglaciated, and Black Hills, along with smaller domed mountains (Fenneman 1931, 1946; Hunt 1974).

Missouri Plateau Section

The Unglaciated section of the Missouri Plateau is north of the Pine Ridge Escarpment in South Dakota, south of the Missouri River in Montana, and west of the Missouri River in North and South Dakota (Fenneman 1931, 1946; Hunt 1974). Portions of this section were undoubtedly glaciated during glacial advances earlier than Wisconsin Age. However, there is little geologic evidence of older glaciation. The important distinction between the Unglaciated and Glaciated sections is the type and age of parent material from which the soil develops. The landscape surface of the Unglaciated section is highly eroded fluvial sedimentary deposits of material removed from the uplifted Rocky Mountains. Most of the deposition occurred from slow meandering streams during the Laramide Orogeny, that formed the mountains, and during the 20 to 30 million years of the late Cretaceous and early Tertiary Periods following the uplift. Intense widespread erosion of these sediments occurred from about 5 to 3 million years ago during the late Pliocene Epoch (Bluemle 2000). The extensive erosion during this period removed about 500 to 1000 feet of sediments (Fenneman 1931). These fluvial Tertiary sediments had great differences

in hardness and durability. The soft and unconsolidated material was easily removed and the harder coherent material had greater resistance to weathering and to erosional forces of wind and running water. Differential erosion formed a landscape with well developed integrated drainage systems of broad mature valleys and gently rolling uplands containing widely spaced large hills and buttes with erosion resistant caps raising 500 to 650 feet above the plain (Bluemle 2000).

In addition to the high relief from erosion resistant capped remnant hills and buttes on the landscape, several isolated domed mountain groups with 1500 to 2000 foot rise formed on the Missouri Plateau. These laccolithic mountains developed from the upward push of rising igneous intrusions (molten magma) that did not penetrate through to the surface but caused a diastrophic bulge with a single fold in the uplifted sediments. Differential erosion has since exposed the underlying tilted strata (Froiland and Weedon 1990) and sometimes the intrusive rock (Robinson and Davis 1995). Along with the large dome uplifted Black Hills in South Dakota and Wyoming, which is treated as a separate section, the Sweetgrass Hills, and the Highwood, Bearpaw, Little Rocky, Moccasin, Judith, and Big Snowy mountains in Montana are smaller domed mountain groups (Fenneman 1931, Hunt 1974). The Highwood and Bearpaw domed mountains include extinct volcanoes (Fenneman 1931).

Drainage of the Missouri Plateau during the highly erosional period of the Pliocene (5 to 3 million years ago) was primarily north and northeast towards the Hudson Bay area. The climate became cooler about 2.6 million years ago and, about 700,000 years ago, the climate was cold enough to produce continental glaciers (Bluemle 2000). Early glacial advances blocked the northward paths of the rivers draining the Unglaciated section and diverted water flow into steeper southern routes. The increased gradient of several rivers caused drastic downcutting through areas of poorly consolidated, soft, fine textured sediments resulting in formation of badland regions (Fenneman 1931).

The Glaciated section of the Missouri Plateau is north of the Missouri River in Montana, including the Alberta Plain between the foot of the Rocky Mountains and the Missouri Coteau Escarpment in Canada, and extends southward between the Missouri River and the east escarpment of the Missouri Coteau in North and South Dakota (Fenneman 1931, Hunt 1974). The section has a mantle of glacial and glacier related drift deposited between 70,000 and 10,000 years ago during the Wisconsin Age. The Missouri Coteau has 500 to 600 feet of terminal moraine deposits. The thick deposits of unsorted glacial sediment are a result of the large quantities of additional rock and sediments picked up from beneath the ice and forced upward into the glacier along shear planes that were generated by great internal stress (Bluemle 2000) when the advances of numerous glaciers were forced to progress up the steep escarpment of Tertiary deposited fluvial sediments. Large masses of stagnant ice remained buried under debris on the Coteau area for about 3000 years following the northern retreat of the last continental glacier. As the stagnant blocks of ice melted, the overlying material slumped down forming depressions (Bluemle 2000). The resulting topography is an irregular surface with closely spaced hills of 100 to 150 feet in height enclosing basins, or kettles, that usually contain ponds (Fenneman 1931). The drainage is local and completely unintegrated with only a few short streams.

The glaciated areas north of the Missouri River and on the Alberta Plain have a mantle of till and outwash. The topography is generally rough. The plain is dissected by broad river valleys that have entrenched 200 to 400 feet. The upland areas contain several erosional remnants that have local relief of about 1000 to 2000 feet. The Cypress Hills in Saskatchewan are the highest and have a height tall enough that they were not overriden by glacial ice. The gravel capped Cypress Hills were part of an ancient valley where a thick layer of rock from the Rocky Mountains was deposited by rivers. This heavy gravel layer protected the surface during the severe erosional period of the late Pliocene, while surrounding higher areas were eroded down to levels below the gravel layer forming an inverted topography (Fenneman 1931).

High Plains Section

A small portion of the High Plains Section of the Great Plains Province exists between the Pine Ridge Escarpment in South Dakota and the North Platte-Platte River Valley in Nebraska and is included within the Northern Plains (Fenneman 1931, 1946; Hunt 1974). Contrary to the erosional surface of the Unglaciated section of the Missouri Plateau north of Pine Ridge, the northern portion of the High Plains is primarily a depositional surface. The uplands of Pine Ridge north of the Niabrara River are exposed Tertiary fluvial sediments of the Arikaree Formation

deposited during the Miocene and have a gently rolling to nearly flat topography. The Goshen Hole Lowland located in western Nebraska south of the west end of Pine Ridge is a landform about 50 miles wide and 150 miles long where the North Platte River removed about 700 feet of fine textured clay Tertiary sediments during a period when the river had a relatively steep gradient. The Sand Hills region in Nebraska is located south of the Niobrara River and north of the Platte River. Wind deposited sand covers the Tertiary sediments of the region and forms a sand dune topography. Small areas have active dune movement, however, most of the region has been stabilized by grassland vegetation. Some of the sand hills are several hundred feet high. Lakes, ponds, or wetlands form in the depressions. The Loess Plain in north central Nebraska is located east of the Sand Hills region. Wind deposited silt (loess) about 100 feet thick covers the Tertiary sediments of the area and forms a gently rolling topography (Fenneman 1931).

Central Lowland Province

The Small Lakes Section and the Dissected Till Plains Section of the Central Lowland Province are separated by the age of the glacial till and the degree of development of integrated drainage systems. The Small Lakes Section is located in the northwestern part of the Central Lowland Province and extends eastward from the escarpment of the Missouri Coteau to the Great Lakes Section (Hunt 1974). However, for this report, the Small Lakes Section description extends eastward only to the transition between the Tall Grass Prairie and the Oak Forest in western Minnesota.

Small Lakes Section

The Small Lakes Section has a mantle of Wisconsin Age glacial till and glacial lake deposits. The Saskatchewan Plain between the Missouri Coteau Escarpment and the Manitoba Escarpment in Canada and the Glaciated Plains (Drift Prairie) east of the Missouri Coteau in North and South Dakota extending into western Minnesota are an undulating plain of ground moraine forming a knob and kettle topography with low to moderate relief (Hunt 1974). Water collects in the lower portions of the landscape forming lakes and ponds or marshes with the size decreasing westward with the decrease in annual precipitation (Hunt 1974). The Small Lakes Section does have a few river systems, however, these rivers are still at the early stages of developing complex integrated drainage systems. Thick glacial deposits forming a hummocky collapsed topography (Bluemle 2000) cover Moose Mountain in Saskatchewan and the Turtle Mountains in Manitoba and North Dakota as a result of shear stress planes developing in the ice as the glaciers advanced over preexisting high relief erosional remnant hills.

Glacial Lake Plains of relatively flat fine sediments and reworked till were formed by glacial lakes that developed when meltwater collected in landscape depressions, along the edge of receding glaciers, or as a result from ice damming drainage routes (Ojakangas and Matsch 1982, Bluemle 2000). Lakes Agassiz, Aitkin, Dakota, Duluth, Minnewaukan, Regina, Souris, and Upham were major glacial lakes that existed for periods sometime between 12,200 and 7,500 years ago. Lake Agassiz was, by far, the largest of the glacial lakes and its western edge is defined by the Manitoba-Pembina Escarpment. This escarpment was formed during the highly erosional period of the Pliocene when artesian ground water from the Cretaceous Dakota sandstone formation and overland water from the Grand, Cheyenne, and White Rivers flowed into the ancestral Red River, cut through the relatively soft Cretaceous sediments down to the west sloping Precambrian igneous rock of the Canadian Shield, and progressively shifted the erosional face westward (Bluemle 2000). These erosional surfaces were later covered with thick layers of glacial till and lake sediments during the Pleistocene glaciation. The exceptionally flat surface of Glacial Lake Agassiz sediments east of the Manitoba-Pembina Escarpment form the Manitoba Plain in Canada and the Red River Valley Plain in eastern North Dakota and western Minnesota.

Dissected Till Plains Section

The Dissected Till Plains Section was not glaciated during the Wisconsin Age. The glacial till of this section is from older glacial advances. The old dissected till deposits extend westward from the Mississippi River across southern Iowa and northern Missouri and narrows northward into southwestern Minnesota and southeastern South Dakota (Fenneman 1946, Raisz 1957). The western limit of the old glacial till occurs in eastern Nebraska. The drainage systems on older till have had longer to develop a complex integrated pattern with closely spaced deep valleys and rounded uplands. There are few lakes and ponds in this section and a younger mantle of about 30 feet of wind blown loess (silt) covers the region (Hunt 1974).

Soil Characteristics

Soil development is effected by climate, parent material, topography, living organisms, and time (Brady 1974). The main climatic factors that affect soil development are temperature and precipitation. Climate determines the type and rate of weathering that occurs. The rates of biogeochemical processes in soil are effected by soil temperature and soil moisture. Climate determines the type of native vegetation and the quantity of biomass production. There is a relationship between the type of native vegetation and the kind of soil that develops. Increases in soil moisture, increase the biomass production and tend to increase organic content of soils. Increases in soil temperature, increase the rate of decomposition and tend to decrease organic content of soils (Brady 1974).

The Northern Plains has a continental climate with cold winters and hot summers. Mean air temperatures increase from north to south changing from about 35° - 40° F (1.7° - 4.4° C) in the north to about 48° - 51° F (8.9° - 10.6° C) in the south. Most of the precipitation occurs during the early portion of the growing season. Total annual precipitation fluctuates greatly from year to year. Periods of water deficiency during the growing season occur more frequently than growing seasons without deficiencies. Drought conditions are common. Mean annual precipitation increases from west to east and increases from north to south. In the northern portion, precipitation ranges from about 12 inches (304.8 mm) in the west to about 24 inches (609.6 mm) in the east. In the southern portion, precipitation ranges from about 14 inches (355.6 mm) in the west to about 32 inches (812.8 mm) in the east.

Evapotranspiration affects the quantity of moisture in the soil and the duration infiltrated water remains available for plant growth. The potential evapotranspiration for most of the Northern Plains is greater than annual precipitation. Potential evapotranspiration demand increases from north to south, and increases from east to west. Along the eastern edge of the Northern Plains, the precipitation is greater than potential evapotranspiration during most years. The region also has several local areas where the combination of stored soil water, precipitation, plus water runin is greater than evapotranspiration. Subirrigated soils where the rooting zone is moist for most of the growing season would be comparable to conditions with greater precipitation than evapotranspiration.

The properties of the parent material that affect soil development include texture and structure, and chemical and mineral composition. The texture and structure of parent material varies from fine to coarse and is related to the type of source material and the degree of weathering. The texture of the parent material determines the texture of the soil and the relative content of clay, silt, sand, and gravel. The texture of the soil controls the downward movement of water. The chemical and mineral composition of the parent material strongly influences the growth of the native vegetation and determines the effectiveness of the weathering forces. Parent material influences the quantity and type of clay minerals that develop (Brady 1974). The parent material on the Northern Plains is eroded Tertiary fluvial sedimentary deposits, unsorted glacial till, sorted glacier related deposits of outwash and lake sediments, and wind deposited sand and silt.

Landform topography modifies soil development by influencing the quantity of precipitation absorbed and retained in the soil, determines aspect to solar radiation, and influences the rate of soil removal by erosion. Water, organic matter, mineral matter, and soluble salts move down slope, whether over the surface or internally. The steeper the gradient, the greater the movement. Soil temperature changes with slope aspect. Increases in soil temperature, increase evapotranspiration and decomposition rates. Upper slope soils tend to have lower soil moisture, less organic matter, and thinner horizon development than lower slope soils from similar parent material (Brady 1974).

Living organisms (including plants, animals, and soil microorganisms) affect soil development by influencing organic matter accumulation, profile mixing, nutrient cycling, and structural stability. The source of soil organic matter is the dead tissue and waste from organisms, decomposition is performed by soil organisms, nutrient cycles are complex processes involving living organisms, burrowing critters mix soil material, and soil aggregation is a result of soil organism secretions (Brady 1974).

Time is required for soils to develop and mature. However, soils do not all develop at the same rate. Conditions that increase soil development are warm humid climate, parent material highly permeable by water, unconsolidated material, low lime content, depression or level topography, good drainage, and forest vegetation. Conditions that retard soil development are cold dry climate, parent material not permeable by water, consolidated

material, high lime content, steeply sloping topography, poor drainage, and grassland vegetation (Brady 1974). Some very old soils in the Northern Plains show little or no evidence of horizon development because they exist in dry regions, on steep, actively eroding slopes where the rate of soil removal is as great or greater than the rate of soil development.

The soils that are developing in the Northern Plains fit into the order classification descriptions of Mollisols, Aridisols, and Entisols.

Mollisols are mineral soils that develop under grassland vegetation with a thick mollic epipedon that is "soft", high in organic matter, and dark colored. The limited leaching results in a high base saturation with a concentration of positively charged exchangeable cations other than hydrogen. Most Mollisols in the Northern Plains have, or are developing, an argillic (clay) layer in an upper subhorizon and have an accumulation of calcium carbonate (lime) at some level of the profile (Soil Survey Staff 1975).

Aridisols are mineral soils that develop in aridic (dry) or torric (hot and dry) climates with a thin ochic epipedon that is low in organic matter and light colored. Soil water is not available to plants for long periods during the growing season. In the Northern Plains, the Aridisols have an argillic (clay) layer in an upper subhorizon and as a result of limited leaching, soluble salts, like calcium carbonate, accumulate in a zone that marks the average depth of moisture penetration (Soil Survey Staff 1975).

Entisols are mineral soils that show little or no evidence of horizon development and have a thin ochic epipedon that is low in organic matter and light colored. In the Northern Plains, considerable retardation of soil development produces Entisols where dry and/or salty medium to fine textured sediments with sparse grass or shrub vegetation are located on gentle to steep, actively eroding slopes with the rate of soil removal as great as the rate of soil development, or where coarse textured, well sorted, wind deposited sand with low water holding capacity and thin grass vegetation become dry and are easily moved by wind (Soil Survey Staff 1975).

Classification of soils into principal suborders is based on differences caused by climate and associated native vegetation. The biological processes in soil are effected by soil temperature and soil moisture. The different climatic characteristics important in soil development are separated into specific soil temperature regimes and soil moisture regimes.

The Northern Plains has two soil temperature regimes based on mean annual soil temperature. The mean annual soil temperature is considered to be the mean annual air temperature plus 1.8° F (1° C) (Soil Survey Staff 1975). The Frigid soil temperature regime has mean annual soil temperatures of less than 47° F (8° C). The Mesic soil temperature regime has mean annual soil temperatures higher than 47° F (8° C) and lower than 59° F (15° C) (Soil Survey Staff 1975). The separation between the Frigid and Mesic soil temperature regimes occurs along a wide irregular belt that extends eastward from central Wyoming along its north border with Montana and continues to north central South Dakota just south of its north border with North Dakota, then extends at a southeasterly diagonal to about the center of South Dakota's east border with Minnesota, and then extends at a northeasterly angle to the boundary of the Oak Forest.

Soil moisture regimes are based on the soil moisture conditions in the soil. The Northern Plains has four north-south zones of soil moisture regimes that increase in soil moisture from west to east. The soils in the Aridic and Torric soil moisture regime, typically of arid climates, are dry in all parts for more than half the time and the soils are never moist for as long as 90 days during the growing season (Soil Survey Staff 1975). The soils in the Ustic soil moisture regime, typically of semi arid climates, are dry in some or all parts for 90 or more days in most years, but not dry in all parts for more than half the time, and are not dry for as long as 45 days during the 4 months that follow the summer solstice in 6 or more years out of 10 years (Soil Survey Staff 1975). The soils in the Udic soil moisture regime, typically of sub humid climates, are not dry for as long as 90 days. During the summer, the amount of stored moisture plus rainfall is approximately equal to or exceeds the amount of evapotranspiration (Soil Survey Staff 1975). The soils in the Perudic soil moisture regime, typically of humid climates, are rarely dry. During the summer, the precipitation is greater than the evapotranspiration (Soil Survey Staff 1975).

The combination of four soil moisture regimes (Aridic, Ustic, Udic, and Perudic) and two soil temperature regimes (Frigid and Mesic) results in eight distinct soil moisture-temperature regimes in the

Northern Plains. The soils in the Aridic-Frigid soil moisture-temperature regime are primarily Aridic Borolls (arid cool Mollisols) and Torriorthents (hot dry recently eroded medium to fine textured Entisols) and support vegetation of short grasses with some mid grasses. The soils in the Ustic-Frigid soil moisture-temperature regime are primarily Typic Borolls (semi arid cool Mollisols) and support vegetation of mid and short grasses. The soils in the Udic-Frigid soil moisture-temperature regime are primarily Udic Borolls (sub humid cool Mollisols) and support vegetation of mid grasses with some tall grasses. The soils in the Perudic-Frigid soil moisture-temperature regime are primarily Aquolls (humid cool Mollisols that are saturated and absent of oxygen at times for unknown lengths) and support vegetation of tall grasses. The soils in the Aridic-Mesic soil moisture-temperature regime are primarily Argids (arid warm Aridisols with thin horizons, dry for long periods, and have a clay layer) and Aridic Ustolls (arid warm Mollisols) and support vegetation of short grasses. The soils in the Ustic-Mesic soil moisture-temperature regime are primarily Ustipsamments (semi arid warm Entisols that are well sorted wind deposited sands) and Typic Ustolls (semi arid warm Mollisols) and support vegetation of mid and short grasses with lower topographic slopes supporting tall grasses. The soils in the Udic-Mesic soil moisture-temperature regime are primarily Udic Ustolls (sub humid warm Mollisols) and support vegetation of mid grasses and tall grasses. The soils in the Perudic-Mesic soil moisture-temperature regime are primarily Udolls (humid warm Mollisols that do not have a calcium carbonate layer) and support vegetation of tall grasses.

Native Vegetation Types

Development of plant communities and vegetation types is effected by the climatic characteristics of temperature, precipitation, and evapotranspiration demand; the soil characteristics of texture, structure, and chemical and mineral composition; and the landform topographic characteristics of slope, aspect, and elevation. Vegetation of the Northern Plains separates into 10 grassland vegetation types and 7 grassland with woodland or forest vegetation types. The vegetation of the Northern Plains map (figure 1) developed by Dr. W.C. Whitman (Barker and Whitman 1989) is a compilation of information from several sources supplementary to the basic map of potential natural vegetation by Kuchler (1964). Modifications to vegetation type designations, distributions, and boundaries were conflated into the base map from state vegetation maps for Montana (Ross and Hunter 1976, Hacker and Sparks 1977), Nebraska (Kaul 1975, Bose 1977), North Dakota (Shaver 1977), South Dakota (Baumberger 1977), and Wyoming (Shrader 1977). Vegetation type designations and distributions from scientific papers were added for Canada (Clarke, Campbell, and Campbell 1942; Moss and Campbell 1947; Coupland and Brayshaw 1953; Coupland 1950, 1961). A new concept of a plains rough fescue mixture along a portion of the northern border of North Dakota was introduced to the map details by Whitman and Barker (1989).

No living plant species are known to have originated in the Northern Plains. All plant species considered to be native to the Northern Plains originated and developed in other regions and sometime later migrated into the Northern Plains. The plant communities and vegetation types, however, are relatively young and began development in place about 5,000 years ago when the current climate with cycles of wet and dry periods began. Nomenclature of plants in the vegetation types of the Northern Plains followed Flora of the Great Plains (1986) in Barker and Whitman (1989) and, in addition, nomenclature of grass plants follows Flora of North America (2003, 2007) in this report.

Tall Grass Prairie

The Tall Grass Prairie, Bluestem-Switchgrass-Indiangrass Type, exists on the eastern margin of the Northern Plains Grasslands and extends from southern Manitoba through eastern North and South Dakota and western Minnesota southward into northwestern Iowa and northeastern Nebraska to the Platte River. The physiography of the region consists of the Manitoba Plain and the Red River Valley Plain of the Small Lakes Section and extends into the Dissected Till Plains Section of the Central Lowland Province. The climate is humid with evapotranspiration lower than precipitation. The soil moisture regime is Perudic and the soil temperature regime is Frigid in the north and Mesic in the south. The soils are primarily Aquolls in the north and Udolls in the south. The major grasses of the Bluestem-Switchgrass-Indiangrass Type of the Tall Grass Prairie (table 1) are big bluestem, porcupinegrass, switchgrass, prairie dropseed, and indiangrass. Cool-season grass species increase towards the northern portions and warm-season grass species increase towards the southern portions. Big bluestem occupies the lower slopes and subirrigated soils in the north and increases in dominance in the south. Prominent forbs are prairie clover, tall blazing

star, large beardtongue, stiff sunflower, scurf pea, white prairie aster, white sage, prairie goldenrods, and violets. Major shrubs are leadplant, white spiraea, wild roses, western snowberry, and willows. Most of this vegetation type has been converted to cropland, and only fragments of tall grass prairie vegetation remain. Plant communities with tall grass species exist in several other vegetation types where near equivalent environmental conditions develop from combinations of precipitation, stored soil water, and water runin that are greater than evapotranspiration.

