# Organic Crop Cultivar Selection for Great Plains States in the North Central Region

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## RESEARCH SUMMARY

There is a need to identify crop cultivars that are adapted to environments managed organically. Our objective is to identify superior performing cover crop (hairy vetch and winter pea), field pea, and potato cultivars in certified organic environments in central and western North Dakota. Ten to fifteen cover crop, field pea, and potato cultivars were seeded at Carrington and Dickinson during the 2010-11 growing season. Cultivars that are adapted to environments managed organically were identified.

## INTRODUCTION

North Dakota is second behind only California in area dedicated to organic crop production nationally, and contains twice the organic crop acreage of all other states in the NCR except Minnesota, Wisconsin, and Kansas. In addition to wheat, North Dakota is a leading organic producer (domestic rank in parentheses) of dry pea/lentil (2), potato (6), and 12 other forage, grain, and seed crops (1-4). North Dakota organic farmers are major green manure/cover crop growers (4), and they contribute to domestic organic corn (14) and soybean (12) supplies even though the state is outside of the U.S. Corn Belt. The rank and diversity of crops grown is a testament to the importance of North Dakota to the U.S. organic farming sector.

The availability of crop cultivars adapted to local conditions is considered essential for successful crop production, but there has been almost no attempt to select crop varieties under organic conditions in North Dakota or other Great Plains states. As a result, organic Great Plains farmers either grow crop varieties developed and selected under conventional management (i.e., using synthetic fertilizers and pesticides), or under organic management but in different agro-ecoregions. In some instances, innovative cropping practices used elsewhere, such as no-till organic farming, cannot be adopted on North Dakota farms because the crop varieties available are not suited to these practices under the environmental conditions that exist in the state.
Crop variety selection in certified organic fields in North Dakota and other Great Plains states will provide farmers with varieties that are adapted to organic environments and emerging cropping practices, particularly those directed at improving soil health and quality. On-farm productivity and profitability will increase as the varieties presently grown are replaced with newer varieties which will be selected under organic conditions for improved growth traits.

Crop variety trials conducted under certified organic management are valued highly and encouraged by organic farmers and their proponents (Sooby et al., 2007). Small-grain variety comparisons have occurred in certified organic fields in North Dakota, with primary emphasis on wheat (Carr et al., 2006). Recently, organic variety testing conducted by scientists at North Dakota State University was expanded to include field pea, potato, and vegetable crops in small trials at research facilities and on farms near Carrington and Dickinson (unpublished data). However, inadequate funding continues to limit the organic variety testing effort in the state. Research indicates that crop variety selection should occur in certified organic fields if the goal is to release varieties adapted to organic farming conditions (Mason et al., 2007; Murphy et al., 2007). Przystalski et al. (2008) analyzed small-grain variety trials in Europe and found that the ranking of top-performing varieties under conventional management generally did not match the ranking of those same varieties under organic management. In addition, growth trait data typically were not collected in the field studies, even though Sooby et al. (2007) pointed out that quantifying seedling vigor, canopy development, and other growth traits may help explain the superiority of adapted varieties in organic environments. Attempts to correlate growth trait data with agronomic performance statistically could help elucidate plant characteristics that confer advantages to some varieties over others under organic conditions. The objective of this study is to identify field pea, potato, and cover crop (hairy vetch and winter pea) cultivars that are adapted to dryland growing conditions in central and western North Dakota.

## MATERIALS AND METHODS

Between 10 and 15 field pea, potato, and cover crop (i.e., winter pea and hairy vetch) cultivars and advanced experimentals, depending on availability, will be established in plots in certified organic fields at NDSU research facilities in south central (Carrington) and southwestern (Dickinson) North Dakota during 2010, 2011, and 2012. Plots will be arranged in an randomized complete block designs with cultivar treatments replicated four times in each of the three (i.e., field pea, potato, and cover crop) cultivar studies at each site. Minimum plot dimensions will be 5 by 15 ft. A subset of the cultivar treatments at the research sites will be established in strip plots that will be seeded in certified organic fields on two commercial farms in eastern, central, and western North Dakota in both 2011 and 2012 (six farms in total each year). The strip plots will be arranged in a randomized complete block with variety treatments replicated twice. Cultivar selection for the on-farm trials will be based on performance at the research sites the previous year, along with seed availability. Crops and cultivars will be evaluated for field performance as determined by selected growth traits along with seed yield and quality.

