Recommendations From Recent Research With Durum

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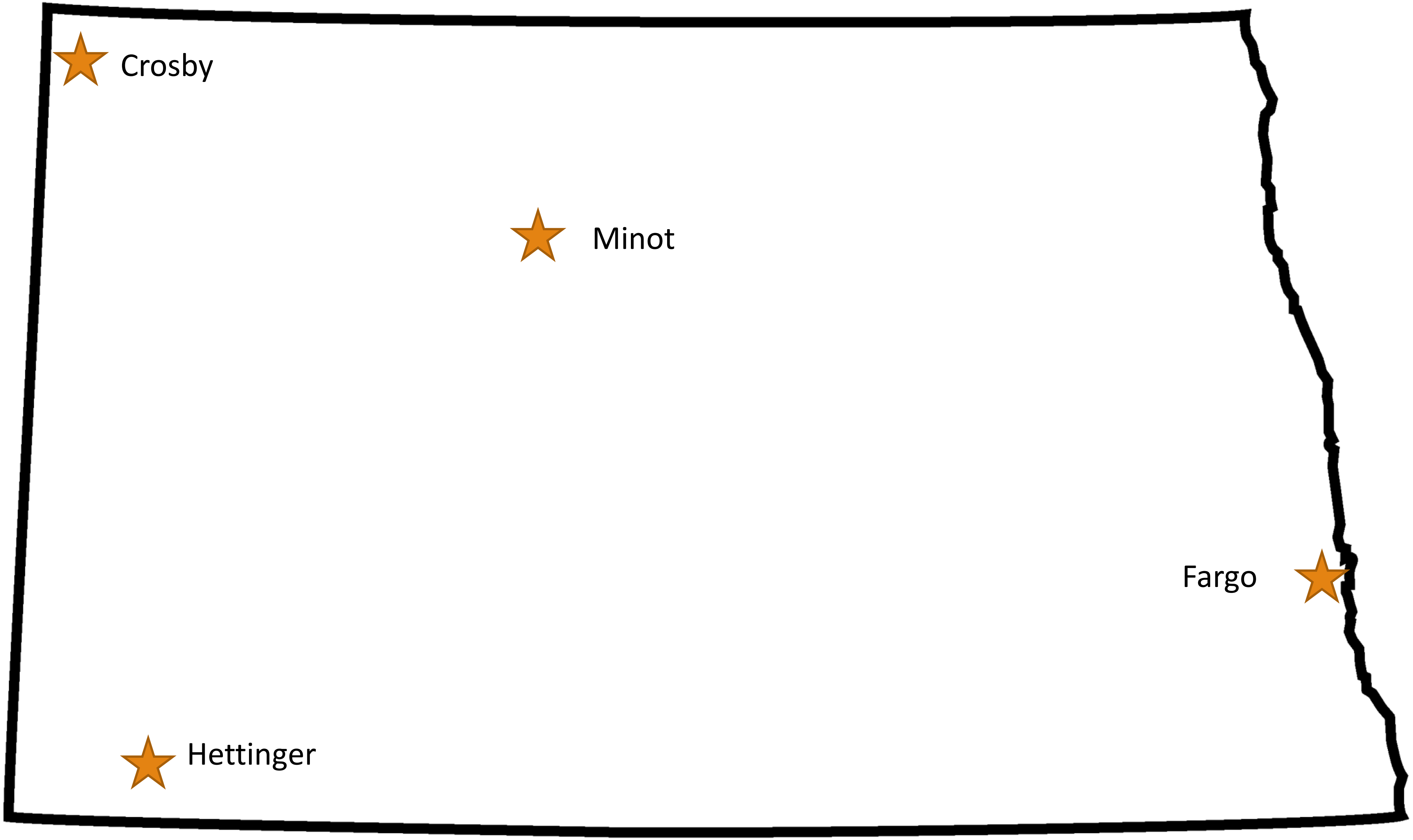
Topics for Discussion

Planting Date Trials

- Introduction
- Materials and Methods
  - Data collection
  - Statistical analysis
- Results
- Conclusions