Transition Mixed Grass Prairie

The Transition Mixed Grass Prairie, Wheatgrass-Bluestem-Needlegrass Type (figure 1), exists between the Tall Grass Prairie on the east and the Mixed Grass Prairie on the west and extends from east central Saskatchewan and southwestern Manitoba through east central North and South Dakota and east central Nebraska to the Platte River. The physiography of the region consists of the Saskatchewan Plain and the Glaciated Plains (Drift Prairie) of the Small Lakes Section of the Central Lowland Province and extends into the eastern portion of the High Plains Section of the Great Plains Province. The climate is sub humid with evapotranspiration greater than precipitation over most of the area except for subirrigated soils and topographic slope positions with water runin. The soil moisture regime is Udic and the soil temperature regime is Frigid in the north and Mesic in the south. The soils are primarily Udic Borolls in the north and Udic Ustolls in the south. The major grasses of the Wheatgrass-Bluestem-Needlegrass Type of the Transition Mixed Grass Prairie (table 2) are western wheatgrass, thickspike (northern) wheatgrass, little bluestem, porcupinegrass, needle and thread, and green needlegrass. Cool-season grass species increase towards the northern portions and warm-season grass species increase towards the southern portions. The needlegrasses and thickspike wheatgrass increase in the north. Little bluestem increases in the south. Prominent forbs are white prairie aster, scurf peas, prairie coneflower, purple coneflower, milkvetches, dotted blazing star, white sage, soft goldenrod, curlycup gumweed, hairy golden aster, and stiff sunflower. Major shrubs are wild roses, western snowberry, silverberry, leadplant, white spiraea, and willows. Plant communities change with topographic position. Wetland communities develop in nearly concentric rings around depressions. The salt-affected “pot holes” support saline plant communities. Wet meadow communities develop on subirrigated soils. Upland communities develop on well drained soils and xeric communities develop on shallow soils. Kentucky bluegrass and western snowberry communities have greatly increased in this region as a result of high stocking rates and too early of grazing starting dates.

Mixed Grass Prairie

The Mixed Grass Prairie has a high mid grass component with some short grasses and some tall grasses present and is separated into three vegetation types based on differences resulting from soil texture and soil temperature regime.

The Mixed Grass Prairie, Wheatgrass-Needlegrass Type (figure 1), exists on semi arid cool soils between the Transition Mixed Grass Prairie on the east and the Short Grass Prairie on the west and extends from mid Saskatchewan through western North Dakota and eastern Montana to north central and northwestern South Dakota. The physiography of the region consists of the eastern portions of the Glaciated and Unglaciated sections of the Missouri Plateau Section, including the Alberta Plain, of the Great Plains Province. The climate is semi arid with evapotranspiration greater than precipitation. The soil moisture regime is Ustic and the soil temperature regime is Frigid. The soils are primarily Typic Borolls. The major grasses of the Wheatgrass-Needlegrass Type of the Mixed Grass Prairie (table 3) are western wheatgrass, needle and thread, blue grama, prairie Junegrass, and green needlegrass. Prominent forbs are white prairie aster, scarlet gaura, scarlet globemallow, purple prairie clover, dotted blazing star, purple locoweed, fringed sage, white sage, hairy golden aster, curlycup gumweed, Hood’s spiny phlox, prairie smoke, green sage, and prairie chickweed. Major shrubs are silver sagebrush, buffaloberry, wild roses, western snowberry, broom snakeweed, and creeping juniper. This vegetation type grows in soils developed from glacial till north and east of the Missouri River and grows in soils developed from Tertiary sedimentary deposits south and west of the Missouri River. Soils in the unglaciated section are developing an argillic (clay) layer and accumulating soluble salts in a subhorizon at decreasing depths from east to west.

The Mixed Grass Prairie, Wheatgrass-Grama Type (figure 1), exists on semi arid warm clay soils south of the Wheatgrass-Needlegrass Type and is in southwestern South Dakota. The physiography of the region consists of the southeastern portion of the Unglaciated section of the Missouri Plateau

Section of the Great Plains Province. The climate is semi arid with evapotranspiration greater than precipitation. The soil moisture regime is Ustic and the soil temperature regime is Mesic. The soils are primarily clay textured Typic Ustolls. The major grasses of the Wheatgrass-Grama Type of the Mixed Grass Prairie (table 4) are western wheatgrass, blue grama, and buffalograss. This vegetation type is separated from the Wheatgrass-Needlegrass Type because the clay textured soils and warmer soil temperature regime result in near removal of needle and thread and in greatly increasing blue grama and buffalograss.

The Mixed Grass Prairie, Wheatgrass Type (figure 1), exists on semi arid warm dense clay soils south of the Wheatgrass-Needlegrass Type and is in northwestern South Dakota. The physiography of the region consists of the central portion of the Unglaciated section of the Missouri Plateau Section of the Great Plains Province. The climate is semi arid with evapotranspiration greater than precipitation. The soil moisture regime is Ustic and the soil temperature regime is Mesic. The soils are primarily dense clay textured Typic Ustolls. The major grasses of the Wheatgrass Type of the Mixed Grass Prairie (table 5) are western wheatgrass, green needlegrass, and thickspike wheatgrass. This vegetation type is separated from the Wheatgrass-Needlegrass Type because the dense clay textured soils and warmer soil temperature regime result in removal of blue grama and near removal of needle and thread.

Short Grass Prairie

The Northern Short Grass Prairie, Grama-Needlegrass-Wheatgrass Type (figure 1), exists on the western side of the Northern Plains Grasslands and extends from southeastern Alberta and southwestern Saskatchewan through central Montana and southward into northeastern Wyoming. The physiography of the region consists of the western portions of the Glaciated and Unglaciated sections of the Missouri Plateau Section of the Great Plains Province. The climate is arid with evapotranspiration greater than precipitation. The soil moisture regime is Aridic and the soil temperature regime is Frigid in the north and Mesic in the south. The soils are primarily Aridic Borolls and Torriorthents in the north and Argids and Aridic Ustolls in the south. The major grasses of the Grama-Needlegrass-Wheatgrass Type of the Northern Short Grass Prairie (table 6) are blue grama, needle and thread, small needlegrass, western wheatgrass, thickspike wheatgrass, green needlegrass, and buffalograss. Prominent forbs are fringed sage, green sage, milkvetches, Hood's spiny phlox, curlycup gumweed, and prairie chickweed. Major shrubs are big sagebrush, silver sagebrush, rabbitbrush, broom snakeweed, plains prickly pear, greesewood, shadescale, saltbush, and winterfat. Dr. Whitman (Barker and Whitman 1989) continued the separation of this vegetation type from the Wheatgrass-Needlegrass Type because of the notable increase in the shortgrass component and the relative decrease of western wheatgrass and needle and thread. Cool-season grass species increase towards the northern portions and warm-season grass species increase towards the southern portions. The needlegrasses increase in the north. Blue grama and buffalograss increase in the south. Because of the presence of mid cool-season grasses, the Northern Shortgrass Prairie has sometimes been combined with the Northern Mixed Grass Prairie. However, these two vegetation types are distinct and should remain separated. The Grama-Needlegrass-Wheatgrass Type has the appearance of a shortgrass prairie and has an arid soil moisture regime, less soil horizon development, shallower soil depth to the accumulating soluble salts and developing argillic (clay) layer, shallower rooting depth, lower soil water holding capacity, greater evapotranspiration potential, and generally more xeric than the Wheatgrass-Needlegrass Type.

The Northern Short Grass Prairie, Saltgrass Type, exists on salt affected soils distributed in local areas across the Northern Short Grass Prairie region. The major grasses of the Saltgrass Type of the Northern Short Grass Prairie (table 7) are saltgrass, alkali cordgrass, basin wildrye, foxtail barley, little barley, and Nuttall's alkali grass. Few plant species can tolerate the harsh environmental conditions of salt-affected areas. The tolerant species have mechanisms to exclude uptake of salts, or physiologically separate and discharge the undesired salts.

The Southern Short Grass Prairie, Blue grama-Buffalograss Type (figure 1), exists in northwestern Nebraska and extends into east central Wyoming north of the North Platte River. The physiography of the region consists of a small western portion of the High Plains Section of the Great Plains Province. The climate is arid with evapotranspiration greater than precipitation. The soil moisture regime is Aridic and the soil temperature regime is Mesic. The soils are primarily Argids and Aridic Ustolls. The major grasses of the Blue grama-Buffalograss Type of the Southern Short Grass Prairie (table 8) are blue grama and

buffalograss. This vegetation type is separated from the Grama-Needlegrass-Wheatgrass Type because the arid soil moisture regime and mesic soil temperature regime severely reduce the mid cool-season grasses and greatly increase the short warm-season grasses. Only a small area of the Southern Short Grass Prairie extends into the Northern Plains.

Sandhills Prairie

The Sandhills Prairie, Bluestem-Sandreed-Grama-Needlegrass Type (figure 1), exists in the north central portion of Nebraska south of the Niobrara River and north of the Platte River. Other Sandhills Prairie areas exist scattered throughout the Northern Plains. Many areas are too small to map. A large area of Sandhills Prairie exists along the Sheyenne River in southeastern North Dakota and another large area exists near Swift Current, Saskatchewan. The physiography of the Nebraska Sandhills consists of the Sand Hills region of the High Plains Section of the Great Plains Province. The climate is semi arid with evapotranspiration greater than precipitation. The soil moisture regime is Ustic and the soil temperature regime is Mesic. The soils are primarily Ustipsamments. The major grasses of the Bluestem-Sandreed-Grama-Needlegrass Type of the Sandhills Prairie (table 9) are big bluestem, little bluestem, sand bluestem, prairie sandreed, sideoats grama, needle and thread, and switchgrass. Prominent forbs are purple prairie clover, silky prairie clover, scurf peas, goldenrods, sunflowers, white camas, and wild lily. Major shrubs are leadplant, wild roses, western snowberry, willows, creeping juniper, common juniper, eastern red cedar, and yucca. This vegetation type is fundamentally the Tall Grass Prairie vegetation on sand soils. The tall grass species occupy the lower slopes and subirrigated soils while the mid and short grasses occupy the dryer upper slopes. A unique assemblage of grasses grow in blowout areas with active wind erosion and deposition and are blowout grass, sandhill muhly, sand dropseed, indian ricegrass, and Schweinitz cyperus.

Foothills Prairie

The Foothills Prairie, Plains Rough Fescue Type (figure 1), exists as a fringe along the montane forest of the Rocky Mountain foothills from Alberta to south central Montana and along the aspen groveland and aspen parkland bordering the boreal forest zone in Alberta and Saskatchewan and the type mingles with the Wheatgrass-Bluestem-Needlegrass Type extending across Saskatchewan and southwestern Manitoba and into northern North Dakota. The physiography of the region consists of the northern portion of the Glaciated section of the Missouri Plateau Section of the Great Plains Province and the northern portion of the Small Lakes Section of the Central Lowland Province. The major grasses of the Plains Rough Fescue Type of the Foothills Prairie (table 10) are plains rough fescue, Parry's oatgrass, timber oatgrass, bluebunch wheatgrass, slender wheatgrass, western wheatgrass, thickspike wheatgrass, Nelson's needlegrass, and Richardson's needlegrass. Prominent forbs are lupines, tall larkspur, sticky-leaved geranium, and arrowleaf balsamroot. Major shrubs are shrubby cinquefoil and big sagebrush. This vegetation type consists of a high proportion of tussock-forming grass species that are now known to develop on other landforms than Rocky Mountain foothills.

Grassland with Woodland or Forest

The Pacific Bunchgrass Prairie, Bluebunch-Fescue Type (figure 1), exists in the south central portion of Montana. Numerous other areas too small to map exist within the Great Plains. The physiography of the region consists of the Unglaciated section of the Missouri Plateau Section of the Great Plains Province. The major grasses of the Bluebunch-Fescue Type of the Pacific Bunchgrass Prairie (table 11) are bluebunch wheatgrass, Idaho fescue, western wheatgrass, sideoats grama, and little bluestem. Prominent forbs are white prairie aster, western yarrow, American vetch, scarlet gaura, and fringed sage. Major shrubs are western snowberry, silver sagebrush, rabbitbrush, broom snakewood, and plains prickly pear. This vegetation type is commonly associated with big sagebrush and exists as open grasslands between savanna stands of ponderosa pine or Rocky Mountain juniper.

The Badlands and River Breaks, Woody Draw and Savanna Types (figure 1), exist in central Montana along the Missouri and Musselshell Rivers, in western North Dakota along the Little Missouri River, and in southwestern South Dakota along the White River. The physiography of the region consists of the Unglaciated section of the Missouri Plateau Section of the Great Plains Province. The major grasses of the Woody Draw and Savanna Types of the Badlands and River Breaks (table 12) are western wheatgrass, needle and thread, blue grama, green needlegrass, and prairie Junegrass. The grassland communities of this vegetation type exist as open grasslands or understory grasslands associated

with thin stands of trees growing in highly eroded badland areas, on steep east and north facing slopes, or in steep, sharply eroded breaks along streams and rivers. The woodlands and savannas consist primarily of ponderosa pine and Rocky Mountain juniper, and the hardwood draws consist of green ash, American elm, boxelder, and hawthorn. Major shrubs are wild roses, Juneberry, chokecherry, skunk bush, western snowberry, and shrubby cinequefoil.

The Pine Savanna, Pine-Juniper-Bluebunch Type (figure 1), exists on rough uplands in south central and southeastern Montana, north central Wyoming, western South Dakota, and southwestern North Dakota. The physiography of the region is the Unglaciated section of the Missouri Plateau Section of the Great Plains Province. The major grasses of the Pine-Juniper-Bluebunch Type of the Pine Savanna (table 13) are bluebunch wheatgrass, western wheatgrass, thickspike wheatgrass, needle and thread, blue grama, green needlegrass, and little bluestem. The grassland communities of this vegetation type exist as open grasslands or understory grasslands associated with numerous disconnected savanna stands of ponderosa pine and Rocky Mountain juniper growing on eroded uplands with thin soils. Major shrubs are big sagebrush, bitterbrush, western snowberry, skunk bush, rabbitbrush, and common juniper.

The Black Hills Pine Forest, Pine-Spruce-Aspen Type (figure 1), exists in southwestern South Dakota and northeastern Wyoming. The physiography of the region consists of the Black Hills section of the Missouri Plateau Section of the Great Plains Province. The major grasses of the Pine-Spruce-Aspen Type of the Black Hills Pine Forest (table 14) are western wheatgrass, bluebunch wheatgrass, needle and thread, green needlegrass, prairie Junegrass, and blue grama. The grassland communities of this vegetation type exist as open grasslands or understory grasslands associated with the open park stands of ponderosa pine in the higher hills and with the savanna stands of ponderosa pine in the lower hills. Grassland communities are not important in the deep cool canyons with dense, nearly closed stands of white spruce and paper birch, in the dense secondary growth of aspen and paper birch, or in the dense deciduous forest stands of green ash, bur oak, American elm, boxelder, and hackberry along streams. Important shrubs are beaked hazelnut, Juneberry, chokecherry, willows, big sagebrush, sand sagebrush, and mountain mahogany.

The Montane Forest, Pine-Fir-Spruce Type (figure 1), exists on the Sweetgrass Hills, and the Highwood, Bearpaw, Little Rocky, Moccasin, Judith, and Big Snowy mountains in Montana and the Cypress Hills in Saskatchewan. The physiography of the region consists of the laccolithic domed mountains in the Unglaciated section and the erosional upland remnant in the Glaciated section of the Missouri Plateau Section of the Great Plains Province. The major grasses of the Pine-Fir-Spruce Type of the Montane Forest (table 15) are bluebunch wheatgrass, Idaho fescue, Nelson's needlegrass, spike fescue, prairie Junegrass, needle and thread, and spike oatgrass. The grassland communities of this vegetation type exist as open grasslands and understory grasslands associated with open stands of ponderosa pine and Douglas fir on the lower elevations of the domed mountains. Prominent forbs are arrowleaf balsamroot, lupine, sticky-leaved geranium, bluebells, and prairie smoke. Major shrubs are western snowberry, white spiraea, and bearberry. Grassland communities are not important at the higher elevations with closed forest stands of subalpine fir, Douglas fir, and Engelmann spruce. Grassland communities are associated with the open forest stands of lodgepole pine, white spruce, paper birch, and aspen on the Cypress Hills.

The Upland Woodlands, Aspen-Ash-Oak-Juniper Types (figure 1), exist as scattered areas with various types of trees, shrubs, and grasses in North Dakota, Manitoba, and Saskatchewan. The physiography of the region consists of upland positions of the Small Lakes Section of the Central Lowland Province and of upland positions of the Unglaciated section of the Missouri Plateau Section of the Great Plains Province. The major grasses of the Aspen-Ash-Oak-Juniper Types of the Upland Woodlands (table 16) are roughleaf ricegrass, little ricegrass, and long-beaked sedge. Grass plants of these vegetation types are part of the understory community. Prominent forbs are northern bedstraw, wild strawberry, violets, anise root, and black snakeroot. Major shrubs are beaked hazelnut, western snowberry, Juneberry, chokecherry, red raspberry, bittersweet, gooseberry, wild plum, and northern hawthorn. The aspen woodlands contain trembling aspen, balsam poplar, paper birch, green ash, and sometimes bur oak. The ash woodlands contain green ash, American elm, boxelder, and occasionally hackberry. The oak woodlands contain bur oak, green ash, American elm, boxelder, aspen, and occasionally ironwood. The juniper woodlands contain Rocky Mountain juniper.

The Riparian Woodlands, Cottonwood-Ash-Elm Type (figure 1), exists along the floodplains of the larger rivers and streams and as small groves along minor drainage ways located throughout the Northern Plains. The major grasses of the Cottonwood-Ash-Elm Type of the Riparian Woodlands (table 17) are Canada wildrye, slender wheatgrass, Virginia wildrye, prairie sandreed, needle and thread, green needlegrass, marsh muhly, reed canarygrass, prairie cordgrass, bottlebrush grass, and mountain ricegrass. The grassland communities of this vegetation type exist as understory grasslands associated with open woodlands and sometimes fairly dense forest stands of cottonwood, green ash, boxelder, American elm, hackberry, peach-leaved willow, and occasionally bur oak. Prominent forbs are false solomon's seal, dogbane, wild licorice, fringed loosestrife, and meadow rue. Major shrubs are western snowberry, wild roses, skunk bush, golden currant, gooseberry, dogwood, poison ivy, bittersweet, wild grape, thicket creeper, and western clematis.

The environmental and biological factors that affect development of plant communities and vegetation types are the same factors that affect soil development. Soil moisture regimes affect distribution of plant species affiliations. The species affiliations that are the major vegetation types in the Northern Plains; Tall Grass Prairie, Transition Mixed Grass Prairie, Mixed Grass Prairie, and Short Grass Prairie; coincide with the four soil moisture regimes; Perudic, Udic, Ustic, and Aridic; respectively. The four soil moisture regimes are further separated into two soil temperature regimes; Frigid in the northern portions and Mesic in the southern portions. Soil temperature regimes affect composition and distribution of cool-season and warm-season grasses within the vegetation types. In the northern Frigid temperature regime, warm-season grass species decrease and cool-season grass species increase. In the southern Mesic temperature regime, cool-season grass species decrease and warm-season grass species increase.

Changes in elevation, slope, and aspect resulting from the various physiographic landforms in the Northern Plains affect plant species topographic distribution and plant community productivity by causing differential distribution and retention of soil water. Lower slopes have greater soil water than upper slopes. East and north facing slopes retain more soil water longer than south and west facing slopes. Lowland landscape slopes have soil water in amounts greater than precipitation levels because of water runin from upper slopes. Upland landscape slopes have soil water in amounts similar to precipitation levels because water runin and water runoff occur in low quantities and are about the same. Xeric landscape slopes have soil water in amounts less than precipitation levels because of restricted water infiltration, low water holding capacity, high evapotranspiration demand, and/or high water runoff.

Some slope positions have sufficiently low evapotranspiration demand and/or receive sufficient quantities of water runin for woodland and forest plant communities to develop. Woodlands and forests also develop along rivers and streams and at higher elevation positions that receive greater quantities of precipitation.

Enhancement of the Land Natural Resources

Generating greater new wealth with livestock agriculture requires enhancement of the land natural resources. These essential changes are doable and not the herculean task that they first appear to be. A few small catalyzing changes correctly timed can have remarkable effects.

The forces that change hills into valleys, rocks into clay, and forests into grasslands work slowly over thousands and millions of years. The physiographic landform characteristics have changed little during the past 10,000 years. The current climate with wet and dry periods, and the current soil moisture and soil temperature regimes have been operational for about 5,000 years. The native plant species completed development of their physiological processes and defoliation resistance mechanisms in conjunction with early herbivore evolution millions of years ago.

By contrast, the soils, plant communities, and vegetation types in the Northern Plains are relatively young and their development is still ongoing. These developmental processes can be manipulated through implementation of biologically effective management that benefits all living and nonliving ecosystem components by meeting the biological requirements of the plants and soil organisms which causes improvements in the biogeochemical processes, ecosystem health, soil quality, plant community composition, and vegetation type affiliations. These important improvements enhance the quality and productivity of the land natural resources and result in generation of greater new wealth.