Crop cultivar selection impacts on crop-weed competition will be assessed on a subset of five or six field pea cultivars at the research site in southwestern North Dakota during 2011 and 2012. Peas cultivars will be strategically chosen to allow comparisons of traits that are expected to play critical roles in pea-weed competition (e.g., normal leaf type with lodging vs. normal leaf type with upright habit). Pea cultivars will be planted in a randomized complete block design, with cultivars as the blocking factor. Each block also will include a crop-free plot (weedy check) to assess maximum potential weed growth. No weed control will be applied and weeds that naturally emerge will comprise the weed populations in each plot. Individual plots dimensions will be 12 by 15 ft. At critical growth stages (2-3 nodes, 6-8 nodes, and onset of flowering), measurements will be made to determine crop competitive ability against weeds by comparing visual assessments of weed cover within pea plots to weed cover within the crop-free weedy check plots.

Light interception will be measured in each plot using a PAR/LAI ceptometer at these same times. After measuring light interception, a 0.25 square meter of each plot will be destructively harvested. Weed biomass will be separated from pea biomass and each biomass fraction will be dried to a constant weight.
Data collected from the crop variety studies in all years will be analyzed using a mixed model procedure from SAS. Multi-model inference will be conducted to determine what, if any, growth traits contribute to the model for crop yield. Stability of varieties for grain yield will be determined using the Cultivar Superiority (Performance) Measure test.

**RESULTS AND DISCUSSION**

2011 Field Pea Cultivar Trial

Fifteen field pea cultivars (Agassiz, CDC Golden, CDC Meadow, CDC Striker, Cooper, Cruiser, DS Admiral, Eclipse, Majoret, Medora, Miami, NDP080102, NDP080106, PS07100091, and Spider) were seeded on 04 May at Carrington, and on 18 May at Dickinson, North Dakota in randomized and replicated, small-plot field experiments. Seeding was delayed at both locations because of cool wet conditions during the early spring period, and also at Dickinson because of volunteering buckwheat from the crop planted in 2010. Volunteering buckwheat remained a problem even after pre-plant tillage following spring warm-up. Green foxtail (*Setaria viridis* (L.) Beauv.) became established and competed with pea plants for growth resources as the growing season progressed at Dickinson. Competition from volunteering crops and weeds for growth resources was not as severe at Carrington as at Dickinson, but severe thunderstorms with heavy rain, along with a hail storm on 24 July, significantly damaged pea plots and likely caused significant yield loss.

Average seed yield at Carrington was 33 bu/acre across the 11 cultivars for which yield data were determined, with Spider producing equal or greater amounts of seed than other cultivar treatments (Table 2). Spider also was among the highest yielding cultivars at Dickinson, although seed yield of Spider was only 13.6 bu/acre at this location (Table 3). The low seed yield for cultivars at Dickinson reflected the large population of volunteering buckwheat which, when combined with weeds, appeared to prevent vigorous pea growth. Pea plant stands averaged only 4 plants/ft$^2$ across pea cultivars by 09 June, with virtually no plants in plots of cultivars Miami, NDP080106, and PS07100091. An additional three cultivars (Cooper, Medora, and NDP080102) produced only a handle of seed in plots (< 1 bu/acre). Agassiz, CDC Golden, DS Admiral, Eclipse, Majoret, Medora, and Spider produced equal or greater amounts of seed than other cultivars at Dickinson and demonstrated they are the most productive for grain yield under weedy conditions. There was no obvious relationship between plant stand or plant height and seed yield among pea cultivars at Dickinson. Similarly, there did not appear to be a strong relationship between seedling vigor or plant height and seed yield at Carrington (Table 2). However, plant stands of cultivars with < 6 plants/ft$^2$ tended to have lower seed yields than plant stands of cultivars with > 6 plants/ft$^2$, with a few exceptions.