Cadmium Management Trials

- Introduction
- Source trial
  - Materials and methods
  - Results
- Timing trial
  - Materials and methods
  - Results
- Conclusions


Crosby
Minot
Fargo
Hettinger

Planting date, seeding rate, and cultivar impact agronomic traits and pasta quality of durum wheat

Introduction

Durum wheat commonly grown in ND

Durum wheat is subject to price discounts

Quality requirements differ depending on end-user

On-farm decisions can impact quality

Many durum wheat production studies conducted in past

Materials and Methods

2014 and 2015

Minot and Hettinger, ND

RCB with split plot arrangement

Replicated four times

Whole plot was planting date

Sub plots in a two-way factorial

- Cultivar x seeding rate
- Carpio, Divide, and Joppa
- 900 K, 1.2 million, and 1.5 million pls/A

Data Collection

Plant height

Yield (13% moisture)

Test weight (AACC method 55-10.01)

Protein content

1000 KWT (Shuey et al., 1960)

Vitreous kernels

Falling number (AACC method 56-81.03)

Yellow pigment (AACC method 14-50.01)

Polyphenol oxidase (AACC method 22-85.01)

Semolina (AACC method 26-50.01)

Semolina protein content (AACC method 26-50.01)

Gluten index (AACC method 38-12.02)

Wet gluten (AACC method 38-12.02)

Ash content (AACC method 08-01.01)

AACC International, 2000

Statistical Analyses

PROC GLM (SAS Institute, 2010)

Planting date, seeding rate, and cultivar were considered fixed effects

Replications and years were considered random effects

F-protected LSDs (Carmer et al., 1989)

Pooled correlation values determined for agronomic and quality traits

Planting and harvest date of durum wheat at Hettinger and Minot, ND in 2014 and 2015.

Year/Location	Planting Date	Harvest Date	Year/Location	Planting Date	Harvest Date
2014			*2015*		
Hettinger	May 2	August 28	Hettinger	April 14	August 17
	May 15	September 4		April 29	August 17
	May 27	September 8		May 13	August 20
	June 9	October 14		May 27	September 4
Minot	May 14	September 9	Minot	April 29	August 28
	May 27	September 16		May 11	August 28
	June 4	October 9		May 26	September 12
	June 17	October 24		June 9	September 12

Results

Impact of main effects on planting date, cultivar, and seeding rate on agronomic traits associated with durum wheat in Minot and Hettinger, ND in 2014 and 2015.

	Ht	TW	Yield	Pro	Kwt	FN	Large	Vit
Planting	cm	lb bu	bu A	%	$g\ 1000^{-1}$	s	%	%
1	84	61.6	65.1	13.7	44.1	460	70.4	67.8
2	90	61.4	60.2	13.5	44.1	440	68.6	73.8
3	88	59.9	52.6	13.6	40.1	417	59.1	65.4
4	83	58.1	42.5	14.8	42.6	385	63.5	71.5
LSD[z]	NS	NS	1.1	NS	NS	NS	NS	NS
Cultivar								
Carpio	86	60.4	55.8	13.7	43.8	437	72.8	66.9
Divide	87	60.0	53.3	14.3	42.3	444	65.0	68.9
Joppa	86	60.3	53.1	13.7	42.0	369	58.4	73.1
LSD	NS	0.2	NS	1	1.0	NS	4.6	5.0
Seeding								
222	86	60.2	54.6	13.9	43.2	425	66.7	69.7
297	86	60.3	55.8	13.9	42.6	426	65.3	70.2
371	86	60.2	54.9	13.9	42.3	426	64.2	69.0
LSD	NS	NS	NS	NS	0.9	NS	2.2	NS
CV	4.9	1.5	8.6	0.4	4.4	7.3	7.1	9.4

[a] Ht = plant height, TW = test weight, Pro = protein, Kwt = weight of 1000 seeds, FN = falling number, Large = kernels remaining on a 2.92 mm sieve, Vit = vitreous kernel, NS= not significant at *p*=0.05 level

[z] LSD was calculated to compare all levels of planting date according to Fisher's Protected LSD ($p \le 0.05$); CV = coefficient of variation

Effect of cultivar on quality traits associated with durum wheat grown in Minot and Hettinger, ND in 2014 and 2015.