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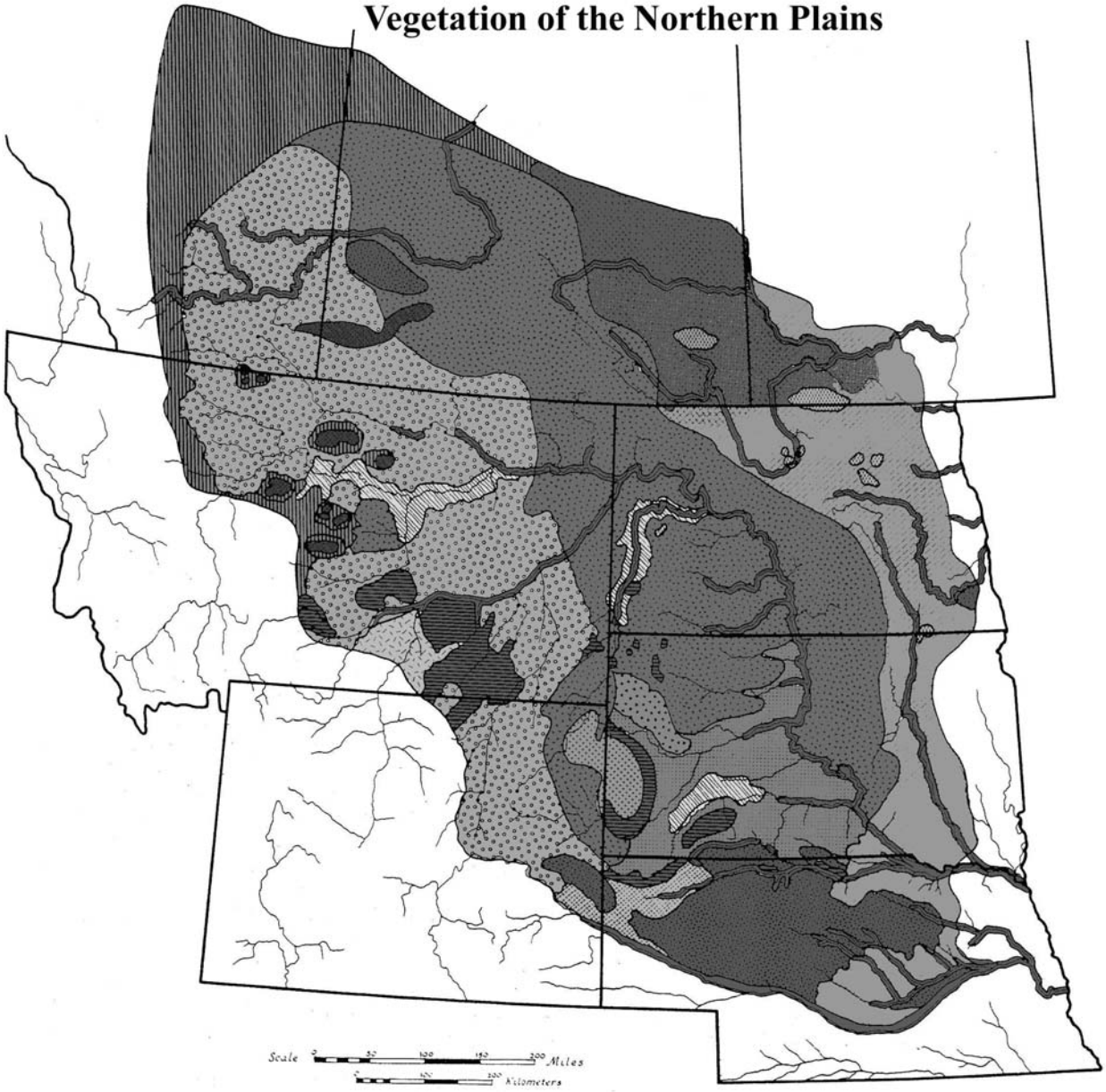
Vegetation of the Northern Plains



map from Barker and Whitman 1989

- Wheatgrass-Bluestem-Needlegrass
- Wheatgrass-Needlegrass
- Wheatgrass-Grama-Needlegrass
- Wheatgrass-Bluestem-Needlegrass (Rough-Fescue Mixed)
- Wheatgrass-Grama grass
- Wheatgrass
- Sandhills Prairie
- Grama-Buffalograss
- Foothills Prairie (Rough Fescue)
- Pacific Bunchgrass
- Badlands and River Breaks
- Pine Savanna
- Black Hills Pine Forest
- Montane Forest
- Upland Woodlands
- Riparian Woodlands

Table 1. Major Grasses of the Tall Grass Prairie; Bluestem-Switchgrass-Indiangrass Type.

Standardized Common Name	Flora of the Great Plains 1986	Flora of North America 2003, 2007
Big bluestem	Andropogon gerardii	Andropogon gerardii
Porcupinegrass	Stipa spartea	Hesperostipa spartea
Switchgrass	Panicum virgatum	Panicum virgatum
Prairie dropseed	Sporobolus heterolepis	Sporobolus heterolepis
Indiangrass	Sorghastrum nutans	Sorghastrum nutans
Northern reedgrass	Calamagrostis stricta	Calamagrostis stricta inexpansa
Prairie cordgrass	Spartina pectinata	Spartina pectinata
Sideoats grama	Bouteloua curtipendula	Bouteloua curtipendula
Slender wheatgrass	Agropyron caninum majus majus	Elymus trachycaulus trachycaulus
Bearded wheatgrass	Agropyron caninum majus unilaterale	Elymus trachycaulus subsecundus
Kentucky bluegrass	Poa pratensis	Poa pratensis
Needle and thread	Stipa comata	Hesperostipa comata
Little bluestem	Andropogon scoparius	Schizachyrium scoparium scoparium
Mat muhly	Muhlenbergia richardsonis	Muhlenbergia richardsonis
Needleleaf sedge	Carex eleocharis	Carex duriuscula
Sun sedge	Carex heliophila	Carex inops heliophila
Woolly sedge	Carex lanuginosa	Carex pellita

Table 2. Major Grasses of the Transition Mixed Grass Prairie; Wheatgrass-Bluestem-Needlegrass Type.		
Standardized Common Name	Flora of the Great Plains 1986	Flora of North America 2003, 2007
Western wheatgrass	Agropyron smithii	Pascopyrum smithii
Thickspike wheatgrass	Agropyron dasystachyum	Elymus lanceolatus
Little bluestem	Andropogon scoparius	Schizachyrium scoparium scoparium
Porcupinegrass	Stipa spartea	Hesperostipa spartea
Needle and thread	Stipa comata	Hesperostipa comata
Green needlegrass	Stipa viridula	Nassella viridula
Bearded wheatgrass	Agropyron caninum majus unilaterale	Elymus trachycaulus subsecundus
Slender wheatgrass	Agropyron caninum majus majus	Elymus trachycaulus trachycaulus
Sideoats grama	Bouteloua curtipendula	Bouteloua curtipendula
Blue grama	Bouteloua gracilis	Bouteloua gracilis
Prairie Junegrass	Koeleria pyramidata	Koeleria macrantha
Prairie sandreed	Calamovilfa longifolia	Calamovilfa longifolia
Big bluestem	Andropogon gerardii	Andropogon gerardii
Kentucky bluegrass	Poa pratensis	Poa pratensis
Needleleaf sedge	Carex eleocharis	Carex duriuscula
Threadleaf sedge	Carex filifolia	Carex filifolia
Sun sedge	Carex heliophila	Carex inops heliophila

Table 3. Major Grasses of the Mixed Grass Prairie; Wheatgrass-Needlegrass Type.		
Standardized Common Name	Flora of the Great Plains 1986	Flora of North America 2003, 2007
Western wheatgrass	Agropyron smithii	Pascopyrum smithii
Needle and thread	Stipa comata	Hesperostipa comata
Blue grama	Bouteloua gracilis	Bouteloua gracilis
Prairie Junegrass	Koeleria pyramidata	Koeleria macrantha
Green needlegrass	Stipa viridula	Nassella viridula
Plains reedgrass	Calamagrostis montanensis	Calamagrostis montanensis
Little bluestem	Andropogon scoparius	Schizachyrium scoparium scoparium
Prairie sandreed	Calamovilfa longifolia	Calamovilfa longifolia
Sandberg bluegrass	Poa sandbergii	Poa secunda
Thickspike wheatgrass	Agropyron dasystachyum	Elymus lanceolatus
Slender wheatgrass	Agropyron caninum majus majus	Elymus trachycaulus trachycaulus
Small needlegrass	Stipa curtiseta	Hesperostipa curtiseta
Bluebunch wheatgrass	Agropyron spicatum	Pseudoroegneria spicata
Buffalograss	Buchloe dactyloides	Buchloe dactyloides
Kentucky bluegrass	Poa pratensis	Poa pratensis
Threadleaf sedge	Carex filifolia	Carex filifolia
Sun sedge	Carex heliophila	Carex inops heliophila

Table 4. Major Grasses of the Mixed Grass Prairie on Clay Soils; Wheatgrass-Grama Type.		
Standardized Common Name	Flora of the Great Plains 1986	Flora of North America 2003, 2007
Western wheatgrass	Agropyron smithii	Pascopyrum smithii
Blue grama	Bouteloua gracilis	Bouteloua gracilis
Buffalograss	Buchloe dactyloides	Buchloe dactyloides
Thickspike wheatgrass	Agropyron dasystachyum	Elymus lanceolatus
Green needlegrass	Stipa viridula	Nassella viridula

Table 5. Major Grasses of the Mixed Grass Prairie on Dense Clay Soils; Wheatgrass Type.		
Standardized Common Name	Flora of the Great Plains 1986	Flora of North America 2003, 2007
Western wheatgrass	Agropyron smithii	Pascopyrum smithii
Green needlegrass	Stipa viridula	Nassella viridula
Thickspike wheatgrass	Agropyron dasystachyum	Elymus lanceolatus
Associated Grass		
Needle and thread	Stipa comata	Hesperostipa comata

Table 6. Major Grasses of the Northern Short Grass Prairie; Grama-Needlegrass-Wheatgrass Type.		
Standardized Common Name	Flora of the Great Plains 1986	Flora of North America 2003, 2007
Blue grama	Bouteloua gracilis	Bouteloua gracilis
Needle and thread	Stipa comata	Hesperostipa comata
Small needlegrass	Stipa curtiseta	Hesperostipa curtiseta
Western wheatgrass	Agropyron smithii	Pascopyrum smithii
Thickspike wheatgrass	Agropyron dasystachyum	Elymus lanceolatus
Green needlegrass	Stipa viridula	Nassella viridula
Buffalograss	Buchloe dactyloides	Buchloe dactyloides
Associated Grasses		
Red threeawn	Aristida purpurea robusta	Aristida purpurea longiseta
Indian ricegrass	Oryzopsis hymenoides	Achnatherum hymenoides
Plains muhly	Muhlenbergia cuspidata	Muhlenbergia cuspidata
Bluebunch wheatgrass	Agropyron spicatum	Pseudoroegneria spicata
Threadleaf sedge	Carex filifolia	Carex filifolia
Deteriorated Grassland		
Cheatgrass	Bromus tectorum	Bromus tectorum
Japanese brome	Bromus japonicus	Bromus japonicus

Table 7. Major Grasses of the Northern Short Grass Prairie on Salty Soils; Saltgrass Type.		
Standardized Common Name	Flora of the Great Plains 1986	Flora of North America 2003, 2007
Saltgrass	Distichlis spicata stricta	Distichlis spicata
Alkali cordgrass	Spartina gracilis	Spartina gracilis
Basin wildrye	Elymus cinereus	Leymus cinereus
Foxtail barley	Hordeum jubatum	Hordeum jubatum jubatum
Little barley	Hordeum pusillum	Hordeum pusillum
Nuttall's alkali grass	Puccinellia nuttalliana	Puccinellia nuttalliana
Common squirreltail	Sitanion hystrix	Elymus elymoides elymoides
Tumblegrass	Schedonnardus paniculatus	Schedonnardus paniculatus

Table 8. Major Grasses of the Southern Short Grass Prairie; Blue grama-Buffalograss Type.		
Standardized Common Name	Flora of the Great Plains 1986	Flora of North America 2003, 2007
Blue grama	Bouteloua gracilis	Bouteloua gracilis
Buffalograss	Buchloe dactyloides	Buchloe dactyloides
Associated Grasses		
Western wheatgrass	Agropyron smithii	Pascopyrum smithii
Needle and thread	Stipa comata	Hesperostipa comata

Table 9. Major Grasses of the Sandhills Prairie; Bluestem-Sandreed-Grama-Needlegrass Type.		
Standardized Common Name	Flora of the Great Plains 1986	Flora of North America 2003, 2007
Big bluestem	Andropogon gerardii	Andropogon gerardii
Little bluestem	Andropogon scoparius	Schizachyrium scoparium scoparium
Sand bluestem	Andropogon hallii	Andropogon hallii
Prairie sandreed	Calamovilfa longifolia	Calamovilfa longifolia
Sideoats grama	Bouteloua curtipendula	Bouteloua curtipendula
Needle and thread	Stipa comata	Hesperostipa comata
Switchgrass	Panicum virgatum	Panicum virgatum
Blue grama	Bouteloua gracilis	Bouteloua gracilis
Blowout Areas		
Blowout grass	Redfieldia flexuosa	Redfieldia flexuosa
Sandhill muhly	Muhlenbergia pungens	Muhlenbergia pungens
Sand dropseed	Sporobolus cryptandrus	Sporobolus cryptandrus
Indian ricegrass	Oryzopsis hymenoides	Achnatherum hymenoides
Schweinitz cyperus	Cyperus schweinitzii	Cyperus schweinitzii

Table 10. Major Grasses of the Foothills Prairie; Plains Rough Fescue Type.		
Standardized Common Name	Flora of the Great Plains 1986	Flora of North America 2003, 2007
Plains rough fescue	Festuca scabrella	Festuca hallii
Parry's oatgrass	Danthonia parryi	Danthonia parryi
Timber oatgrass	Danthonia intermedia	Danthonia intermedia
Bluebunch wheatgrass	Agropyron spicatum	Pseudoroegneria spicata
Slender wheatgrass	Agropyron caninum majus majus	Elymus trachycaulus trachycaulus
Western wheatgrass	Agropyron smithii	Pascopyrum smithii
Thickspike wheatgrass	Agropyron dasystachyum	Elymus lanceolatus
Nelson's needlegrass	Stipa columbiana	Achnatherum nelsonii nelsonii
Richardson's needlegrass	Stipa richardsonii	Achnatherum richardsonii
Needle and thread	Stipa comata	Hesperostipa comata
Prairie Junegrass	Koeleria pyramidata	Koeleria macrantha
Idaho fescue	Festuca idahoensis	Festuca idahoensis
Spike oatgrass	Helictotrichon hookeri	Avenula hookeri
Kentucky bluegrass	Poa pratensis	Poa pratensis
Threadleaf sedge	Carex filifolia	Carex filifolia
Deteriorated Grassland		
Cheatgrass	Bromus tectorum	Bromus tectorum
Japanese brome	Bromus japonicus	Bromus japonicus

Table 11. Major Grasses of the Pacific Bunchgrass Prairie; Bluebunch-Fescue Type.		
Standardized Common Name	Flora of the Great Plains 1986	Flora of North America 2003, 2007
Bluebunch wheatgrass	Agropyron spicatum	Pseudoroegneria spicata
Idaho fescue	Festuca idahoensis	Festuca idahoensis
Western wheatgrass	Agropyron smithii	Pascopyrum smithii
Sideoats grama	Bouteloua curtipendula	Bouteloua curtipendula
Little bluestem	Andropogon scoparius	Schizachyrium scoparium scoparium
Red threeawn	Aristida purpurea robusta	Aristida purpurea longiseta
Needle and thread	Stipa comata	Hesperostipa comata
Plains muhly	Muhlenbergia cuspidata	Muhlenbergia cuspidata
Prairie Junegrass	Koeleria pyramidata	Koeleria macrantha
Blue grama	Bouteloua gracilis	Bouteloua gracilis
Thickspike wheatgrass	Agropyron dasystachyum	Elymus lanceolatus

Table 12. Major Grasses of the Badlands and River Breaks; Woody Draw and Savanna Types.		
Standardized Common Name	Flora of the Great Plains 1986	Flora of North America 2003, 2007
Western wheatgrass	Agropyron smithii	Pascopyrum smithii
Needle and thread	Stipa comata	Hesperostipa comata
Blue grama	Bouteloua gracilis	Bouteloua gracilis
Green needlegrass	Stipa viridula	Nassella viridula
Prairie Junegrass	Koeleria pyramidata	Koeleria macrantha
Plains reedgrass	Calamagrostis montanensis	Calamagrostis montanensis
Kentucky bluegrass	Poa pratensis	Poa pratensis
Sandberg bluegrass	Poa sandbergii	Poa secunda
Buffalograss	Buchloe dactyloides	Buchloe dactyloides
Small needlegrass	Stipa curtiseta	Hesperostipa curtiseta
Thickspike wheatgrass	Agropyron dasystachyum	Elymus lanceolatus
Little bluestem	Andropogon scoparius	Schizachyrium scoparium scoparium
Bluebunch wheatgrass	Agropyron spicatum	Pseudoroegneria spicata
Saltgrass	Distichlis spicata stricta	Distichlis spicata

Table 13. Major Grasses of the Pine Savanna; Pine-Juniper-Bluebunch Type.		
Standardized Common Name	Flora of the Great Plains 1986	Flora of North America 2003, 2007
Bluebunch wheatgrass	Agropyron spicatum	Pseudoroegneria spicata
Western wheatgrass	Agropyron smithii	Pascopyrum smithii
Thickspike wheatgrass	Agropyron dasystachyum	Elymus lanceolatus
Needle and thread	Stipa comata	Hesperostipa comata
Blue grama	Bouteloua gracilis	Bouteloua gracilis
Green needlegrass	Stipa viridula	Nassella viridula
Little bluestem	Andropogon scoparius	Schizachyrium scoparium scoparium

Table 14. Major Grasses of the Black Hills Pine Forest; Pine-Spruce-Aspen Type.		
Standardized Common Name	Flora of the Great Plains 1986	Flora of North America 2003, 2007
Western wheatgrass	Agropyron smithii	Pascopyrum smithii
Bluebunch wheatgrass	Agropyron spicatum	Pseudoroegneria spicata
Needle and thread	Stipa comata	Hesperostipa comata
Green needlegrass	Stipa viridula	Nassella viridula
Prairie Junegrass	Koeleria pyramidata	Koeleria macrantha
Blue grama	Bouteloua gracilis	Bouteloua gracilis
Hairy grama	Bouteloua hirsuta	Bouteloua hirsuta
Buffalograss	Buchloe dactyloides	Buchloe dactyloides
Needleleaf sedge	Carex eleocharis	Carex duriuscula
Threadleaf sedge	Carex filifolia	Carex filifolia

Table 15. Major Grasses of the Montane Forest; Pine-Fir-Spruce Type.		
Standardized Common Name	Flora of the Great Plains 1986	Flora of North America 2003, 2007
Bluebunch wheatgrass	Agropyron spicatum	Pseudoroegneria spicata
Idaho fescue	Festuca idahoensis	Festuca idahoensis
Nelson’s needlegrass	Stipa columbiana	Achnatherum nelsonii nelsonii
Spike fescue	Hesperochloa kingii	Leucopoa kingii
Prairie Junegrass	Koeleria pyramidata	Koeleria macrantha
Needle and thread	Stipa comata	Hesperostipa comata
Spike oatgrass	Helictotrichon hookeri	Avenula hookeri
Sandberg bluegrass	Poa sandbergii	Poa secunda

Table 16. Major Grasses of the Upland Woodlands; Aspen-Ash-Oak-Juniper Types.		
Standardized Common Name	Flora of the Great Plains 1986	Flora of North America 2003, 2007
Roughleaf ricegrass	Oryzopsis asperifolia	Oryzopsis asperifolia
Little ricegrass	Oryzopsis micrantha	Piptatherum micranthum
Long-beaked sedge	Carex sprengelii	Carex sprengelii
Kentucky bluegrass	Poa pratensis	Poa pratensis
Associated Grasses		
Western wheatgrass	Agropyron smithii	Pascopyrum smithii
Bluebunch wheatgrass	Agropyron spicatum	Pseudoroegneria spicata
Thickspike wheatgrass	Agropyron dasystachyum	Elymus lanceolatus
Blue grama	Bouteloua gracilis	Bouteloua gracilis
Porcupinegrass	Stipa spartea	Hesperostipa spartea
Little bluestem	Andropogon scoparius	Schizachyrium scoparium scoparium

Table 17. Major Grasses of the Riparian Woodlands; Cottonwood-Ash-Elm Type.		
Standardized Common Name	Flora of the Great Plains 1986	Flora of North America 2003, 2007
Canada wildrye	Elymus canadensis	Elymus canadensis
Slender wheatgrass	Agropyron caninum majus majus	Elymus trachycaulus trachycaulus
Virginia wildrye	Elymus virginicus	Elymus virginicus
Prairie sandreed	Calamovilfa longifolia	Calamovilfa longifolia
Needle and thread	Stipa comata	Hesperostipa comata
Green needlegrass	Stipa viridula	Nassella viridula
Marsh muhly	Muhlenbergia racemosa	Muhlenbergia racemosa
Reed canarygrass	Phalaris arundinacea	Phalaris arundinacea
Prairie cordgrass	Spartina pectinata	Spartina pectinata
Bottlebrush grass	Hystrix patula	Elymus hystrix
Mountain ricegrass	Oryzopsis racemosa	Piptatherum racemosum
Kentucky bluegrass	Poa pratensis	Poa pratensis
Yellow sedge	Carex pensylvanica	Carex pensylvanica
Long-beaked sedge	Carex sprengelii	Carex sprengelii

Literature Cited

Barker, W.T., and W.C. Whitman. 1989. Vegetation of the Northern Great Plains. North Dakota State University Experiment Station Research Report #111. Fargo, ND. 26p.

Baumberger, R. 1977. South Dakota rangeland resources. Old West Regional Commission. Society for Range Management, Denver, CO. 150p.

Bluemle, J.P. 2000. The face of North Dakota. Third Edition. North Dakota Geological Survey. Educational Series 26. 205p.

Bose, D.R. 1977. Rangeland resources of Nebraska. Old West Regional Commission. Society for Range Management, Denver, CO. 121p.

Brady, N.C. 1974. The nature and properties of soils. MacMillan Publishing Co., Inc., New York, NY. 639p.

Clarke, S.E., J.A. Campbell, and J.B. Campbell. 1942. An ecological and grazing capacity study of the native grass pastures in southern Alberta, Saskatchewan, and Manitoba. Division of Forage Crops Dom. Experiment Station. Technical Bulletin 44. Swift Current, SK. 31p.

Coupland, R.T., and T.C. Brayshaw. 1953. The fescue grassland in Saskatchewan. Ecology 34:386-405.