2011 Potato Cultivar Trial

Sixteen potato cultivars were seeded on 10 May at Carrington and 15 cultivars on 18 May at Dickinson in replicated and randomized field experiments. Cultivars included two russets, three whites, four yellows, five reds, one specialty and one fingerling (Tables 4 and 5). Excellent plant stands were established at Carrington, with at least 75% emergence of plants from seeded tubers by mid-June (Table 4). In contrast, heavy rainfall on 20 May (1.84 inches) and 21 May (0.83) resulted in flooding at Dickinson with some plots remaining underwater for >48 hr. Final plant stands sometimes represented ≤ 50% of the number of tubers planted in a plot (Table 5). Average potato yield was relatively low (average=116 cwt./acre) at Dickinson, compared with 195 cwt./acre at Carrington (Table 4). Kennebec, Missaukee, Jacqueline Lee, and Red Cloud were among the highest yielding cultivars at Carrington. Burbank, Butte, Missaukee, Red Pontiac, and Russian Banana were among the highest yielding cultivars at Dickinson.

Plant disease impacted potato plants at Carrington as the season progressed, drying down plants and causing premature death. The disease was undiagnosed but may have been the result of a hail storm that occurred on 24 July. This storm, coupled with high winds accompanying several thunderstorms, lodged potato vines which remained horizontal for the remainder of the growing season.

Differences in the amount of photosynthetically-active radiation (PAR) intercepted by the potato canopy of six cultivars (Burbank, Butte, Caribe, Kennebec, Red Norland, and Russian Banana) were compared using a PAR/LAI ceptometer (AccuPAR model LP-80, Decagon Devices) at Dickinson. Greatest amounts of PAR were intercepted by the canopy in Russian Banana plots (Figure 1), which reflected the superior plant stand establishment of that cultivar compared with other cultivars included in the field experiment (Table 5). However, cultivar selection, and not just plant stand, influenced PAR interception by the canopy that developed. Plant canopies of Burbank and Butte intercepted more PAR than did those of Caribe and Red Norland by 18 August (Figure 2), even though differences in final plant stand were not detected among those four cultivars (Table 5). These data indicate that potato cultivar selection can be important in determining the amount of PAR striking the soil surface and presumably weed seedlings growing underneath the potato canopy, particularly in instances where the plant stand which develops is less than the targeted plant stand.

Weed density was determined in plots prior to cultivating at Dickinson. No difference in weed density occurred across potato cultivars (data not provided). Similarly, differences in volumetric soil-water content generally were not detected across five potato cultivars (Burbank, Butte, Caribe, Kennebec, and Russian Banana) in plots where soil-water content was determined on roughly weekly intervals, beginning on 08 July (Figure 2). There was no evidence of soil-water uptake by the five potato cultivars at or below a 12-inch soil depth based on volumetric soil-water content. In contrast, soil-water content at a 4-inch depth was typically below 15%. Water use by potato typically is restricted to the first 2-ft of soil in most instances, and data collected at Dickinson in 2011 demonstrate that in some environments water extraction may be limited to the top foot of soil.