Environment/ Cultivar	Pig	PPO	Ash	Sem	Sem-p	GI	WG
			%	%	g kg-1	%	%
Minot 2014							
Carpio	9.3	0.40	1.5	51.7	13.1	95.5	32.6
Divide	7.8	0.07	1.6	50.6	13.2	82.5	35.0
Joppa	8.5	0.08	1.6	51.3	13.1	86.0	34.9
LSD[z]	0.2	0.02	NS	0.5	0.1	1.7	0.5
CV	4.4	26.2	5.6	2.5	1.7	4.7	3.6
Hettinger 2014							
Carpio	9.5	0.42	1.6	49.5	10.7	98.2	22.2
Divide	7.9	0.06	1.6	49.1	10.7	97.0	25.0
Joppa	8.5	0.08	1.6	50.4	10.4	95.2	26.4
LSD	0.1	0.01	NS	0.6	0.2	0.6	0.9
CV	3.0	18.6	4.8	3.1	3.6	1.4	9.1
Minot 2015							
Carpio	10.7	0.37	1.5	58.7	12.3	91.9	32.8
Divide	8.9	0.07	1.5	58.7	12.9	68.3	37.1
Joppa	10.4	0.08	1.6	59.2	14.6	80.6	34.3
LSD	0.2	0.03	NS	NS	NS	2.5	1.1
CV	4.0	42.8	4.3	2.5	71.7	7.7	7.7
Hettinger 2015							
Carpio	10.9	0.32	1.7	57.8	12.6	94.3	30.6
Divide	8.8	0.06	1.7	58.3	13.0	67.9	36.1
Joppa	11.3	0.05	1.7	57.3	12.3	87.9	32.3
LSD	0.1	0.01	NS	NS	0.1	2.0	0.9
CV	2.8	22.2	3.7	6.9	2.3	5.9	6.7

[a] Pig = pigment, PPO = polyphenol oxidase, Sem = semolina extracted, Sem-p = semolina extracted protein, GI = gluten index, and WG = wet gluten, NS= not significant at *p*=0.05 level

[z] LSD_1 was calculated to compare all levels of planting date according to Fisher's Protected LSD ($p \leq 0.05$);

Conclusions

Planting date and cultivar interactions impacted agronomic and quality traits

Cultivar performance similar to previous research

Yield trend Joppa > Carpio > Divide

Carpio best in high yielding environments

Carpio or Divide when planting delayed

Early planting best to maximize yield and test weight

No specific combination consistently resulted in hard amber durum (HAD) wheat

End-use characteristics specific to cultivar

Pooled correlation values did not identify unknown relationships

Effect of fertilizer source and timing of application on cadmium uptake of durum wheat

Introduction

Durum wheat can accumulate cadmium

International marketing concern

Currently, low Cd accumulating durum wheat cultivars not grown in ND

Uptake of Cd affected by soil properties, crop, cultivar, fertilizer,

- pH, salinity, Cl, CEC, OM, and N, P, and Zn

Genetic differences among durum wheat cultivars identified

Zn can compete with Cd in soil and plant

Soil factors measured prior to planting at Crosby, Hettinger, and Minot, ND in 2014 and 2015.