Coupland, R.T. 1950. Ecology of mixed prairie in Canada. Ecological Monographs 20:271-315.

Coupland, R.T. 1961. A reconsideration of grassland classification in the Northern Great Plains of North America. Journal of Ecology 49:135-167.

Fenneman, N.M. 1931. Physiography of western United States. McGraw-Hill Book Company, New York, NY. 534p.

Fenneman, N.M. 1946. Physical divisions of the United States. USDI Geological Survey. Map.

Flora of North America Editorial Committee, eds. 2003, 2007. Flora of North America. Oxford University Press, New York, NY. Vols. 24-25.

Froiland, S.G., and R.R. Weedon. 1990. Natural history of the Black Hills and badlands. The Center for Western Studies, Sioux Falls, SD. 225p.

Goodin, J.R., and D.K. Northington (eds.). 1985. Plant resources of arid and semiarid lands. Academic Press, Inc., Orlando, FL. 338p.

Great Plains Flora Association. 1986. Flora of the Great Plains. University Press of Kansas, Lawrence, KS. 1392p.

Hacker, P.T., and T.P. Sparks. 1977. Montana rangeland resources. Old West Regional Commission. Society for Range Management, Denver, CO.

Hunt, C.B. 1974. Natural regions of the United States and Canada. W.H. Freeman and Company, San Francisco, CA. 725p.

Kaul, R.B. 1975. Vegetation of Nebraska (Circa 1850). Conservation and Survey Division, Institute of Agriculture and Natural Resources, University of Nebraska, Lincoln, NE. Map.

Kuchler, A.W. 1964. Potential natural vegetation of the conterminous United States. American Geographical Society. Special Publication No. 36. New York, NY. 116p. + Maps.

Moss, E.H., and J.A. Campbell. 1947. The fescue grassland of Alberta. Canadian Journal of Research. 25:209-227.

Ojakangas, R.W., and C.L. Matsch. 1982. Minnesota's Geology. University of Minnesota Press, Minneapolis, MN. 255p.

Raisz, E. 1957. Landforms of the United States. Copyrighted Erwin Raisz Map.

Robinson, C.S., and R.E. Davis. 1995. Geology of Devils Tower National Monument. Devils Tower Natural History Association, WY. 96p.

Ross, R.L., and H.E. Hunter. 1976. Climax vegetation of Montana based on climate and soils. USDA, Soil Conservation Service. Bozeman, MT. 64p.

Shaver, J.C. 1977. North Dakota rangeland resources. Old West Regional Commission. Society for Range Management, Denver, CO. 118p.

Shrader, J.A. 1977. Wyoming rangeland resources. Old West Regional Commission. Society for Range Management, Denver, CO. 87p.

Soil Survey Staff. 1975. Soil taxonomy. USDA Agriculture Handbook No. 436. Washington, DC. 754p.

Whitman, W.C., and W.T. Barker. 1989. Mapping North Dakota's natural vegetation. Proceedings of the North Dakota Academy of Science. 43:4-5.

Managing Drought Resistance into Grasslands

Llewellyn L. Manske PhD
Range Scientist
North Dakota State University
Dickinson Research Extension Center

The percent reduction in herbage production during drought conditions on grasslands managed with traditional grazing management practices, like repeated seasonal, seasonlong, and deferred grazing, is greater than the percent reduction in precipitation (Manske 2002a, b). The shortage of rainfall is the most obvious detrimental factor occurring during a drought, however, it is not the only factor contributing to the reduction in herbage biomass production. The other primary factors responsible for this enhanced loss of herbage production are reductions in available mineral nitrogen and degradation of ecosystem health status.

Reductions in mineral nitrogen limit herbage production more often than water in temperate grasslands (Tilman 1990). Grasslands in the Northern Plains are not low in nitrogen. Grassland soils contain about 3 to 8 tons of organic nitrogen per acre. Plants, however, can not use organic nitrogen. The organic nitrogen must be converted into inorganic (mineral) nitrogen to be usable by plants. Soil microorganisms in the rhizosphere zone around perennial grass roots convert organic nitrogen into inorganic nitrogen. This process is symbiotic and mutually beneficial for both the plants and the rhizosphere organisms. Plants fix carbon and capture energy from the sun during photosynthesis. Organisms in the rhizosphere are low in carbon and receive a portion of the carbon fixed by the plants. Grassland plants are low in inorganic nitrogen which is a waste product from rhizosphere organism metabolism. Plants trade carbon to rhizosphere organisms for nitrogen and rhizosphere organisms trade nitrogen to plants for carbon (Manske 2007).

The quantity of organic nitrogen converted into inorganic nitrogen by rhizosphere organisms is dependent on the quantity of carbon released into the rhizosphere by plants. The quantity of carbon released by the plants is dependent on the type of grazing management practices used and the amount of leaf material removed by grazing at different plant phenological growth stages. Traditional grazing management practices that are not based on the biological requirements and the phenological growth stages of plants restrict the quantity of carbon released into the rhizosphere causing a reduction in rhizosphere organism volume and activity, resulting in a reduction in the quantity of available inorganic nitrogen. The quantity of available inorganic nitrogen gradually decreases each year. After several years of management with traditional grazing practices that are antagonistic to biogeochemical proceses, the accumulated reduction in available inorganic nitrogen results in a substantial reduction in herbage biomass production; generally around 25% to 50% of the grasslands' potential herbage biomass production during average growing seasons (Manske 2007).

Wight and Black (1979) conducted a fertilization on native rangeland plot study at the ARS Research Center, Sidney, MT from 1967 to 1976 and determined the precipitation use efficiency (pounds of herbage produced per inch of precipitation received) for unfertilized treatments deficient in available mineral nitrogen and fertilized treatments not deficient in available mineral nitrogen. The pounds of herbage produced per inch of precipitation were greater on rangeland ecosystems with adequate mineral nitrogen available compared to rangeland ecosystems that had insufficient quantities of available mineral nitrogen. During the eight study years with normal precipitation, the ambient deficiency in available mineral nitrogen on rangeland ecosystems caused the weight of herbage production per inch of precipitation to be reduced an average of 45.4% below the herbage produced per inch of precipitation on rangeland ecosystems without mineral nitrogen deficiencies.

The traditional grazing management practices of 6.0-month seasonlong (6.0-M SL) and 4.5-month seasonlong (4.5-M SL) caused decreases of 51.2% and 33.7% in rhizosphere volume after 20 years of treatment, respectively (figure 1) (Manske 2008b). A traditional deferred (DEF) grazing practice caused a 70.6% decrease in available mineral nitrogen after 35 years of treatment (figure 1) (Manske 2008b). During growing seasons with drought conditions, both inorganic nitrogen and soil water are greatly diminished in grasslands managed with traditional grazing practices and together low nitrogen and low water cause most of the reductions

in herbage production and the resulting reductions in stocking rate.

The biologically effective twice-over rotation grazing management strategy (TOR) that is based on partial defoliation at beneficial phenological growth stages and on meeting the biological requirements of grass plants enhanced the biogeochemical processes in grassland ecosystems and caused a 67.7% increase in available inorganic nitrogen after six years of treatment and caused a 122.7% increase in rhizosphere volume after 20 years of treatment (figure 1) (Manske 2008b).

Biologically effective grazing management improves the biogeochemical processes in grassland ecosystems and activates the defoliation resistance mechanisms in grass plants. The increased rhizosphere organism volume and activity increases the quantity of available mineral nitrogen resulting in increases in herbage biomass production and beef weight production per acre. The increased ectomycorrhizal fungi in the rhizosphere improves the structure of the soil by increasing the quantity and depth of aggregation which increases the quantity of water infiltration and increases the water holding capacity of the soil. The increased plant density and increased litter cover shade the soil, lowering the soil temperature and decreasing the rate of soil water loss through evaporation (Manske 2007). Biologically effective grazing management improves the health status of grassland ecosystems (Manske 2001) and increases the drought resistance of grasslands.

Drought resistance in grasslands is directly related to the ecosystem health status and depends on the effectiveness of the grazing management to meet the biological requirements of grass plants, to enhance the ecosystems biogeochemical processes, to cause improvements in soil aggregation, water infiltration, water holding capacity, vegetative reproduction, plant density, litter cover, rhizosphere volume and microorganism activity, and to increase the quantity of available mineral nitrogen converted from soil organic nitrogen.

The antagonistic effects of traditional grazing management practices on the living and nonliving (abiotic) ecosystem components degrade ecosystem health status and decrease drought resistance over time in grasslands by causing deterioration of soil characteristics, reduction of plant physiological mechanisms, decrease of rhizosphere volume and activity, suppression of ecosystem biogeochemical processes, and reduction of the quantity of available mineral nitrogen. The level of ecosystem health status and drought resistance determines the severity of the reduction in herbage biomass production and the reduction in stocking rate during drought conditions, and determines the length of time needed for ecosystem recovery following a drought.

Grasslands with low health status managed by heavy stocking or by starting dates too early and/or ending dates too late with traditional grazing practices, like repeated seasonal, 6.0-month seasonlong, and deferred grazing, require 2 years of recovery with reduced stocking rates for moderate drought conditions and 4 years of recovery with greatly reduced stocking rates for severe drought conditions (Whitman et al. 1943; Manske 1989, 1990).

Grasslands with moderate health status managed with moderately stocked traditional grazing practices, like 4.5-month seasonlong, require 1 year of recovery with reduced stocking rates for moderate drought conditions and 2 years of recovery with reduced stocking rates for severe drought conditions (Manske 1989, 1990).

Grasslands with high health status managed with biologically effective twice-over rotation grazing strategies have sufficient resistance to moderate drought conditions that reduction in stocking rate is not necessary during 1 season of moderate drought, however, if 2 growing seasons with moderate drought conditions occur successively, stocking rates need to be reduced during the second season. High health status grasslands require less than 1 growing season with no reduction in stocking rates to recover from moderate drought conditions and require 1 year with reduced stocking rates to recover from severe drought conditions (Manske 1989, 1990).

Periods with rainfall shortage are normal weather conditions for the Northern Plains. Average 6 month perennial plant growing seasons, mid April to mid October, have water deficiency or drought conditions during 32.8% of the period, amounting to 2 months per growing season, and occur during 78.5% of the years. Growing seasons with drought conditions that receive less than 75% of the long-term mean precipitation occur during 15.5% of the years. Moderate drought conditions, that have growing season precipitation at less than 75% and greater than 50% of the long-term mean, occur during 12.1% of the years. Severe drought conditions, that have

growing season precipitation at less than 50% of the long-term mean, occur during 3.5% of the years. Nondrought conditions are actually the abnormal phenomenon and occur during only 6.0% of the growing seasons (table 1) (Manske 2008a).

During a hypothetical 48 year career in agriculture (table 1), a beef producer in the Northern Plains experiences 3 growing seasons with no drought conditions, 37 growing seasons each with an average of 2 months with water deficiencies, 6 growing seasons with moderate drought conditions that have precipitation at less than 75% but greater than 50% of the long-term mean, and 2 growing seasons with severe drought conditions that have precipitation at less than 50% of the long-term mean.

Grasslands with low health status and low drought resistance have a total of 28 years during a 48 year career (58.3%) with reduced herbage production and reduced stocking rates; 8 years caused by drought conditions and 20 years caused by recovery from drought conditions; and have 20 years (41.7%) in which the grasslands are properly stocked at full capacity (table 1).

Grasslands with moderate health status and moderate drought resistance have a total of 18 years during a 48 year career (37.5%) with reduced herbage production and reduced stocking rates; 8 years caused by drought conditions and 10 years caused by recovery from drought conditions; and have 30 years (62.5%) in which the grasslands are properly stocked at full capacity (table 1).

Grasslands with high health status and high drought resistance have a total of 4 years during a 48 year career (8.3%) with reduced herbage production and reduced stocking rates; 2 years caused by drought conditions and 2 years caused by recovery from drought conditions; and have 44 years (91.7%) in which the grasslands are properly stocked at full capacity (table 1).

The shortage of rainfall is not the only factor that causes reductions in herbage production and reductions in stocking rate during drought conditions. Deteriorated soil characteristics, reduced plant physiological mechanisms, decreased rhizosphere volume and activity, suppressed ecosystem biogeochemical processes, and reduced available mineral nitrogen on grasslands with low or moderate health status are the additional negative factors that intensify the severity of the problems that develop during drought conditions. These living and nonliving (abiotic) ecosystem components can be improved with biologically effective grazing management and changed into beneficial factors that diminish the detrimental effects from drought conditions on grasslands with high health status. Implementation of twice-over rotation grazing management can improve the drought resistance in grasslands.

Acknowledgment

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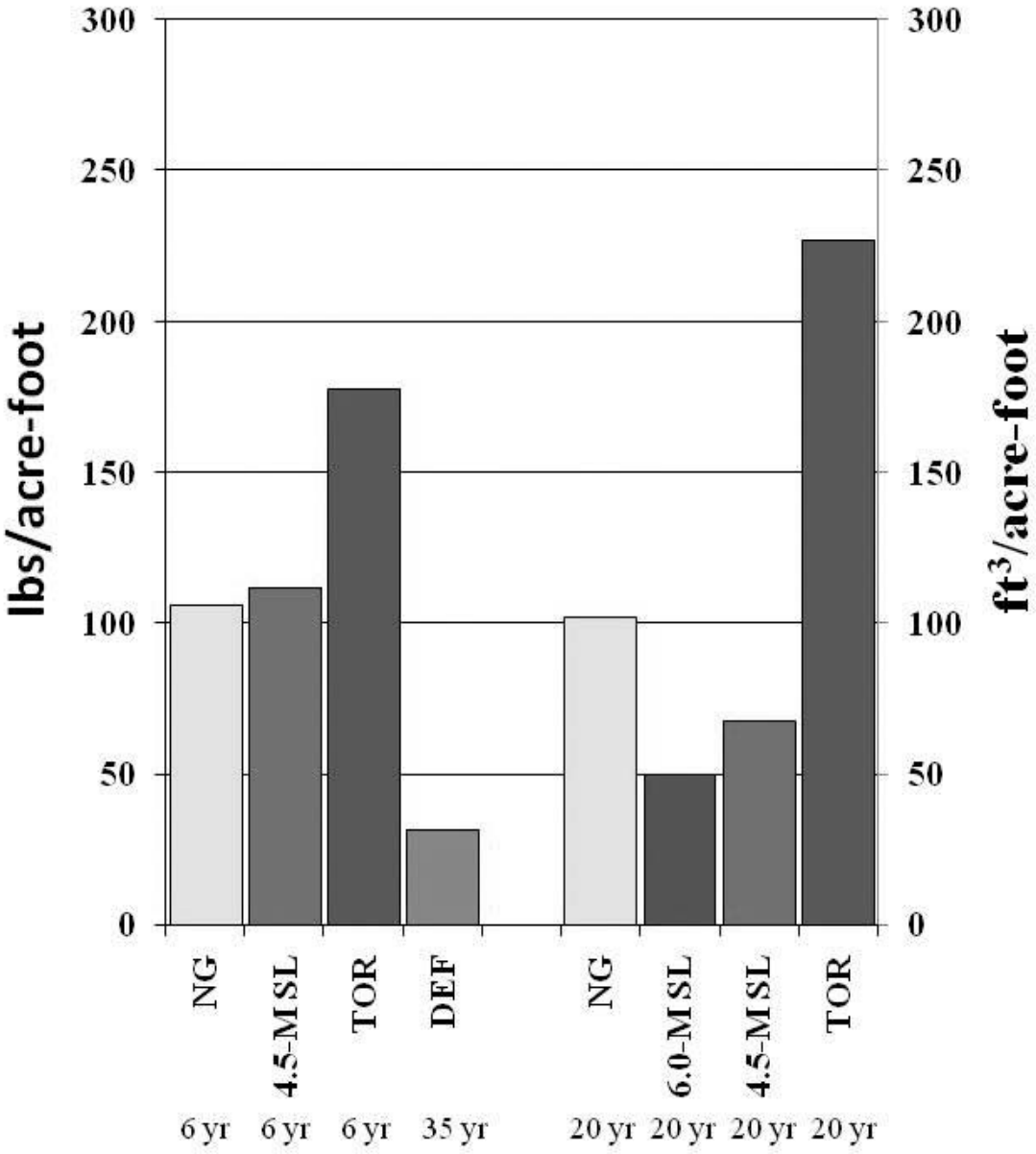

Mineral nitrogen (lbs/ac-ft) and rhizosphere volume (ft^3/ac-ft) for 6, 20, and 35 years of grazing treatments.

Table 1. Effects from drought conditions and length of recovery time on the number of years with reduced stocking rates on grasslands with different managed health status.

			Healthy Grasslands	Moderately Healthy Grasslands	Low Health Grasslands
Ag Career		yrs	48	48	48
No Drought	(6.0%)	yrs	3	3	3
Drought for 2 mo/yr	(78.5%)	yrs	37	37	37
Moderate Drought Growing Seasons	(12.1%)	yrs	6	6	6
Recovery Time		yrs	0	6	12
Severe Drought 1936-1988 levels	(3.5%)	yrs	2	2	2
Recovery Time		yrs	2	4	8
Reduced Stocking for Droughts		yrs	2	8	8
Reduced Stocking for Recovery Time		yrs	2	10	20
Total Time with Reduced Stocking		yrs	4	18	28
Fully Stocked		yrs	44	30	20

Drought frequency data from Manske 2008a.
Recovery time data from Whitman et al. 1943 and Manske 1989, 1990.

Literature Cited

Manske, L.L. 1989. The drought of the 1980's compared to the drought of the 1930's and grazing management recommendations. NDSU Extension Service. Video Tape Presentation. Fargo, ND.

Manske, L.L. 1990. North Dakota rangeland changes similar to 1930's. NDSU Extension Service News Release. February. Fargo, ND. 3p.

Manske L.L. 2001. Grassland ecosystem monitoring: A nonquantitative procedure for assessing rangeland performance status. NDSU Dickinson Research Extension Center. Range Mangement Report DREC 01-1034. Dickinson, ND. 16p.

Manske, L.L. 2002a. Healthy plants have smaller forage reductions during precipitation shortages. NDSU Extension Service News Release. August. Fargo, ND. 3p.

Manske, L.L. 2002b. Management practices contributed to last summer's herbage reductions. NDSU Extension Service News Release. December. Fargo, ND. 2p.

Manske, L.L. 2007. Biology of defoliation by grazing. NDSU Dickinson Research Extension Center. Range Management Report DREC 07-1067. Dickinson, ND. 25p.

Manske, L.L. 2008a. Environmental factors to consider during planning of management for range plants in the Dickinson, North Dakota, region, 1892-2007. NDSU Dickinson Research Extension Center. Range Research Report DREC 08-1018k. Dickinson, ND. 37p.

Manske, L.L. 2008b. Grazing and burning treatment effects on soil mineral nitrogen and rhizosphere volume. NDSU Dickinson Research Extension Center. Range Research Report DREC 08-1066b. Dickinson, ND. 15p.

Tilman, D. 1990. Constraints and tradeoffs: toward a predictive theory of competition and succession. Oikos 58:3-15.

Whitman, W., H.C. Hanson, and R. Peterson. 1943. Relations of drought and grazing to North Dakota range lands. North Dakota Agricultural Experiment Station Bulletin 320. Fargo, ND. 29p.

Wight, J.R., and A.L. Black. 1979. Range fertilization: plant response and water use. Journal of Range Management 32:345-349.

Environmental Factors that Affect Range Plant Growth, 1892-2008

Llewellyn L. Manske PhD
Range Scientist
North Dakota State University
Dickinson Research Extension Center

Environmental factors affect range plant growth. The three most ecologically important environmental factors affecting rangeland plant growth are light, temperature, and water (precipitation). Plant growth and development are controlled by internal regulators that are modified according to environmental conditions. A research project was conducted to describe the three most important environmental factors in western North Dakota and to identify some of the conditions and variables that limit range plant growth. Rangeland managers should consider these factors during the development of long-term management strategies (Manske 2009).

Light is the most important ecological factor affecting plant growth. Light is necessary for photosynthesis, and changes in day length (photoperiod) regulate the phenological development of rangeland plants. Changes in the day length function as the timer or trigger that activates or stops physiological processes initiating growth and flowering and that starts the process of hardening for resistance to low temperatures in fall and winter. The tilt of the earth's axis in conjunction with the earth's annual revolution around the sun produces the seasons and changes the length of daylight in temperate zones. Dickinson (Fig. 1) has nearly uniform day and night lengths (12 hours) during only a few days, near the vernal and autumnal equinoxes, 20 March and 22 September, respectively, when the sun's apparent path crosses the equator as the sun travels north or south, respectively. The shortest day length (8 hours, 23 minutes) occurs at winter solstice, 21 December, when the sun's apparent path is farthest south of the equator. The longest day length (15 hours, 52 minutes) occurs at summer solstice, 21 June, when the sun's apparent path is farthest north of the equator. The length of daylight changes during the growing season, increasing from about 13 hours in mid April to nearly 16 hours in mid June, then decreasing to around 11 hours in mid October (Fig. 1).

Temperature, an approximate measurement of the heat energy available from solar radiation, is a significant factor because both low and high temperatures limit plant growth. Most plant biological activity and growth occur within only a narrow range of temperatures, between 32° F (0° C) and 122° F (50° C). The long-term (117-year) mean annual temperature in the Dickinson, North Dakota, area is 40.9° F (4.9° C) (Table 1). January is the coldest month, with a mean temperature of 11.5° F (-11.4° C). July and August are the warmest months, with mean temperatures of 68.8° F (20.4° C) and 67.0° F (19.5° C), respectively. Months with mean monthly temperatures below 32.0° F (0.0° C) are too cold for active plant growth. Low temperatures define the growing season for perennial plants, which is generally from mid April to mid October (6.0 months). Perennial grassland plants are capable of growing for longer than the frost-free period, but to continue active growth, they require temperatures above the level that freezes water in plant tissue and soil. Winter dormancy in perennial plants is not total inactivity but reduced activity.