<u>Field Pea/Weed Competition Study</u>
Due to difficult spring weather conditions and differences among pea cultivars in seed germination rate and seedling vigor, pea plant density varied substantially among pea cultivars. At the first destructive harvest (2-3 nodes), weed biomass and weed LAI did not differ among pea cultivars or the weedy check. Pea LAI and pea biomass did not

differ among pea cultivars. At the second destructive harvest (6-8 nodes), weed LAI did not differ among pea cultivars or the weedy check but weed biomass for Cooper and NDP080102 was less than weed biomass for the weedy check. Pea LAI and pea biomass did not differ among cultivars either on a per-quadrat or per-plant basis. At the third and final destructive harvest, weed LAI again did not differ among pea cultivars or the weedy check, but weed biomass for Cooper and NDP080102 was less than the weedy check and weed biomass for Cooper was greater than weed biomass for PS07100091. Per-plant pea LAI and per-plant pea biomass did not differ among pea cultivars, but per-plant yield (on a quadrat basis) was greater for PS07100091 than for Cooper. Cooper also had fewer pods per plant compared to PS07100091 and NDP080106. However, plot level yield per-plant did not differ among cultivars. Plot level yield unadjusted for pea plant density was greater for NDP080102 compared to PS07100091.

Pea cultivars with greater competitive ability should be associated with reduced weed LAI or weed biomass when compared to the weedy check. At the third harvest, weed biomass in Cooper and NDP080102 (both semi-leafless cultivars) plots was reduced compared to the weedy check, but this is probably due to pea plant density differences rather than differences in competitive ability. Even though PS07100091 (a normal leaved cultivar) plots contained the same weed biomass as the weedy check at the third harvest, the per plant yield of PS07100091 was greater than that of Cooper, which was exposed to less weed biomass. This might indicate that the normal-leaved cultivars do not reduce weed biomass via competition but may potentially maintain yield in spite of increased weed pressure. Clearer results will be obtained once this research is repeated in 2012. Every effort will be made to standardize the pea densities across the plots during the upcoming field trial. Controlled greenhouse experiments are also currently underway to assess the competitive ability of two pea cultivars against common lambsquarters, one of the most common weed species in the field study. The results of the greenhouse study will support the results of the field research.

On Farm Trials

Wet spring conditions prevented the seeding of field pea by farmers who planned on comparing cultivars in 2011. Two farmers planted potato cultivars but still are finishing up field work and have been unable to provide summaries of their observations in time for inclusion in this progress report. One farmer has seeded three vetch cultivars and another farmer has seeded three winter pea cultivars in 2011. All farmers in 2011 along with those involved in on-farm trials in 2012 will provide summaries to the project coordinator in 2012.

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Table 1. Hairy vetch and winter pea cover crop plant stand in fall, 2010 (fall), and spring, 2011 (spring) at Carrington and Dickinson, North Dakota.[1]

| | | Carrington | Dickinson | |
|---|---|---|---|---|
| Cultivar | Cover crop species | Spring | Fall | Spring |

| | | -------------- Plants ft$^2$ -------------- | | |
|---|---|---|---|---|
| Fenn | winter pea | 0.8 | 5.3 | -- |
| Frostmaster | winter pea | 0.1 | 6.0 | -- |
| Glacier | winter pea | 0.0 | 7.1 | -- |
| Granger | winter pea | 0.6 | 8.2 | -- |
| MN Common | hairy vetch | 33 | 5.4 | 1.8 |
| Melrose | winter pea | 0.2 | 7.5 | -- |
| ND Common | hairy vetch | 30 | 6.1 | 3.0 |
| Panninic | Hungarian vetch | 6.1 | 5.6 | -- |
| Purple Bounty | hairy vetch | 6.3 | 4.8 | -- |
| Specter | winter pea | 0.0 | 6.9 | -- |
| Whistler | winter pea | 0.0 | 7.4 | -- |
| Windham | winter pea | 0.3 | 8.1 | -- |
| | | | | |
| Mean | | 6.4 | 6.0 | 2.4 |
| C.V. | | 44.9 | 16.8 | 54 |
| LSD.05 | | 4.2 | 1.6 | NS |

[1]Seed was planted directly in a field with 4-inch wheat stubble on 13 September in the experiment at Carrington, and into green-manured spring rye that was disked prior to planting seed on 31 August at Dickinson. Fall plant stand was determined by counting plants on 27 September at Dickinson while spring plant stand was determined by counting plants in May at both locations.