Location/Year	Depth	NO_3-N	P	K	pH	OM	Zn	S	Fe	Cl	Cd
	cm	kg ha^{-1}	mg kg^{-1}	mg kg^{-1}		%	mg kg^{-1}	kg ha^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}
Crosby											
2014	0-15	11	20	400	6.3	4.0	1.04	7	47	29	0.4
	15-30	8	4	336	7.2	3.0	0.30	3	26	42	
2015	0-15	14	16	645	7.1	4.0	1.20	24	27	6	0.8
	15-30	3	5	281	7.6	3.6	0.66	103	29	1	
Hettinger											
2014	0-15	105	23	400	6.1	3.3	0.89	3	71	6	1.3
	15-30	30	5	225	7.5	2.5	0.30	17	17	23	
2015	0-15	81	35	625	6.4	3.8	2.17	11	64	11	0.7
	15-30	34	8	200	7.0	2.6	0.37	20	24	14	
Minot											
2014	0-15	49	14	385	5.0	3.9	1.14	44	83	42	0.4
	15-30	35	3	192	7.4	2.9	0.31	156	25	77	
2015	0-15	270	23	447	6.3	3.8	1.46	255	61	16	0.5
	15-30	130	8	220	7.3	2.5	0.54	355	20	9	

Data Collection

Plant height

Grain yield

Test weight

Protein content

DON

Cd, Fe and Zn determinations of harvested grain (Thavaraja et al., 2015)

Source Trial

Crosby, Hettinger, and Minot

2014 and 2015

Carpio, Joppa, and AC Strongfield

RCB with split-plot arrangement

- Whole plot fertilizer source
- Subplot cultivar

PROC GLM procedure of SAS (SAS Institute, 2010)

F-protected LSDs (Carmer et al., 1989)

PROC STEPWISE procedure of SAS

Type, rate, and placement of fertilizer treatments for the source trial conducted in Crosby, Hettinger, and Minot, ND in 2014 and 2015.

Treatment	Fertilizer	Rate	Placement
1	KCl	20 lb/A	With seed at planting
2	KCl	20 lb/A	With seed at planting
	Zn-EDTA	1 gal/A	Feekes 10 growth stage
3	Zn-EDTA	1 gal/A	Feekes 10 growth stage
4	$ZnSO_4$	30 lb/A	Broadcast at seeding
5	$ZnSO_4$	30 lb/A	Broadcast at seeding
	KCl	20 lb/A	With seed at planting
6	Untreated	n/a	n/a

Combined average cultivar means for the source trial conducted in Hettinger, ND in 2014 and Crosby, Minot, and Hettinger, ND in 2015.

Treatment	TW	Yield	Protein	Cd	Fe	Zn	Cd	Fe	Zn
	lb bu	bu A	%	mg g^{-1}	mg g^{-1}	mg g^{-1}	mg ha^{-1}	mg ha^{-1}	mg ha^{-1}
Carpio	60.2	57.9	13.2	0.150	31.1	28.8	603	120425	105729
Joppa	59.7	62.0	12.8	0.126	29.6	26.7	542	121941	107458
AC Strongfield	59.3	57.2	14.5	0.094	35.3	28.7	378	133534	105504
LSD (0.05)	NS	NS	1.0	0.038	3.4	1.5	51	NS	NS
CV	2.1	7.0	5.3	22.1	11.6	8.8	25.3	13.9	13.7

TW= test weight

Combined average treatment means for the source trial conducted in Hettinger, ND in 2014 and Crosby, Minot and Hettinger, ND in 2015.

Treatment	TW	Yield	Protein	Cd	Fe	Zn	Cd	Fe	Zn
	lb bu	bu A	%	mg g^{-1}	mg g^{-1}	mg g^{-1}	mg ha^{-1}	mg ha^{-1}	mg ha^{-1}
KCl	59.4	61.6	14.0	0.151	33.1	27.0	621	134412	106961
KCl + Zn EDTA	59.4	63.5	14.4	0.137	33.5	29.7	599	140991	125664
Zn EDTA	59.5	57.2	13.2	0.097	31.5	29.1	394	120563	108187
$ZnSO_4$	59.4	57.3	13.3	0.111	31.2	27.8	459	119583	103246
$ZnSO_4$ + KCl	60.2	57.2	12.9	0.123	32.2	29.3	467	121174	106638
Untreated	59.9	57.2	13.4	0.121	30.5	25.4	507	115077	86688
LSD (0.05)	NS	NS	0.8	NS	NS	NS	73	NS	NS
CV	2.1	7.0	5.3	22.1	11.6	8.8	25.3	13.9	13.7