Water (precipitation) is essential for all plants and is an integral part of living systems. Water is ecologically important because it is a major force in shaping climatic patterns and biochemically important because it is a necessary component in physiological processes. Plant water stress limits growth. Water stress can vary in degree from a small decrease in water potential to the lethal limit of desiccation. The long-term (117-year) annual precipitation for the area of Dickinson, North Dakota, is 15.97 inches (405.67 mm). The growing season precipitation (April to October) is 13.50 inches (343.13 mm), 84.58% of the annual precipitation. June has the greatest monthly precipitation, at 3.54 inches (89.97 mm). The seasonal distribution of precipitation (Table 2) shows the greatest amount of precipitation occurring in the spring (7.29 inches, 45.70%) and the smallest amount occurring in winter (1.53 inches, 9.58%). Total precipitation received in November through March averages less than 2.5 inches (15.47%). The precipitation received in May, June, and July accounts for 50.66% of the annual precipitation (8.09 inches).

Of the past 117 years (1892 to 2008), 14 (11.97%) were drought years, receiving 75% or less of the long-term mean precipitation level. Fifteen (12.82%) were wet years, receiving 125% or more of

the long-term mean precipitation level. Eighty-eight years (75.21%) received normal annual precipitation amounts, between 75% and 125% of the long-term mean. Of the past 117 growing seasons, 18 (15.38% were drought growing seasons, 20 (17.09%) were wet growing seasons, and 79 (67.52%) received precipitation at normal levels.

Temperature and precipitation act together to affect the physiological and ecological status of range plants. The balance between rainfall and potential evapotranspiration determines a plant's biological situation. When rainfall is lower than evapotranspiration demand, a water deficiency exists. The ombrothermic graph technique (Emberger et al. 1963), which plots mean monthly temperature and monthly precipitation on the same axis, was used to identify months with water deficiency conditions during 1892-2008 (Manske 2009). The long-term ombrothermic graph for the Dickinson area (Fig. 2) shows near water deficiency conditions for August, September, and October, a finding indicating that range plants generally may have difficulty growing and accumulating biomass during these 3 months. Favorable water relations occur during May, June, and July, a period during which range plants should be capable of growing and accumulating herbage biomass.

Drought years occurred during 12.0% of the past 117 years, and 15.4% of the growing seasons were drought growing seasons. The 117-year period (1892 to 2008) contained a total of 702 growing-season months. Water deficiency conditions occurred during 230.5 of these, a finding indicating that during 32.83% of the growing season months, or for an average of 2.0 months during every 6.0-month growing season, range plants were under water stress and therefore limited in growth and herbage biomass accumulation. Water deficiency occurred in May and June 13.7% and 10.3 % of the time, respectively. Water deficiency conditions occurred in July less than 40% of the time. Water deficiency conditions occurred in August, September, and October more than 50% of the time: 52.1% of the time in August, 50.4 % of the time in September, and 47.0% of the time in October. Water deficiency conditions lasting a month or more cause plants to experience water stress severe enough to reduce herbage production. These levels of water stress are a major factor limiting the quantity and quality of plant growth in western North Dakota and can limit livestock production if not considered during the development and implementation of long-term grazing management strategies.

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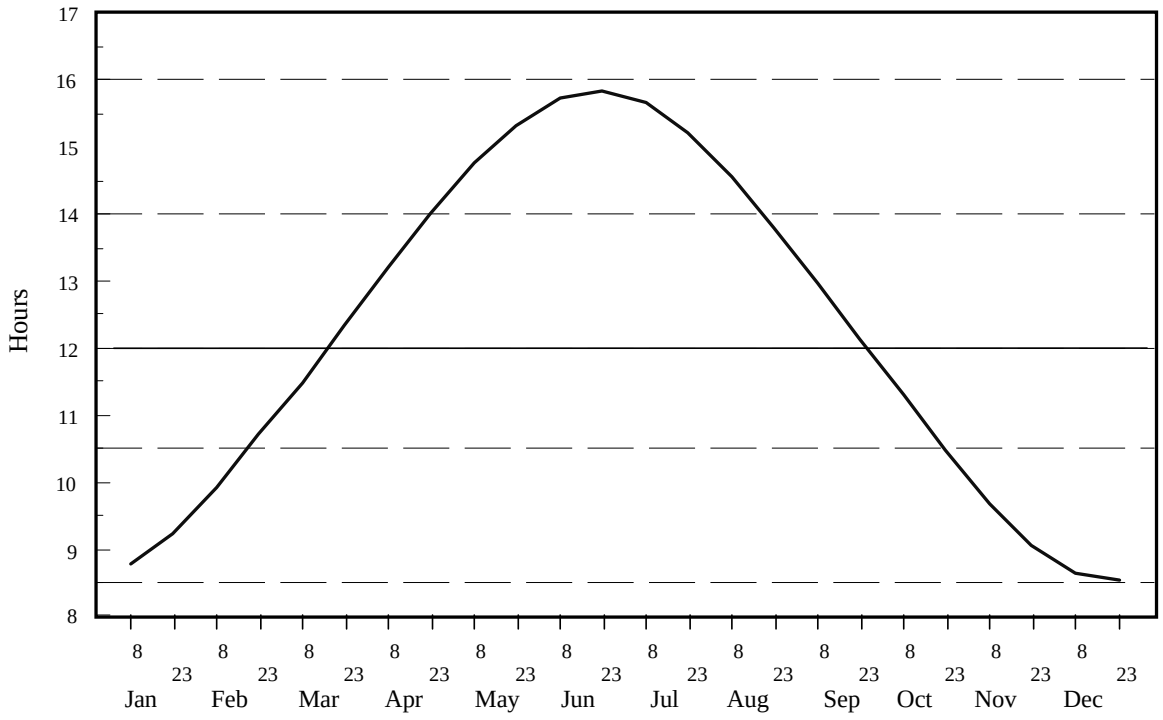


Fig. 1. Annual pattern of daylight duration at Dickinson, North Dakota.

Table 1. Long-term (1892-2008) mean monthly temperature and monthly precipitation at Dickinson, ND.

	° F	° C	in.	mm
Jan	11.48	-11.40	0.41	10.39
Feb	15.29	-9.28	0.40	10.15
Mar	26.20	-3.22	0.72	18.27
Apr	41.57	5.32	1.42	35.97
May	52.80	11.56	2.33	59.22
Jun	62.00	16.67	3.54	89.97
Jul	68.79	20.44	2.22	56.41
Aug	67.03	19.46	1.72	43.75
Sep	56.05	13.36	1.32	33.58
Oct	43.77	6.54	0.95	24.23
Nov	28.38	-2.01	0.54	13.62
Dec	17.01	-8.33	0.40	10.11
	MEAN		**TOTAL**	
	40.86	**4.93**	**15.97**	**405.67**

Table 2. Seasonal percentage of mean annual precipitation distribution (1892-2008).

Season	**in.**	**%**
Winter (Jan, Feb, Mar)	1.53	9.58
Spring (Apr, May, Jun)	7.29	45.70
Summer (Jul, Aug, Sep)	5.27	33.01
Fall (Oct, Nov, Dec)	1.89	11.82
TOTAL	15.97	

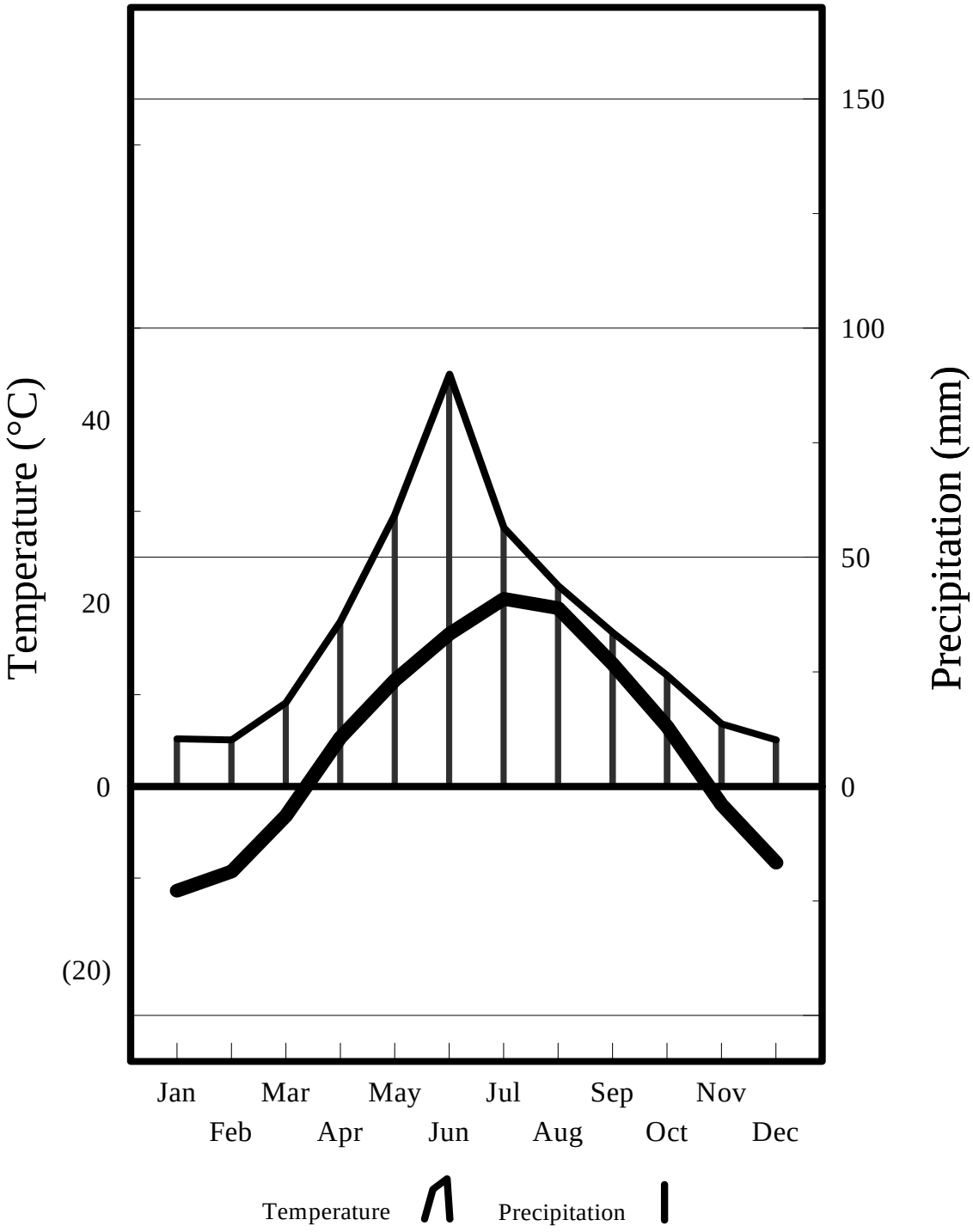


Fig. 2. Ombrothermic diagram of long-term (1892-2008) mean monthly temperature and monthly precipitation at Dickinson, North Dakota.

Literature Cited

Emberger, C., H. Gaussen, M. Kassas, and A. dePhilippis. 1963. Bioclimatic map of the Mediterranean Zone, explanatory notes. UNESCO-FAO. Paris. 58p.

Manske, L.L. 2009. Environmental factors to consider during planning of management for range plants in the Dickinson, North Dakota, region, 1892-2008. NDSU Dickinson Research Extension Center. Range Research Report DREC 09-1018l. Dickinson, ND. 37p.

2008 Winter Wheat - Recrop **Dickinson, ND**

Variety	Heading Date	Winter Survival	Seeds per Pound	Plant Height	Test Weight	Protein	Grain Yield 2005	Grain Yield 2007	Grain Yield 2008	Returns[1]	Average Yield[2] 2 Year	Average Yield[2] 3 Year
	June	%		in	lbs/bu	%	bu/ac	bu/ac	bu/ac	$/ac	bu/ac	bu/ac
Accipiter	22	93	20,433	22	55.4	16.0	--	--	18.6	-27.67	--	--
Alice	19	80	19,681	21	56.4	15.2	--	79.0	15.4	-47.36	47.2	--
CDC Buteo	22	90	18,706	23	58.5	15.5	58.3	82.7	17.6	-31.34	50.2	--
CDC Falcon	22	87	20,479	21	55.0	16.1	61.4	79.8	17.9	-32.58	48.9	53.0
Darrell	21	90	16,588	23	56.9	15.3	54.0	79.9	19.4	-20.70	49.7	51.1
Expedition	17	77	18,291	21	56.6	14.9	52.4	71.0	15.0	-50.45	43.0	46.1
Harding	24	77	18,144	23	55.8	16.5	65.6	74.0	14.5	-53.81	44.3	51.4
Hawken	20	60	18,790	20	54.0	15.6	--	--	13.9	-59.66	--	--
Jagalene	23	70	18,184	23	57.0	15.5	38.9	64.5	16.4	-40.40	40.5	39.9
Jerry	21	90	16,746	23	56.5	16.1	66.0	82.9	18.3	-28.39	50.6	55.7
Millennium	20	90	17,021	22	57.4	15.0	69.0	86.7	17.6	-32.29	52.1	57.7
NuDakota	24	37	20,180	19	51.9	15.6	--	80.2	10.1	-85.73	45.2	--
Overland	19	93	16,865	21	58.3	14.9	--	--	21.4	-6.50	--	--
Peregrine	24	97	19,984	25	56.1	15.2	--	--	17.5	-34.15	--	--
Radiant	24	93	16,811	23	57.0	15.2	--	70.7	19.5	-19.95	45.1	--
Roughrider	23	83	20,206	22	56.4	16.3	46.9	63.3	12.4	-67.70	37.8	40.8
Lyman	18	93	16,964	21	57.5	15.4	--	--	18.2	-28.20	--	--
Wesley	17	87	17,619	21	56.1	15.8	48.7	78.9	14.1	-56.57	46.5	47.2
Yellowstone	24	90	16,739	24	56.6	15.9	41.1	75.4	18.8	-24.87	47.1	45.1
Trial Mean	21	84	18,371	22	56.3	15.5	53.3	77.7	16.9	-38.06	--	--
CV %	7.4	9.5	2.5	8.7	1.1	2.2	9.3	10.4	12.8	--	--	--
LSD 0.05	2	13	944	3	0.9	0.7	7.0	11.4	3.1	--	--	--

Planting Date: September 18, 2007

Harvest Date: July 31, 2008

Previous Crop: Oat

Seeding Rate: 1 million live seeds/ac

[1]Returns were calculated by multiplying the 2008 yield by protein premium or discount paid at the Southwest Grain Terminal located at Gladstone on September 9. The price paid on this date was $6.55/bu for a grain protein concentration of 12%. $.01/bu was paid for each additional 0.2% increase in grain protein up to 15%, above which an additional premium was not paid. Grain was discounted $0.03/bu for each 0.2% reduction in grain protein from 12% to 10%, below which no additional discount was assigned. Returns factored in discounts for grain with a test weight < 60 lb/bu [-$0.01/bu for 0.5 lb/bu between 60 and 58 lb/bu; -$0.02/bu for 0.5 lb/bu between 58 and 57 lb/bu; -$0.03/bu for 0.5 lb/bu between 57 and 55 lb/bu; -$0.04/bu for 0.5 lb/bu between 55 and 52 lb/bu; and -$0.05/bu for 0.5 lb/bu between 52 and 51 lb/bu]. Returns also deduct $149.03, the sum of all listed costs from the December 2007 Farm Management Planning Guide Projected 2008 Crop Budgets South West North Dakota for winter wheat.

[2]Average yields are from 2005, 2007, and 2008 since winter wheat was not grown in 2006.

2008 Oat - Recrop **Dickinson, ND**

Variety	Days to Head	Seeds per Pound	Plant Height	Test Weight	Grain Yield 2006	Grain Yield 2007	Grain Yield 2008	Returns[1]	Average Yield 2 Year	Average Yield 3 Year
			in	lbs/bu	bu/ac	bu/ac	bu/ac	$/ac	bu/ac	bu/ac
AC Pinnacle	76	13,324	26	38.6	108.1	108.5	55.2	-16.29	81.8	90.6
Beach	75	13,680	28	39.6	94.4	102.4	51.2	-24.12	76.8	82.7
Buff*	71	17,397	26	38.5	60.9	71.5	48.9	-29.10	60.2	60.4
CDC Dancer	74	14,472	27	39.0	96.0	112.2	57.8	-10.40	85.0	88.6
CDC Minstrel	74	14,039	27	38.4	--	--	52.1	-22.36	--	--
Furlong	75	12,196	27	36.9	--	--	57.4	-13.38	--	--
HiFi	74	14,885	27	36.0	87.9	93.9	50.7	-28.79	72.3	77.5
Hytest	72	13,898	28	39.0	90.5	96.3	57.0	-11.94	76.7	81.3
Jerry	73	13,298	28	38.1	90.5	110.0	53.5	-19.39	81.7	84.6
Killdeer	74	14,530	24	37.1	93.5	115.6	56.3	-15.26	86.0	88.5
Maida	74	13,198	29	37.6	84.2	100.6	50.4	-26.47	75.5	78.4
Monida	76	15,759	26	36.0	104.8	96.5	60.1	-9.73	78.3	87.1
Morton	75	14,831	29	38.3	97.2	104.6	49.2	-28.47	76.9	83.7
Otana	74	15,657	30	39.4	96.3	109.7	66.0	6.90	87.9	90.7
Paul*	75	17,067	26	40.4	58.5	81.7	33.7	-61.60	57.7	58.0
Souris	74	15,659	24	37.0	97.0	112.9	55.9	-16.73	84.4	88.6
Stallion	74	15,918	29	38.9	100.2	109.5	61.8	-1.90	85.6	90.5
Stark*	76	16,611	27	42.0	68.1	73.3	39.9	-48.00	56.6	60.4
Youngs	75	12,547	28	36.5	98.0	116.8	52.1	-25.38	84.5	89.0
Trial Mean	74	14,425	27	37.9	93.0	104.3	52.8	-22.17	--	--
CV %	1.2	6.2	5.3	3.0	9.8	10.1	9.3	9.7	--	--
LSD 0.05	1	1,248	2	1.6	12.7	14.8	6.9	14.88	--	--

Planting Date: April 14, 2008
Harvest Date: July 30, 2008
* Hulless
Previous Crop: Field Pea
Seeding Rate: 1 million live seeds/ac

[1]Returns were calculated by multiplying the 2008 yield by the test weight discount paid at the Southwest Grain Terminal located in Gladstone on September 9. The price paid was $2.10/bu for grain with a test weight greater than 37 lb/bu. Grain with a test weight of 37 lb/bu was discounted $.04/bu, with an additional discount of $.04/bu per pound to 30 lb/bu. Below 30 lb/bu, an additional discount of $.07/bu occurred per pound. Returns also deduct $131.72, the sum of all listed costs from the December 2007 Farm Management Planning Guide Projected 2008 Crop Budgets South West North Dakota for oats.

2008 Durum - Recrop **Dickinson, ND**

Variety	Days to Head	Seeds per Pound	Plant Height	Test Weight	Protein	Grain Yield 2006	Grain Yield 2007	Grain Yield 2008	Returns[1]	Average Yield 2 Year	Average Yield 3 Year
			in	lbs/bu	%	bu/ac	bu/ac	bu/ac	$/ac	bu/ac	bu/ac
AC Commander	81	11,460	17	60.6	17.7	--	61.4	12.3	-58.60	36.9	--
AC Napoleon	81	13,663	18	59.3	18.5	--	46.9	13.8	-45.24	30.3	--
AC Navigator	81	11,540	18	61.0	17.2	54.9	48.3	12.7	-54.60	30.5	38.6
Alkabo	82	12,658	19	60.8	16.9	54.6	46.9	13.5	-47.47	30.2	38.4
Alzada	78	11,718	19	60.3	16.7	--	--	17.5	-11.98	--	--
Ben	80	13,137	20	60.1	18.2	47.2	45.1	13.2	-50.60	29.1	35.2
DG Star	81	13,034	18	59.3	18.0	--	--	11.2	-68.09	--	--
DG Max	81	12,970	18	60.6	18.0	--	--	12.5	-56.75	--	--
Dilse	82	12,997	18	59.6	19.1	48.3	46.8	13.6	-47.23	30.2	36.2
Divide	81	12,871	19	60.3	17.1	50.4	44.7	16.6	-20.51	30.6	37.2
Grande D'oro	82	11,982	18	59.5	17.2	--	--	11.5	-65.66	--	--
Grenora	81	12,596	18	59.8	17.6	52.2	47.8	13.7	-46.03	30.7	37.9
Lebsock	81	13,362	19	60.4	17.4	50.1	45.9	15.0	-34.63	30.4	37.0
Maier	80	13,023	19	60.4	18.4	49.8	45.2	14.7	-37.32	29.9	36.6
Mountrail	81	13,990	17	59.3	18.2	53.2	46.6	12.4	-57.79	29.5	37.4
Pierce	80	13,853	19	60.9	17.1	49.1	46.5	17.5	-12.54	32.0	37.7
Rugby	80	14,233	20	60.0	17.9	46.5	43.6	14.3	-40.51	29.0	34.8
Strongfield	81	12,741	20	59.8	18.9	54.6	46.7	13.2	-50.70	29.9	38.2
Wales	80	12,593	18	60.1	17.5	--	--	14.2	-41.53	--	--
Trial Mean	81	13,002	19	60.1	17.7	49.6	48.4	13.6	-46.82	--	--
CV %	1.0	3.9	8.4	0.8	--	11.7	6.7	19.5	--	--	--
LSD 0.05	1	704	NS	0.6	--	NS	4.57	NS	--	--	--

Planting Date: April 15, 2008
Harvest Date: August 13, 2008
Previous Crop: Field Pea
Seeding Rate: 1.2 million live seeds/ac

[1]Returns were calculated by multiplying the 2008 yield by the test weight discount paid at the Southwest Grain Terminal located at Gladstone on September 9. The price paid on this date was $9.75/bu for grain with a minimum test weight of 60 lb/bu. Grain was discounted $.02/bu for each 0.5 lb reduction in test weight between 60 and 58 lb/bu,$.04/bu per 0.5 lb reduction between 58 and 54 lb/bu, and $0.05/bu per 0.5 lb/bu reduction between 54 and 50 lb/bu. Returns also deduct $167.90, the sum of all listed costs from the December 2007 Farm Management Planning Guide Projected 2008 Crop Budgets South West North Dakota for durum.

2008 Commercial White Wheat - Recrop **Dickinson, ND**

Variety	Days to Head	Seeds per Pound	Plant Height	Test Weight	Protein	-----Grain Yield----- 2007	2008	2 Year Average
			in	lbs/bu	%	-----bu/ac-----		bu/ac
AC Karma	71	15,591	24	58.9	15.8	40.5	29.6	35.0
AC Snowbird	73	18,237	26	58.8	16.7	41.4	26.2	33.8
AC Vista	71	14,319	24	57.6	15.8	47.0	28.0	37.5
Agawam	70	12,328	23	60.8	16.2	49.9	24.8	37.4
Alpine	72	15,399	25	60.5	15.6	--	34.0	--
Diamond	72	14,510	25	60.8	16.7	44.3	28.1	36.2
Explorer	70	17,363	23	59.3	16.6	45.8	29.7	37.7
Glenn (hrsw)	71	15,814	24	61.5	16.8	49.4	27.5	38.4
Golden 86	70	13,703	23	60.3	16.4	45.8	24.4	35.1
IDO377S	72	17,107	25	57.5	16.6	--	27.3	--
Kantana	72	18,467	25	60.4	17.0	36.4	24.7	30.6
Lochsa	71	15,010	24	57.5	16.3	46.6	27.5	37.1
Lolo	72	15,070	25	58.8	15.9	47.8	29.8	38.8
Otis	72	15,877	25	59.9	16.0	46.4	27.8	37.1
Peerless	75	16,930	28	60.5	15.9	42.0	28.1	35.0
Penewawa	73	16,264	26	56.3	14.6	42.3	29.1	35.7
Reeder (hrsw)	74	18,908	27	59.8	17.0	45.5	26.8	36.1
Snow Crest	70	16,242	23	56.5	16.9	40.8	25.1	33.0
Steele-ND (hrsw)	72	16,719	25	58.4	16.5	47.2	26.7	36.9
Waikea	70	13,046	23	57.4	16.0	52.6	27.7	40.2
Trial Mean	72	15,956	25	59.0	16.3	44.9	27.6	--
CV %	0.7	6.9	2.1	2.0	1.3	5.6	6.8	--
LSD 0.05	1	1,546	1	1.7	0.5	3.6	2.7	--

Planting Date: April 14, 2008
Harvest Date: August 7, 2008
Previous Crop: Field Pea
Seeding Rate: 1.2 million live seeds/ac

2008 Hannover Durum Recrop **Dickinson, ND**

Variety	Seeds per Pound	Test Weight	Protein	------Grain Yield------ 2005	2007	2008	Returns[1]	Average Yield[2] 2 Year	3 Year
		lbs/bu	%	-------bu/ac-------			$/ac	----bu/ac----	
Alkabo	11,395	60.0	14.7	39.6	38.6	34.3	166.01	36.45	37.5
Ben	11,316	59.6	15.3	41.0	38.3	29.9	123.15	34.12	36.4
DG Star	12,042	58.6	15.6	--	--	32.1	143.20	--	--
Divide	12,245	59.0	15.3	38.4	37.5	34.2	163.80	35.81	36.7
Grenora	12,089	59.0	15.1	42.7	37.5	35.6	177.47	36.56	38.6
Mountrail	12,636	59.0	15.6	--	40.3	32.4	147.04	36.37	--
Trial Mean	11,954	59.2	15.3	40.4	38.5	33.1	153.45	--	--
CV %	3.9	0.6	--	9.1	4.5	10.0	10.0	--	--
LSD 0.05	696	0.5	--	NS	NS	NS	NS	--	--

Planting Date: April 22, 2008

Harvest Date: August 18, 2008

Previous Crop: Field Pea

Seeding Rate: 1.2 million live seeds/ac

[1]Returns were calculated by multiplying the 2008 yield by the test weight discount paid at the Southwest Grain Terminal located at Gladstone on September 9. The price paid on this date was $9.75/bu for grain with a minimum test weight of 60 lb/bu. Grain was discounted $.02/bu for each 0.5 lb reduction in test weight between 60 and 58 lb/bu,$.04/bu per 0.5 lb reduction between 58 and 54 lb/bu, and $0.05/bu per 0.5 lb/bu reduction between 54 and 50 lb/bu. Returns also deduct $167.90, the sum of all listed costs from the December 2007 Farm Management Planning Guide Projected 2008 Crop Budgets South West North Dakota for durum.

[2]Average yields are from 2005, 2007, and 2008 since durum was not grown in 2006.

2008 Glen Ullin Durum Fallow **Dickinson, ND**

Variety	Seeds per Pound	Test Weight	Protein	------Grain Yield------ 2005	2007	2008	Returns[1]	Average Yield[2] 2 Year	3 Year
		lbs/bu	%	-------bu/ac-------			$/ac	----bu/ac----	
Alkabo	11,539	61.8	13.1	57.6	35.7	36.4	187.01	36.07	43.2
Ben	11,799	61.9	14.2	60.5	42.4	35.7	180.34	39.03	46.2
DG Star	11,746	60.8	13.5	--	--	32.1	144.97	--	--
Divide	11,252	61.8	11.8	59.1	36.2	42.9	250.26	39.53	46.1
Grenora	11,791	61.3	13.9	62.3	38.4	37.6	199.14	38.03	46.1
Mountrail	13,223	60.8	13.3	--	44.6	37.0	192.77	40.78	--
Trial Mean	11,892	61.4	13.3	60.3	39.5	37.0	192.42	--	--
CV %	5.5	1.4	--	6.5	8.6	23.1	23.1	--	--
LSD 0.05	986	NS	--	NS	5.2	NS	NS	--	--

Planting Date: April 22, 2008
Harvest Date: August 18, 2008
Previous Crop: Chemical Fallow
Seeding Rate: 1.2 million live seeds/ac

[1]Returns were calculated by multiplying the 2008 yield by the test weight discount paid at the Southwest Grain Terminal located at Gladstone on September 9. The price paid on this date was $9.75/bu for grain with a minimum test weight of 60 lb/bu. Grain was discounted $.02/bu for each 0.5 lb reduction in test weight between 60 and 58 lb/bu,$.04/bu per 0.5 lb reduction between 58 and 54 lb/bu, and $0.05/bu per 0.5 lb/bu reduction between 54 and 50 lb/bu. Returns also deduct $167.90, the sum of all listed costs from the December 2007 Farm Management Planning Guide Projected 2008 Crop Budgets South West North Dakota for durum.

[2]Average yields are from 2005, 2007, and 2008 since durum was not grown in 2006.

2008 Hard Red Spring Wheat - Recrop **Dickinson, ND**

Variety	Days to Head	Seeds per Pound	Plant Height	Test Weight	Protein	Grain Yield 2006	Grain Yield 2007	Grain Yield 2008	Returns[1]	Average Yield 2 Year	Average Yield 3 Year
			in	lbs/bu	%	bu/ac	bu/ac	bu/ac	$/ac	bu/ac	bu/ac
AP 604 CL	73	18,310	25	59.8	17.3	--	53.0	32.8	113.72	42.9	--
Alsen	74	16,621	25	58.6	17.2	40.1	51.5	29.5	87.06	40.5	40.3
Blade	74	15,173	25	60.4	17.8	--	--	34.7	128.46	--	--
Breaker	74	14,691	27	59.9	17.1	--	--	36.4	142.16	--	--
Briggs	73	16,855	28	59.4	17.0	44.0	50.5	29.6	88.42	40.1	41.4
Choteau	73	16,865	23	59.0	16.6	41.2	48.5	34.2	124.66	41.4	41.3
Cromwell	74	16,853	23	59.9	17.6	--	--	31.1	100.31	--	--
FBC Dylan	74	16,234	24	58.8	16.4	39.4	46.4	29.2	85.26	37.8	38.3
Faller	75	16,415	24	57.5	16.1	42.4	52.8	29.8	89.51	41.3	41.7
Freyr	73	16,998	26	59.4	16.1	42.9	50.4	33.7	120.98	42.1	42.3
Glenn	73	17,023	27	60.9	16.3	41.6	52.7	31.0	99.62	41.9	41.8
Granger	74	16,181	26	59.4	16.5	43.7	51.2	31.1	99.90	41.1	42.0
Granite	76	17,713	24	61.0	16.9	42.0	46.9	34.8	129.09	40.8	41.2
Howard	74	17,271	26	58.5	16.1	43.6	53.6	30.9	98.26	42.2	42.7
Kelby	73	17,736	23	59.8	15.6	38.1	53.6	34.2	121.96	43.9	41.9
Knudson	74	15,600	24	59.9	17.1	41.4	53.7	32.2	108.73	43.0	42.4
Kuntz	73	19,541	24	58.5	15.5	--	50.8	31.3	97.62	41.0	--
ND901CL	73	18,317	27	60.0	17.0	--	--	33.8	121.78	--	--
Parshall	74	17,744	25	59.1	16.4	41.9	51.4	31.4	102.76	41.4	41.6
RB07	72	16,838	24	60.4	16.3	42.7	57.5	37.2	148.29	47.3	45.8
Reeder	75	19,369	23	58.8	17.4	40.8	43.8	28.4	78.63	36.1	37.7
Rush	72	16,871	24	61.0	16.6	36.9	45.6	29.7	89.05	37.6	37.4
Samson	74	17,087	25	58.4	16.8	--	--	34.6	127.83	--	--
Steele-ND	74	17,778	27	57.5	16.4	43.4	50.8	30.4	93.90	40.6	41.5
Tom	73	14,809	25	60.3	16.3	--	--	32.3	109.58	--	--
Traverse	72	16,408	26	56.9	15.9	41.3	53.9	34.4	124.34	44.2	43.2
Vantage	76	18,110	22	59.9	17.4	--	--	33.0	115.19	--	--
Trial Mean	73	17,117	26	59.2	16.6	41.3	50.5	32.1	107.72	--	--
CV %	1.2	3.9	5.6	1.0	2.3	7.9	6.7	10.5	--	--	--
LSD 0.05	1	941	2	0.9	0.8	4.6	4.7	4.7	--	--	--

Planting Date: April 14, 2008

Harvest Date: August 5, 2008

Previous Crop: Field Pea

Seeding Rate: 1.2 million live seeds/ac

[1]Returns were calculated by multiplying the 2008 yield by protein premium or discount paid at the Southwest Grain Terminal located at Gladstone on September 9. The price paid on this date was $7.18/bu, for a grain protein

concentration of 14%. An additional $.07/bu was paid for each additional 0.2% increase in grain protein up to 15%, 15% protein received an additional $.20/bu. An additional $.04/bu was paid for each additional 0.2% increase in grain protein up to 17% above which an additional premium was not paid. Grain was discounted $0.08/bu for each 0.2% reduction in grain protein from 14% to 11%,below which no additional discount was not assigned. Returns factored in discounts for grain with a test weight <58 lb/bu [-$0.02/bu for 0.5 lb/bu between 58 and 57 lb/bu; -$0.03/bu for 0.5 lb/bu between 57 and 55 lb/bu; -$0.04/bu for 0.5 lb/bu between 55 and 52 lb/bu; and -$0.05/bu for 0.5 lb/bu between 52 and 51 lb/bu]. Returns also deduct $146.49, the sum of all listed costs from the December 2007 Farm Management Planning Guide Projected 2008 Crop Budgets South West North Dakota for spring wheat.

2008 Barley - Recrop **Dickinson, ND**

Variety	Days to Head	Seeds per Pound	Plant Height	Test Weight	Protein	% Plump	Grain Yield 2006	Grain Yield 2007	Grain Yield 2008	Returns[1]	Average Yield 2 Year	Average Yield 3 Year
			in	lbs/bu	%	>6/64	bu/ac	bu/ac	bu/ac	$/ac	bu/ac	bu/ac
Six Row												
Drummond	71	14,419	25	42.9	15.2	64.9	89.9	71.2	53.8	23.77	62.5	71.7
Lacey	73	15,248	22	43.9	14.2	56.8	88.4	79.3	53.6	23.64	66.5	73.8
Legacy	74	15,600	23	41.3	14.5	61.1	76.0	68.1	51.7	13.39	59.9	65.3
Rasmusson	72	14,862	23	43.0	14.0	62.8	103.1	75.1	53.5	22.43	64.3	77.2
Robust	73	16,039	25	44.1	14.8	57.9	89.8	70.8	49.2	11.15	60.0	69.9
Stellar-ND	73	13,468	23	41.1	13.8	67.5	83.8	69.3	50.4	8.73	59.8	67.8
Tradition	72	14,455	24	42.3	14.7	66.8	82.3	75.4	53.3	20.55	64.4	70.3
Two Row												
AC Metcalfe	75	13,514	22	45.2	14.7	87.1	88.6	70.9	52.3	22.86	61.6	70.6
Bowman	74	11,550	24	46.3	15.1	87.8	85.8	70.6	55.4	33.39	63.0	70.6
CDC Copeland	77	13,180	22	43.4	15.5	81.9	80.9	68.7	45.8	-0.60	57.2	65.1
Conlon	71	10,743	25	46.7	14.6	95.2	82.3	63.9	49.1	13.58	56.5	65.1
Conrad	76	13,035	21	47.0	15.8	83.1	--	76.3	52.7	25.09	64.5	--
Eslick	76	11,756	21	47.3	14.6	81.3	98.1	78.7	58.5	43.18	68.6	78.4
Geraldine	78	13,603	21	44.8	15.9	57.4	--	70.8	51.6	19.31	61.2	--
Harrington	76	13,796	22	43.8	15.8	74.5	78.6	63.3	47.5	5.83	55.4	63.1
Haxby	74	11,917	22	48.7	15.3	83.4	94.0	76.7	55.1	32.67	65.9	75.3
Hockett	74	11,642	21	46.7	14.4	86.8	--	71.9	55.1	32.13	63.5	--
Pinnacle	74	11,100	24	47.2	13.3	92.5	93.1	69.3	54.1	29.42	61.7	72.2
Rawson	73	10,527	25	47.5	13.7	93.3	91.1	66.4	54.9	31.83	60.7	70.8
Scarlett	77	13,151	18	46.4	15.0	89.0	--	76.7	50.4	17.89	63.6	--
Trial Mean	74	13,437	23	44.6	14.7	75	87.7	71.8	52.3	20.79	--	--
CV %	1.0	5.7	6.2	3.0	--	7.0	11.1	9.7	7.1	7.1	--	--
LSD 0.05	1	1,087	2	1.9	--	7	13.6	NS	5.2	16.16	--	--

Planting Date: April 14, 2008
Harvest Date: July 30, 2008
Previous Crop: Field Pea
Seeding Rate: 1.2 million live seeds/ac

[1]Returns were calculated by multiplying the 2008 yields by the price paid for feed barley minus the test weight discount paid at the Southwest Grain Terminal located at Gladstone on September 9. The price paid on this date was $3.15/bu for grain with test weights heavier than 45 lb/bu. Grain with a test weight of 45 lb/bu was discounted $.03/bu, with an additional discount of $.04/bu per pound down to 42 lb/bu. Below 42 lb/bu, an additional discount of $.05/bu occurred per pound. Returns also deduct $141.02, the sum of all listed costs from the December 2007 Farm Management Planning Guide Projected 2008 Crop Budgets South West North Dakota for barley.

2008 Glen Ullin Spring Wheat **Dickinson, ND**

Variety	Seeds per Pound	Test Weight	Protein	Grain Yield 2005	Grain Yield 2007	Grain Yield 2008	Returns[1]	Average Yield[2] 2 Year	Average Yield[2] 3 Year
		lbs/bu	%	bu/ac	bu/ac	bu/ac	$/ac	bu/ac	bu/ac
Choteau	14,485	61.2	13.7	53.7	39.3	46.1	177.48	42.7	46.4
Faller	13,462	61.0	13.9	--	37.3	46.1	180.88	41.7	--
Glenn	14,873	63.8	14.7	66.6	35.5	40.5	152.86	38.0	47.5
Howard	15,357	61.2	14.3	57.7	38.2	42.1	158.77	40.1	46.0
Kelby	14,696	62.3	14.5	--	23.8	43.8	173.86	33.8	--
Kuntz	16,406	61.8	13.6	--	--	40.2	132.76	--	--
ND901CL	15,125	62.0	14.8	--	--	44.0	181.54	--	--
Steele-ND	14,651	61.7	14.7	57.9	37.1	42.9	170.34	40.0	45.9
Traverse	14,563	59.2	12.9	--	39.7	46.8	167.30	43.3	--
Trial Mean	14,914	61.6	14.0	60.9	35.1	45.2	175.47	--	--
CV %	3.1	1.0	3.1	4.8	8.8	6.8	--	--	--
LSD 0.05	779	1.0	1.0	4.2	4.4	5.2	--	--	--

Planting Date: April 22, 2008

Harvest Date: August 18, 2008

Previous Crop: Chemical Fallow

Seeding Rate: 1.2 million live seeds/ac

[1]Returns were calculated by multiplying the 2008 yield by protein premium or discount paid at the Southwest Grain Terminal located at Gladstone on September 9. The price paid on this date was $7.18/bu, for a grain protein concentration of 14%. An additional $.07/bu was paid for each additional 0.2% increase in grain protein up to 15%, 15% protein received an additional $.20/bu. An additional $.04/bu was paid for each additional 0.2% increase in grain protein up to 17% above which an additional premium was not paid. Grain was discounted $0.08/bu for each 0.2% reduction in grain protein from 14% to 11%,below which no additional discount was not assigned. Returns factored in discounts for grain with a test weight <58 lb/bu [-$0.02/bu for 0.5 lb/bu between 58 and 57 lb/bu; -$0.03/bu for 0.5 lb/bu between 57 and 55 lb/bu; -$0.04/bu for 0.5 lb/bu between 55 and 52 lb/bu; and -$0.05/bu for 0.5 lb/bu between 52 and 51 lb/bu]. Returns also deduct $146.49, the sum of all listed costs from the December 2007 Farm Management Planning Guide Projected 2008 Crop Budgets South West North Dakota for spring wheat.

[2]Average yields are from 2005, 2007, and 2008 since wheat was not grown in 2006.

2008 Hannover Spring Wheat **Dickinson, ND**

Variety	Seeds per Pound	Test Weight	Protein	Grain Yield 2005	Grain Yield 2007	Grain Yield 2008	Returns[1]	Average Yield[2] 2 Year	Average Yield[2] 3 Year
		lbs/bu	%	bu/ac	bu/ac	bu/ac	$/ac	bu/ac	bu/ac
Choteau	15,198	60.0	15.9	31.1	32.5	33.7	119.11	33.1	32.4
Faller	15,183	58.8	16.2	--	30.8	30.9	98.50	30.9	--
Glenn	15,475	62.4	16.2	36.4	30.6	29.2	85.43	29.9	32.1
Howard	15,275	59.8	15.7	35.6	30.4	30.3	91.39	30.4	32.1
Kelby	17,016	60.6	16.2	--	28.6	31.9	106.15	30.2	--
Kuntz	17,824	59.8	15.1	--	--	28.9	77.17	--	--
ND901CL	16,554	60.5	16.4	--	--	30.4	94.80	--	--
Steele-ND	15,687	60.3	16.2	32.3	29.8	29.4	87.03	29.6	30.5
Traverse	15,336	57.9	15.3	--	30.9	32.9	109.35	31.9	--
Trial Mean	15,918	60.0	16.0	35.7	29.6	31.7	103.42	--	--
CV %	3.1	0.9	1.4	11.9	8.6	9.9	--	--	--
LSD 0.05	706	0.8	0.5	6.1	3.7	NS	--	--	--

Planting Date: April 22, 2008

Harvest Date: August 18, 2008

Previous Crop: Field Pea

Seeding Rate: 1.2 million live seeds/ac

[1]Returns were calculated by multiplying the 2008 yield by protein premium or discount paid at the Southwest Grain Terminal located at Gladstone on September 9. The price paid on this date was $7.18/bu, for a grain protein concentration of 14%. An additional $.07/bu was paid for each additional 0.2% increase in grain protein up to 15%, 15% protein received an additional $.20/bu. An additional $.04/bu was paid for each additional 0.2% increase in grain protein up to 17% above which an additional premium was not paid. Grain was discounted $0.08/bu for each 0.2% reduction in grain protein from 14% to 11%,below which no additional discount was not assigned. Returns factored in discounts for grain with a test weight <58 lb/bu [-$0.02/bu for 0.5 lb/bu between 58 and 57 lb/bu; -$0.03/bu for 0.5 lb/bu between 57 and 55 lb/bu; -$0.04/bu for 0.5 lb/bu between 55 and 52 lb/bu; and -$0.05/bu for 0.5 lb/bu between 52 and 51 lb/bu]. Returns also deduct $146.49, the sum of all listed costs from the December 2007 Farm Management Planning Guide Projected 2008 Crop Budgets South West North Dakota for spring wheat.

[2]Average yields are from 2005, 2007, and 2008 since wheat was not grown in 2006.

Report on Dakota SARE Program Activities in 2008

Frank Kutka
DREC Assistant Director and Dakota SARE Coordinator

The Dakota SARE Program is a joint effort of NDSU, SDSU, and the USDA Sustainable Agriculture Research and Education (SARE) Program. The mission of the program in the Dakotas is promoting SARE and professional development in sustainable agriculture among educators in North and South Dakota in order to achieve the NCR-SARE Professional Development Program mission: **Educators who are knowledgeable in the general concepts of sustainable agriculture and motivated to work in partnership with farmers, ranchers, and the general public on developing programs and activities that enhance the sustainability of rural communities and the food and agricultural system**.

Input from a council of advisors was solicited several times in 2008 in order to help develop priorities for the program and to maintain connections with ag educators and farmers in North and South Dakota.

Table 1. Dakota SARE Advisory Council members and affiliations.