TW= test weight

Conclusions

Foliar application of Zn-EDTA resulted in lowest grain Cd

22% decrease in grain Cd compared to untreated

No relationship between yield and grain Cd

AC Strongfield had lowest grain Cd, highest protein and Fe

Soil pH and soil Cl influenced grain Cd

KCl placed with seed had highest grain Cd

Timing Trial

Crosby and Minot, ND

2014 and 2015

Carpio, Joppa, and AC Strongfield

RCB with factorial arrangement of cultivars x timing

PROC GLM procedure of SAS (SAS Institute, 2010)

F-protected LSDs (Carmer et al., 1989)

PROC CORR procedure of SAS

Type, rate, and growth stage of foliar-applied treatments for the timing trial conducted n Crosby and Minot, ND in 2014 and 2015.

Treatment	Application	Rate	Feekes Growth Stage
1	Zn-EDTA	1 gal/A	4 (Tillering)
2	Zn-EDTA	1 gal/A	4
	Headline	8 oz/A	
3	Headline	8 oz/A	4
4	Zn-EDTA	1 gal/A	10 (Boot)
5	Zn-EDTA	1 gal/A	10
	Prosaro	8 oz/A	
6	Prosaro	8 oz/A	10
7	Zn-EDTA	1 gal/A	11.1 (Grain ripening)
8	Zn-EDTA	1 gal/A	10.54 (Late flowering)
9	Zn-EDTA	1 gal/A	10.54
	UAN[†]	10 gal/A	
10	UAN	10 gal/A	10.54
11	Untreated	n/a	n/a

[†]Urea-ammonium nitrate

Combined harvested grain means for treatments across all cultivars and locations for the timing trial conducted in Crosby and Minot, ND in 2014 and 2015.

Treatment	Feekes	TW[†]	Yield	Protein	Cd	Fe	Zn	Cd	Fe	Zn
		lb bu	bu A	%	mg g^{-1}	mg g^{-1}	mg g^{-1}	mg ha^{-1}	mg ha^{-1}	mg ha^{-1}
Zn-EDTA	4	59.0	40.6	13.4	0.092	31.9	33.0	261	86058	88381
Zn-EDTA + py	4	58.9	41.9	13.5	0.090	32.8	32.7	264	92481	90392
Py	4	57.8	41.5	13.6	0.104	31.9	33.6	304	88689	90680
Zn-EDTA	10	58.2	39.3	13.5	0.083	33.2	37.9	218	86627	97942
Zn-EDTA + py + teb	10	58.7	42.2	13.5	0.082	34.4	36.9	233	97904	102543
Py+ teb	10	58.5	41.0	13.5	0.103	31.7	34.2	291	86893	90466
Zn-EDTA	11.1	58.2	41.0	13.6	0.110	34.0	38.5	320	93076	105323
Zn-EDTA	10.54	58.2	42.2	13.6	0.091	33.8	37.0	270	95495	104679
Zn-EDTA + UAN	10.54	58.5	41.4	14.0	0.085	34.3	39.0	242	92492	107553
UAN	10.54	58.6	40.8	14.3	0.106	32.3	34.8	304	87621	93374
Untreated control	n/a	58.2	40.2	13.4	0.101	31.5	32.3	281	83558	84202
LSD (0.05)		NS	NS	0.4	0.016	2.1	3.0	51	6424	9184
CV		2.6	15.5	5.9	45.9	14.7	18.4	57.3	21.9	23.7

[†] TW = test weight, Py = Pyraclostrobin, Teb = tebuconazole , UAN=Urea-ammonium nitrate

Conclusions

Foliar treatments containing foliar-applied Zn-EDTA had lower grain Cd

Zn-EDTA treatments had no antagonistic or synergistic effects

Possible to increase Fe, Zn, and protein will decreasing grain Cd

Application of foliar Zn-EDTA at Feekes 4 or 11.1 did not lower grain Cd

Application of foliar Zn-EDTA at Feekes 10 growth stage with fungicide or at Feekes 10.54 with UAN resulted in lowest grain Cd and highest Fe, Zn and/or protein