Member Name	**Affiliation**
Robin Salverson	**SARE AC, SDSU CES**
Hans Kandel	SARE AC, NDSU Extension
Karen Pearson	**SDSU CES**
Roger Haugen	NDSU Extension
April Borders	**SDSU CES**
Jim Hennessey	NDSU Extension
Brad Brummond	NDSU Extension
Roger Gates	**SDSU CES**
Ron Weiderholt	NDSU Extension
Pandy Pittman	**Wall School Vo-Ag**
Cheyanne Erickson	NDSU Extension/FRTEP
Julie Garreau	**Cheyenne River Youth Project**
Joe Dunn	Sitting Bull College
Jim Beddow	**Rural Learning Center**
Karri Stroh	FARRMS
Jayme Murray	**Farmer**
Gabe Brown	Farmer
Jim Gilkerson	**Farmer**
Ronny Mackaben	**Farmer**
Linda Grotberg	Farmer
David Clay	**PDP Grantee**

Table 2. Meeting times for the Dakota SARE Advisory Council in 2008.

Date	**Location**
7 February	Mandan, ND
18 April	Pierre, SD
14 May	Teleconference
10 October	Pierre, SD
25 November	Medina, ND

In 2008 the following activities were carried out in order to promote the SARE program information services and grant opportunities in the Dakotas:

16 January – Booth at Marketplace for Entrepreneurs, Grand Forks, ND
31 January – Meet with NPSAS Director, Dickinson, ND
5 February – Presentation at Garrison FFA winter ag show, Garrison, ND
5-6 February – Mandak Zero Tillage Farming Association Workshop, Minot, ND
8 February – Northern Great Plains Research Laboratory Customer Focus Group, Mandan, ND
8-9 February – Booth and Presentation at Northern Plains Sustainable Agriculture Society Conference, Mandan, ND
13-16 February – Organic Seed Foundation Conference, Salem, OR (Supported by NDSU)
19 February – Presentation for New York Certified Organic February Workshop (via satellite), several Dakota locations
20-23 February – Midwest Organic and Sustainable Education Service Conference, LaCrosse, WI
26 February – SOAR Meeting, Fort Yates, ND
7 March – Meet with NPSAS Director, Dickinson, ND
10 March – OCIA ND Chapter 1 meeting, Bismarck, ND
23-28 March – SARE National Conference, Kansas City, MO
31 March – 1 April – Presentations at NDSU Extension Spring Conference, Bismarck, ND
3 April – University of North Dakota Seminar, Grand Forks, ND
6 May – Soil Presentation at Heart River School, Dickinson, ND
21 May – Soil Field Trip for Heart River School, Dickinson, ND
16 June – NPSAS Program Committee Meeting, Jamestown, ND
17 June – Presentation to NDSU Extension Leadership Meeting, Fargo, ND
27 June – Gabe Brown Ranch Tour with Dickinson State University and NRCS, Bismarck, ND
30 June – Radio Interview for Fargo AM Radio Market
21-22 July – Display at NPSAS Summer Symposium, Madison, SD
22-23 July – Circle of Sustainability visit to Pine Ridge, Kyle, SD
29-30 July – Circle of Sustainability visit to Cheyenne River, Eagle Butte, SD
30 July – Circle of Sustainability visit to Standing Rock, Fort Yates, ND
4-5 August – Circle of Sustainability visit to Turtle Mountain, Belcourt, ND
5-7 August – Circle of Sustainability visit to Fort Berthold, New Town, ND
18-21 August – Dakotafest Booth, Mitchell, SD
28 August – Burleigh County SCD Tour, Bismarck, ND
11 September – Presentation at NDSU Extension Specialist Meeting, Fargo, ND
17-18 September – Circle of Sustainability visit to Spirit Lake, Fort Totten, ND
24-25 September – Presentation at NRCS Field Day, Glendive, MT
14 October – Grants discussion with Turtle Mountain Community College, Belcourt, ND
27-29 October – Presentation at NDSU Extension Fall Conference, Fargo, ND
17 December – Presentation at ND Dept of Ag Local Foods event, Dickinson, ND

There were also 1) planning calls, visits and emails throughout the year for NPSAS events in North and South Dakota, Chuck Francis' PDP Project, SDSU Cooperative Extension events, Tri-Societies Committee on Organic and Sustainable Agriculture Annual Conference, South Dakota Federal Agencies integration (via NRCS), and the NCR-SARE Circle of Sustainability efforts; 2) promotion of SARE Grants and assistance to grant writers, 3) maintenance of DakotaSARE.info website, and 4) facilitation of SARE Youth Grants in the Dakotas.

This promotion resulted in several successes across the Dakotas. Three Graduate Student Grants were awarded, five Youth Grants were awarded, four Youth Educator Grants, one Professional Development Grant, four Research and Education grants, and five Farmer Rancher Grants were awarded to Dakota educators and researchers.

The primary activity of the Dakota SARE program is professional development of agriculture educators in the various areas of agricultural sustainability identified as priorities by the Advisory Council. In 2008 these trainings by the State Coordinator, mini-grants for trainings by other educators, and travel scholarships so educators could attend conferences and field days were carried out.

Organic Agriculture Initiative

Afternoon workshop held in Mandan, ND for seven educators on the 7th of February.

Travel Scholarships to five educators to attend the NPSAS Winter Conference or the MOSES Annual Conference.

Outcomes of these activities included:

Three of our Travel Scholarship awardees teamed up after the MOSES conference and delivered three field tours about organic agriculture and organic soil management, with funding from the ND Department of Agriculture.

One of our Travel Scholarship awardees gave a presentation about sustainable and organic agriculture to a legislative panel touring his county.

Two of our Travel Scholarship awardees helped the State Coordinator organize a three state video workshop on organic agriculture that included speakers from NDSU, NYCO and Cornell University.

Soil Conservation Initiative

One one-hour workshop about cover crops presented with Hans Kandel to 35 Extension educators in Fargo, ND on 29 October.

Mini-grants were provided to put on a distance education program about soil health for NDSU Extension and to support a no-till/soil health workshop in Bison, SD for Extension, SCD, and NRCS educators.

One travel scholarship allowed an educator to attend the regional SCD meeting.

Outcomes of these activities included:

The interest in cover crops is spreading across the Dakotas. After the session with Hans Kandel the State Coordinator was invited to take part in two more sessions about cover crops in 2009. This is the most interest in SARE that has been exhibited in 4 years!

One of our Mini-Grant awardees has assisted the State Coordinator in setting up further presentations about soil health and has applied for a second mini-grant to continue his PDP project in 2009.

Our Travel Scholarship awardee later applied for a mini-grant to help with a large field day held at her farm where she discussed soil conservation issues and soil health with the visiting public. She will also be presenting at the NPSAS Winter Conference in 2009.

Circle of Sustainability Listening Sessions

In cooperation with Tribal Colleges, NGOs, Extension in North and South Dakota, and area farmers and ranchers, the SARE program took part in listening sessions to gain insight in how to better serve the residents and educators on Reservations. Multi-day meetings were held at Pine Ridge, Rosebud, Cheyenne River, Standing Rock, Turtle Mountain, and Fort Berthold Reservations in July and August. A

one day visit was held in September with educators and students at Cankdeska Cikana Community College in Fort Totten.

A mini-grant helped cover costs for planning meetings about agricultural priorities by agency representatives at the Standing Rock Reservation.

Eight Travel Scholarships helped Extension educators attend the listening sessions, attend a follow up field day about no-till gardening near Fullerton, ND, or attend a conference about agriculture and science education at Tribal Colleges.

Outcomes and later activities that grew out of these included:

The small but significant strides in cross-cultural connection made via these listening sessions were so impressive to the Dakota SARE Advisors that continuing to strengthen these connections and taking this approach to other communities became the primary focus of the 2009 Dakota SARE plan of work.

In September the State Coordinator led a tour for 2 Extension educators and 1 FCS Indian Credit Outreach educator to David Podoll's farm where the Podolls toured all four of us through their no-till, organic garden. All three received travel support for mileage and lodging. All three have expressed interest in further work in this area. Two attended the Great Lakes Indigenous Farming Conference in 2009 and one wrote a Youth Educator Grant to incorporate some of the garden techniques into a youth garden program. Two of these educators were Circle of Sustainability partners.

The State Coordinator presented a 1 hour tele-workshop for an NGO educator at the Pine Ridge Indian Reservation about how to access seeds via the GRIN website for the National Plant Germplasm System. This educator was a Circle of Sustainability partner who may be submitting a Youth Educator Grant and who may be seeking further travel support from SARE in 2009.

Another of our Travel Scholarship awardees is planning a "women in agriculture" project and a SARE sponsored youth project for 2009 which was funded. She is one of our Circle of Sustainability partners at Cheyenne River.

One of our Circle of Sustainability partners at Fort Totten, ND has been using SARE handbooks in courses offered at Cankdeska Cikana Community College since first meeting with the State Coordinator in an informal visit in 2006. After the visits in 2008 he and partners at three other Tribal Colleges in North Dakota have sought to develop new projects in agriculture and natural resources with NDSU.

One of our Circle of Sustainability partners at Kyle, SD borrowed vegetable production DVDs from the State coordinator and showed them to residents of Pine Ridge via community access television.

Several Circle of Sustainability partners in South Dakota will be presenting at the NPSAS Winter Conference in Huron, SD in 2009 and several from Pine Ridge and Rosebud also submitted a SARE R & E proposal.

A one-time grant opportunity of up to $275,000 for Native American communities was developed and announced by NCR-SARE by spring 2009. This was a direct outcome of these listening sessions and the call for proposals adapted language directly from the conversations.

Sustainability for Youth Initiative

A workshop on developing sustainable agriculture programming for 4H youth was held in Bismarck on 31 March to 8 Extension educators.

Promotion of the SARE Youth Grants in North and South Dakota resulted in 13 successful applicants funded by this NCR-SARE program.

Outcomes of these activities:

One of the invited speakers for the youth session in Bismarck has been so enthused by the experiences of being asked to present to youth educators that she wrote up a set of soil health activities that will now become the basis for the new 4H Soil Health Activity Trunk in North Dakota. Her curriculum has been forwarded to Vo-Ag, 4H, NGO, and other youth educators in both North and South Dakota.

A similar workshop for SDSU Youth Development Educators was discussed through 2008 and in fall, SDSU CES decided to hold it at the spring conference.

SARE Youth Grantees were invited to speak at the 2009 NPSAS Winter Conference.

SARE Youth and Youth Educator Grants have developed as a regional program coordinated by North Central Region SARE.

Sustainability and Nutrition Initiative

A Julie Garden-Robinson teamed up with the State Coordinator to present a fun workshop on nutrition and how it relates to agriculture in North Dakota. Sustainability in this production was a part of the presentation to 17 educators.

Travel Scholarships were awarded to two SDSU Extension educators to attend the SARE National Conference in Kansas City.

Outcomes of these activities included:

The workshop has led to increased interaction between SARE and the NDSU nutrition program. Other specialists are now looking to SARE for support to work on “bridge issues” like local foods.

Planning for a sustainability training for nutrition educators in South Dakota continued throughout 2008 and in fall SDSU CES decided to hold one during the spring extension conference.

Both Travel Scholarship awardees agreed to speak at the NPSAS Winter Conference in Huron, SD in 2009.

Sustainability and Community Initiative

One travel scholarship was awarded to an NDSU Leadership Specialist to attend the SARE National Conference in Kansas City.

Outcomes of these activities included:

Ongoing discussions led to the decision by SDSU CES to hold a training session at spring extension conference in 2009 for Community Leadership educators.

Leadership educators with NDSU are now more supportive of what sustainability might mean after the travel to the National Conference and conversations about holding a Circle of Sustainability type of listening session with a community working with the Horizons program have resulted.

General Sustainable Agriculture Education

Five mini-grants were awarded for programs on beef production, gentle livestock handling techniques, a tour of a farm demonstrating several elements of sustainability, integrated pest management, and soil biology.

Seven travel scholarships were awarded for attendance at a range of conferences and field days.

Region 4 West ND

Farm/Ranch Business Management Education

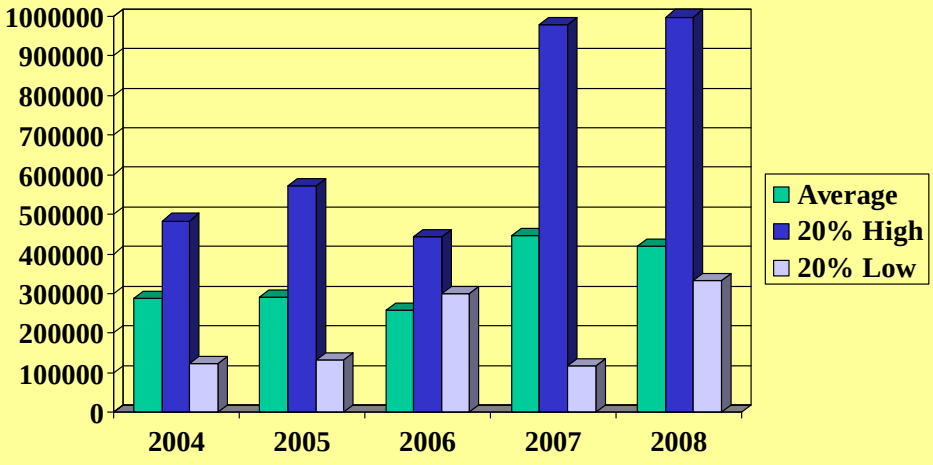
Year 2008

Jerry Tuhy, Instructor

Dickinson ND at DREC

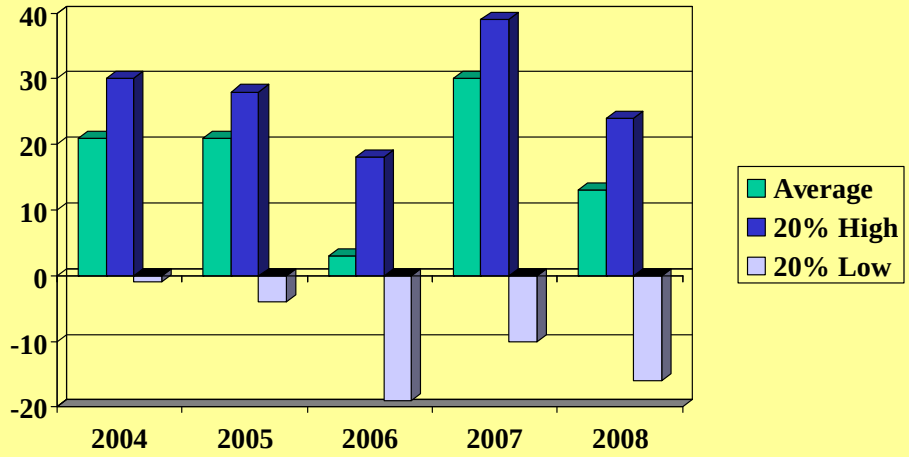
Gross Income (Accrual)

Per farm for year

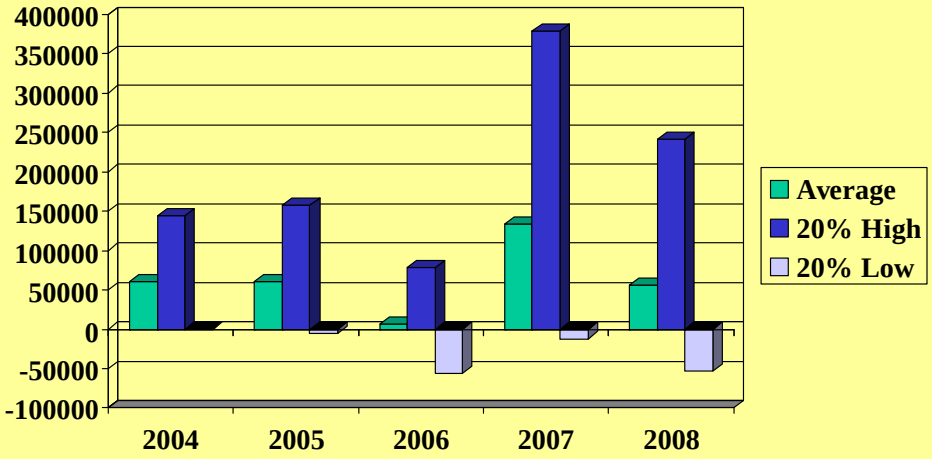


Net Income Ratio (%)

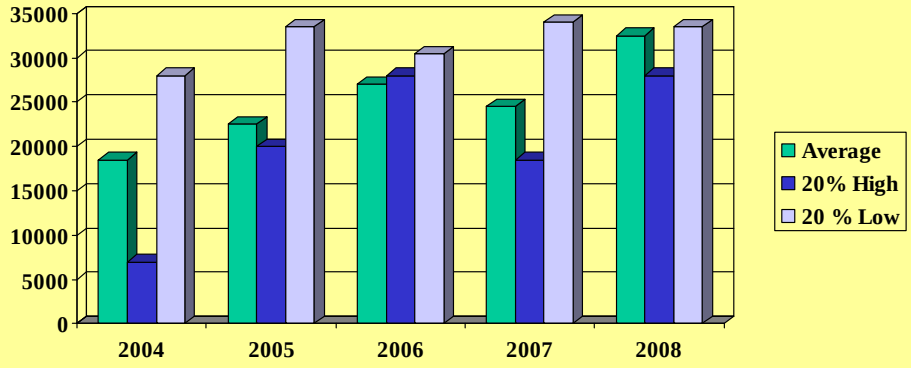
percentage of gross $ that is net $



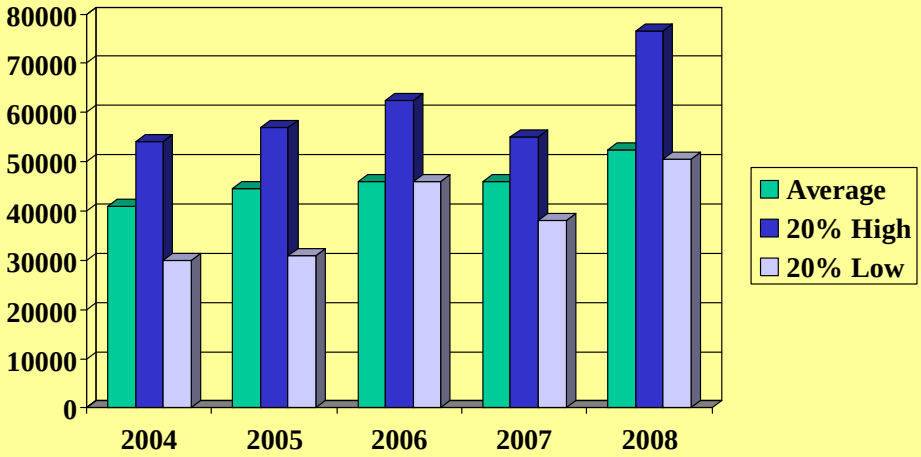
$ Net Farm Income “Profit”



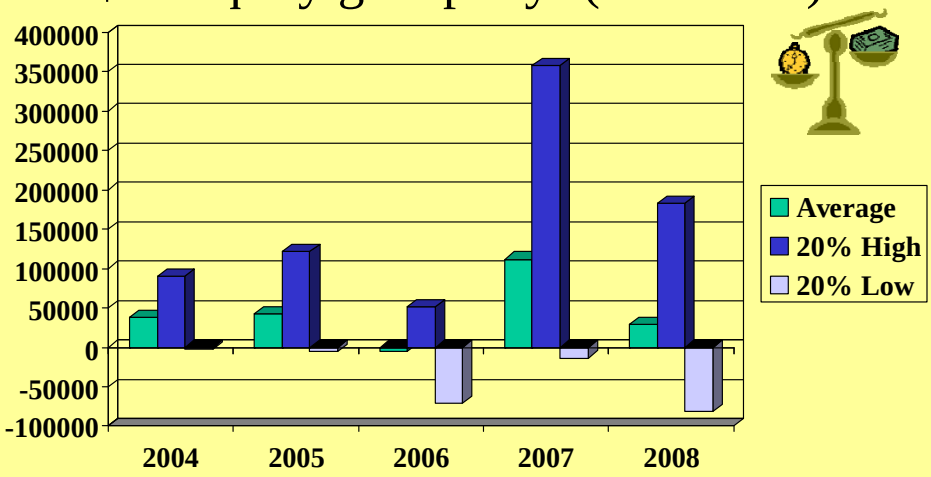
$ Net “Non-Farm” Income



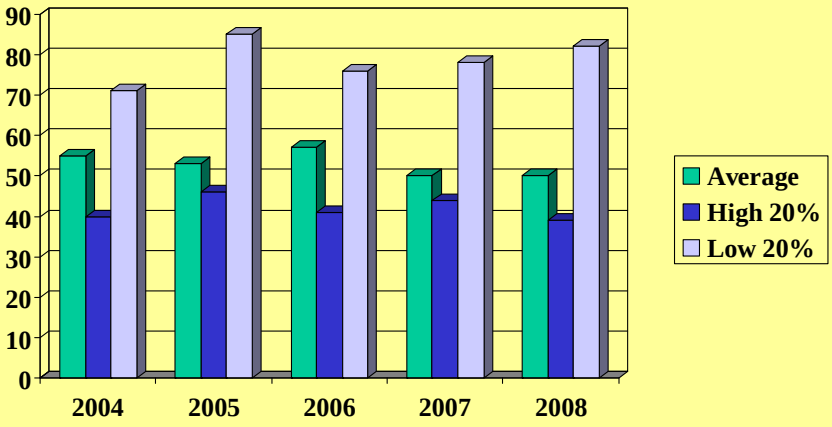
Family Living & Income Taxes
$ spent/year



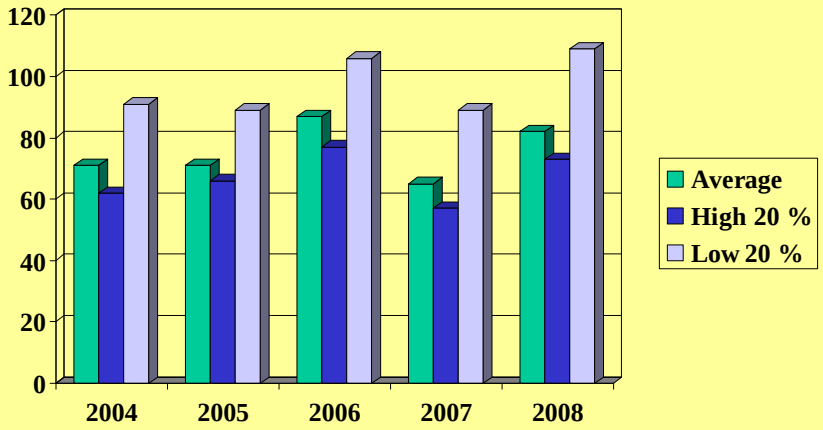
Change in Retained Earnings
$ of equity gain per yr (cost basis)



Farm Debt/Asset Ratio (%) end year

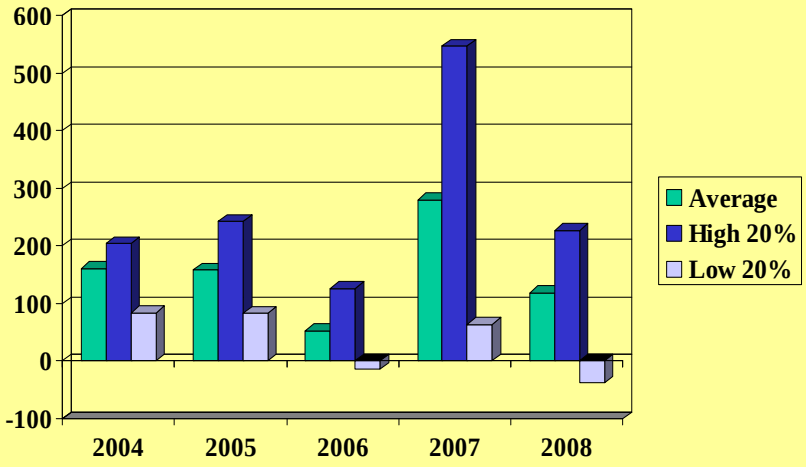


Expense (oper+ Int) as % of Accrual Income



Term Debt Coverage Ratio

a 100% ratio means “we can make all debt payments”

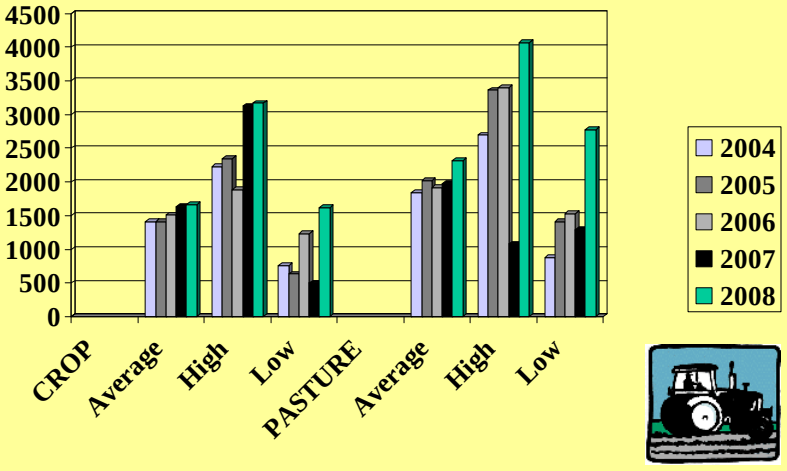


Cash Flow 2008

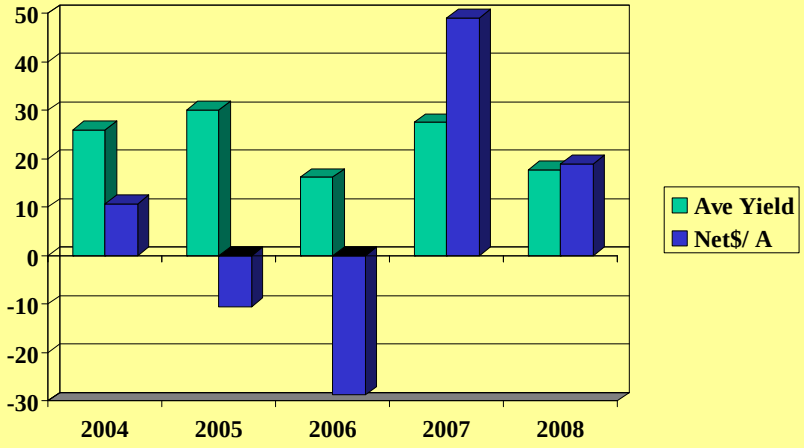
	Average	Low Profit	High Profit
Gross Farm Income	457323	385759	1057203
Non-Farm Income	32410	33376	27847
Cash Farm Expenses	348463	359452	755158
Family Living	48313	47328	72161
Income, SS Tax	4013	3231	4473
Net Capital Purchases	96291	92474	202668
Money Borrowed	288019	378448	443679
Principal Payments	272368	292852	484073

For more info – see www.finbin.umn.edu

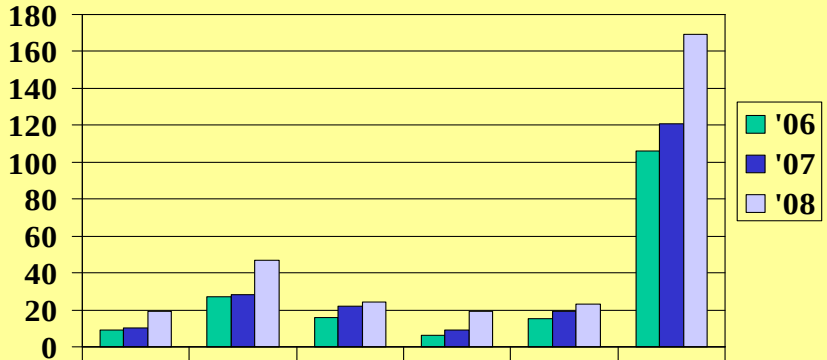
Crop and Pasture Acres



Spring Wheat Ave Yields and Net $ per Acre

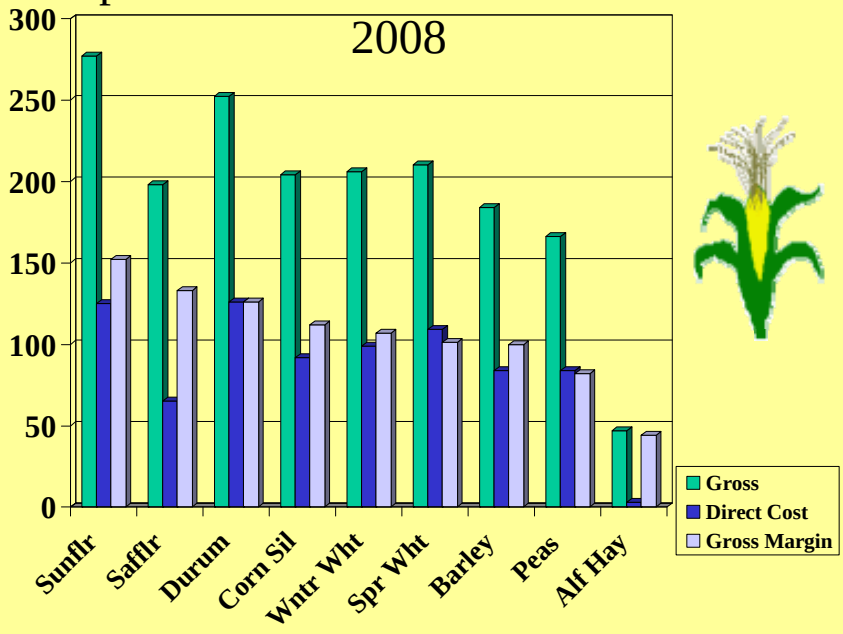


Costs /acre for Spring Wheat comparing 06,07,08



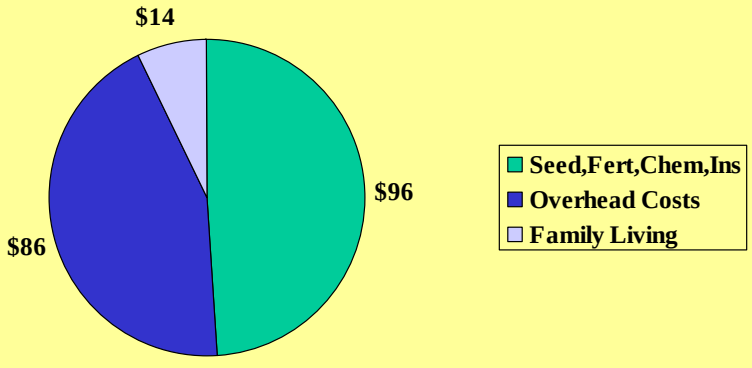
	Seed	Fert.	Chem.	Insur.	Fuel+ Repair	Total Direct
'06	9	27	16	6	15	106
'07	10	28	22	9	19	121
'08	19	47	24	19	23	169

Crop Contributions to Overheads Year 2008



All Crops combined in 2008 Ave Gross=$196

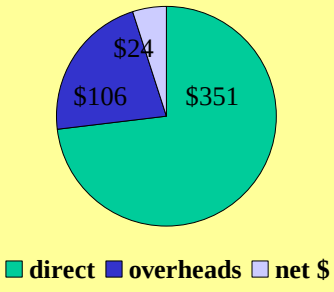
Cash rented crops, not hay, cost=$182/A



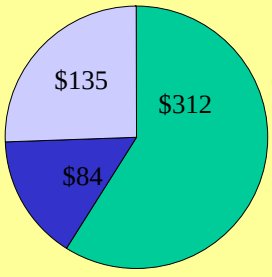
$ Net income /Beef Cow

Beef cow costs, returns 2008 per cow (fuel,repairs in OVHD)

average



high profit



How are low profit and high profit
Beef herds different ? For 2008 yr

	Low Profit	High Profit
Value of calf/cow	$470	$595
Depreciation per cow	$68	$64
Direct cost/cow	$408	$312
Overhead expense/cow	$141	$84
Net Income per Cow	-$146	+$135

Relocate Feeding Areas Affected by Flooding

Teresa Dvorak
Dickinson Research Extension Center

The flooding events in North Dakota have caused a number of concerns for livestock operations. Winter feeding areas along creeks may have been underwater and perhaps cattle were stranded. Ice jams tore through fences, reminding us that these feeding areas are too close to water. With the quick thaw, water was seen running through many feeding areas taking with it manure to deposit farther downstream.

“If your livestock feeding area was negatively affected by recent weather events, chances are that you may qualify for cost-sharing assistance to relocate and modify your current operation,” says Teresa Dvorak, North Dakota State University Extension Service livestock nutrient management specialist. “Most operations have two choices to look at. Your first choice may be relocating the existing facility. The second choice is building a containment system, along with dikes, to keep clean water out of the livestock area and contain water that has come in contact with manure.”

One source of cost-sharing assistance is the 319 program implemented by the Soil Conservation District, North Dakota Stockmen’s Association and North Dakota Department of Agriculture Livestock Pollution Prevention Program. Cost sharing may be available for fencing, watering systems, run-off ponds, clean-water diversions and other construction costs associated with the development of a containment system.

“If we can help these livestock producers with some of the cost they will incur to rebuild and provide a benefit to the environment, it’s a positive for everyone involved,” says Dennis Fewless, North Dakota Department of Health’s Division of Water Quality director.

The benefits of installing an agricultural waste system may include cleaner, drier lots, fence line feeding, heavy-use cement cattle aprons and environmental compliance. Floodwaters in your cattle feeding area means that you did have an impact on the environment because manure was washed away with the water. The installation of a containment system may mitigate future problems associated with flooding.

“This might be a good time for you to consider taking advantage of the cost-share programs to implement an agricultural waste system and get some help to cover those costs,” Dvorak says.

The process starts with a farm visit by any one of several agencies.

For more information about cost-sharing programs and environmental compliance issues, contact the North Dakota Department of Health at (701) 328-5210 or Dvorak at (701) 483-2348 or e-mail teresa.dvorak@ndsu.edu.

NDSU Agriculture Communication

Source: Teresa Dvorak, (701) 483-2348, teresa.dvorak@ndsu.edu

Editor: Rich Mattern, (701) 231-6136, richard.mattern@ndsu.edu

PROJECT NAME: Livestock Waste Education, Information and Assistance Program

PRINCIPLE INVESTIGATORS: Teresa Dvorak, Livestock Nutrient Management Specialist, DREC;
Chris Augustin, Nutrient Management Specialist, CREC

REPORTING PERIOD: Annual report - October 1, 2007 to September 1, 2008

PROJECT PERIOD: March 1997 through June 2010

Annual Progress Update

Task 1 Provide one-on-one consultations to producers to evaluate specific options available to the individual for waste storage, handling, and utilization.

- Met with a swine producer in Edmore, ND. He was having issues composting dead hogs. On-site education took place as he was consulted on proper composting practices of dead animals.
- Assisted a Carrington area small hog farmer, and helped him to determine the value of his hog manure that a neighbor agreed to utilize on his crops.
- Assisted a Turtle Lake, ND producer with assessing the value of a neighbor's manure that he planned to utilize.
- Made a follow up visit to an Arthur, ND producer's operation and discussed manure sampling/testing procedures, composting manure, and soil management.
- Held one on one discussions with 14 different Extension agents and one County SCD Coordinator. These discussions were designed to determine issues in the respective counties that need to be addressed. This has helped with programming for the upcoming year; as well improve networking between county agents and area specialist personnel.
- Met with a producer to determine his impact on the creek that runs through his property. He has less than 30 horses, but was planning to rent out his feedlot for a gentleman to background 200 head of steers.
- Made a presentation to the Grant County zoning board on mortality composting in regards to a swine operation that wanted to build there.
- Held a mini-tour in Adams County for a Bowman County producer. The Bowman County producer needed to build an ag waste system and wanted to gather ideas and options.
- Updated NMP for producers already permitted with the Health Department. The producers were undergoing an expansion and needed to revise their NMP.
- Held a day long training session with the Morton County NRCS office. Emphasis was placed on manure and soil test results and calculating the amount of manure needed.
- Worked with a producer to lay out a first draft of a pen system for his new ag waste system.

Task 2 Develop and deliver educational materials and programs that focus on the utilization of livestock waste nutrients for crop production.

- A website dedicated to nutrient management has been developed. NDSU Extension Service has recently developed a new website server and is still in preliminary formats. As a result, the website is not yet available to producers until the server is "online".

- An Extension bulletin publication that covers solid manure spreader calibration has been written and is nearly complete.
- An Extension bulletin that covers the composting of manure and dead animals is in the process of being written, but is still in the drafting stage.
- A press release that covered manure spreader calibration was issued through NDSU Ag Communications.
- A press release that covered manure fertilizers was issued through NDSU Ag Communications.
- The North Dakota County SCD boards were sent a press release that covered the cost and benefits of utilizing manure fertilizers versus conventional fertilizers.
- An interview by Al Gustin of KFYR radio was conducted. The topic discussed was the cost and benefits of utilizing manure fertilizers versus conventional fertilizers.
- A presentation was made to the Taylor Farm Institute titled "Fertilizer Value of Manure."
- A presentation was made at two sessions of the Dairy Cow College titled "A New Look at Manure Management."
- A presentation was made to a group of women in a program called Annie's Project. The women were educated on nutrient cycling through their farm including nutrition, manure analysis and crop needs and application.
- A presentation was made to the Dairy Production Class at NDSU title "Nutrient Management." Hands-on examples of calculating nutrient needs and manure produced were used.

Task 3 Hold meetings, workshops, and tours to educate producers and those who advise and work with producers about livestock waste management to prevent impacts on water quality.

- A presentation was given to the 3rd Graders of Carrington Elementary School. The presentation dealt with compost and the scientific method was covered by students planting flowers and fertilizing the flowers with compost, conventional fertilizer, and no fertilizer.
- Presented the basics of nutrient management to students of Northwest College of Powell, WY at the Carrington Research Extension Center.
- Assistant coach for the Carrington High School FFA soils judging team. The Carrington team won the state competition and every individual category at the competition.
- Gave a presentation on composting manure and animal mortalities at the Carrington Research Extension Center for the North Dakota Stockman's Association Feedlot Tour. There was also a compost turner demonstration.
- Gave a presentation regarding the cost and benefits of using manure fertilizers versus conventional fertilizers and determining the value of manure fertilizers at the Carrington Research Extension Center Field Days.
- A presentation was given to the North Dakota State College of Science agriculture class regarding cost and benefits of manure fertilizer over conventional fertilizers. A soil pit talk that covered soil forming factors and soil management was also given. This event occurred at the Carrington Research Extension Center.
- At the invite of the Sargent County SCD a composting manure presentation was given at a manure composting demonstration.
- Gave a presentation at the Bowman County Farm and Ranch Resource Night. The title of the presentation was "Finding Value in Ag Waste & The Importance of Manure Spreader Calibration".
- Held one-on-one discussions with 14 different Extension agents and one County SCD Coordinator. These discussions were designed to determine issues in the respective counties that need to be addressed. This has helped with programming for the upcoming year; as well improve networking between county agents and area specialist personnel.

- Held a tour for the Morton County Marketing Club to discuss the benefits of manure composting and the components of ag waste systems.
- A presentation was made at the Bowman Beef Day and the Killdeer Beef Day on manure as a fertilizer.
- A presentation was made at the Mandan Horse Day meeting titled "Composting Horse Manure." The meeting was focused to the small horse owners. This was an excellent opportunity to speak on proper manure handling procedures and environmental concerns with a group of non-ag people.
- Sat on a panel at the Farm Bureau Young Farmers and Ranchers conference to discuss ag waste issues and rules.
- A CAFO training was held at the Carrington Research Extension Center for large AFO in the state. Topics included finding value in manure and animal mortality procedures.
- A presentation was given at the annual Watershed Conference on the results of the Ag waste survey. This was to give those people that work with producers an idea of how well the nutrient management team in ND is doing.
- Participated in a drought training conference for county ag agents to discuss feeding options during a time of short pasture and hay without impacting the environment.

Task 4 New educational materials will be developed and/or assembled which focus on the location, design and management of innovative livestock facilities, focusing on manure management to prevent impacts on water quality.

- A website dedicated to nutrient management has been developed. NDSU Extension Service has recently developed a new website server and is still in preliminary formats. As a result, the website is not yet available to producers until the server is "online".
- Held one on one discussions with 14 different Extension agents and one County SCD Coordinator. These discussions were designed to determine issues in the respective counties that need to be addressed. This has helped with programming for the upcoming year; as well improve networking between county agents and area specialist personnel.
- "A Survey of Recently Installed Ag Waste Systems" was developed to determine future training needs in the nutrient management arena in ND. Producers that have implemented an ag waste system in the previous 3 years were surveyed. This survey will be given annually to producers with new systems.

Task 5 Identify cooperating farmers or ranchers who are willing to volunteer their operation as a site for intensive water quality monitoring. Two farms will be identified for monitoring small and medium AFO runoff and one farm will be identified to monitor tile drainage water quality impacts. Install equipment at the sites to determine edge of feedlot runoff impacts as well as tile drainage impacts.

- Three farms have been identified and agreements signed to participate in the program.
- Full scale automated water sampling equipment has been installed at 2 farms to monitor edge of feedlot and down landscape drainage. There are three gaging stations at each of these two farms.
- Equipment is being installed at a 3rd farm to monitor tile and surface drainage. There will be two gaging stations monitoring tile outlet drainage and one station monitoring surface drainage.

Task 6 *Collect runoff data from Discovery Farms to determine water quality impacts. Work with producers to identify BMP's to address any impacts. Continue to monitor water quality to determine success of adopted BMP.*

- Raw data from the edge of feedlot runoff has been collected at only one site due to lack of rainfall at the other site.
- The runoff samples are being analyzed for common water quality constituents

Managing Winter Feeding Areas

Teresa Dvorak
Dickinson Research Extension Center

Winter feeding areas are a recipe for mud. They are high traffic areas in which the hooves of the cattle loosen the topsoil and compact the soil below. When water and manure is added to this loose soil a mud hole forms. "An improperly managed winter feeding area is easy to find on many operations and a terrible place to feed cattle," says Teresa Dvorak, Livestock Nutrient Management Specialist with the NDSU Dickinson Research Extension Center. "This is the area that gets muddy first and stays muddy the longest."

If cattle are confined in this area for more than 45 days each year and the area does not support vegetative growth the North Dakota Department of Health (NDDoH) considers this an animal feeding operation (AFO). Therefore, the operation is bound by the NDDoH AFO rules. Dvorak says producers should consider alternative management of this feeding area to avoid the operation from falling under these rules. Properly managed winter feeding areas can be an asset to your operation if overused muddy areas are avoided.

Winter feeding of cattle on cropland adjacent to the old feeding area is becoming a more common practice in North Dakota. This practice allows the cattle to move into the old feeding area for water and occasional shelter, but the feeding takes place out on the cropland. The cropland is often referred to as a sacrifice area, but does not need to become this if properly managed. By reducing the intensity of the cattle in one area producers can mitigate problems.

When designing or selecting a winter feeding area several items must be considered. Cropland adjacent to the current feeding area allows the producer to move the cattle off the cropland when excessively wet. The field should have easy access to hay yards and a water source. Allow adequate area per animal to avoid overcrowding. The specific feeding area within the field should be moved frequently to avoid three main issues. The first problem that occurs is a heavy build up of wasted feed. This can cause problems for some no-till drills in the spring and can delay plant emergence. The second problem is the concentration of manure deposited in one area. The manure can be more evenly distributed across the field if the feeding area is moved around the cropland. The final problem that may be observed is compaction. This can lead to muddy areas again and issues with spring planting.

Winter feeding area management must also consider the remaining congregation area and proximity to surface water. Permanent congregation areas (water access) will lead to a concentration of manure. Accumulated manure must be removed in a timely manner and properly applied to cropland. This non-vegetated area is more prone to runoff and erosion. Therefore, a grassed buffer area must exist between this area and surface water or a draw/drainageway running into surface water.

Properly managed winter feeding areas contain the nutrients and pollutants produced on the operation, reduce soil erosion, keep clean water clean and help improve the environment. For more information on the proper management of winter feeding areas contact Teresa Dvorak at (701) 483-2348 ext. 108 or Teresa.dvorak@ndsu.edu.