Table 2. Field pea cultivar trial results during 2011 at the Carrington Research Extension Center in North Dakota.[1]

| Cultivar | Plant stand[2] count 1 | Plant stand[2] count 2 | Seedling Vigor[3] | Plant height[4] | Days to bloom | Seed Weight | Seed Test weight | Seed Yield |
|---|---|---|---|---|---|---|---|---|
| | ------- $ft^2$ ------- | | 1-10 | inch | -d- | No./lb | lb/bu | bu/ac |
| Agassiz | 5.1 | 5.9 | 8.0 | 10.0 | 56.5 | . | . | . |
| CDC Golden | 8.2 | 8.5 | 8.8 | 8.6 | 57.3 | 3194 | 63.1 | 32.3 |
| CDC Striker | 6.8 | 7.4 | 7.0 | 7.0 | 58.5 | 2715 | 63.3 | 39.3 |
| Cooper | 5.1 | 5.2 | 3.8 | 10.2 | 61.3 | 2424 | 62.6 | 30.1 |
| Cruiser | 5.9 | 6.7 | 5.0 | 8.0 | 56.5 | 3285 | 61.8 | 29.6 |
| DS Admiral | 7.2 | 8.2 | 9.5 | 7.7 | 56.8 | 2676 | 63.2 | 41.2 |
| Eclipse | 7.4 | 7.6 | 6.0 | 7.6 | 58.0 | 2548 | 63.3 | 29.5 |
| Majoret | 7.1 | 7.6 | 7.0 | 6.9 | 57.8 | 2751 | 62.8 | 38.8 |
| NDP080102 | 5.4 | 6.2 | 4.0 | 9.0 | 58.5 | 3283 | 63.1 | 28.3 |
| NDP080106 | 4.2 | 4.6 | 3.0 | 5.5 | 58.0 | 3195 | 63.0 | 26.0 |
| PS07100091 | 4.2 | 4.3 | 1.5 | 5.9 | 58.0 | 3134 | 63.0 | 18.0 |
| Spider | 6.0 | 6.5 | 4.5 | 7.7 | 57.8 | 2521 | 63.2 | 43.6 |
| Mean | 6.1 | 6.6 | 5.7 | 57.9 | 15.2 | 2873 | 62.9 | 33.0 |
| C.V.% | 18.4 | 17.6 | 19.5 | 1.0 | 5.1 | 4.8 | 0.6 | 13.8 |
| LSD.05 | 1.6 | 1.7 | 1.6 | 0.8 | 1.1 | 200 | 0.6 | 6.6 |

[1]The field experiment was established by seeding plots on 04 May and harvested grain on 05 August, 2011; the previous crop was emmer.
[2]Plants in each plot counted on 25 May (count 1) and 02 June (count 2).
[3]Seedling vigor determined on 01 June where 1 = poor vigor and 10 = high vigor.
[4]Plant height measured just prior to grain harvest.

Table 3. Field pea cultivar trial results during 2011 at the Dickinson Research Extension Center in North Dakota.[1]

| Cultivar | Plant stand[2] count 1 | Plant stand[2] count 2 | Plant height | Days to bloom | Seed | Seed Test weight | Seed Protein | Seed yield |
|---|---|---|---|---|---|---|---|---|
| | --- Plants ft$^2$ --- | | - inch- | - no.- | no./lb | lb/bu | -%- | bu/ac |
| Agassiz | 3.1 | 4.9 | 12.7 | 48 | 2412 | 64.2 | 23.0 | 14.1 |
| CDC Golden | 3.7 | 5.8 | 14.0 | 49 | 2493 | 65.2 | 22.7 | 11.6 |
| CDC Meadow | 3.9 | 5.6 | 15.4 | 49 | 2860 | 64.9 | 22.2 | 7.9 |
| CDC Striker | 2.6 | 5.3 | 14.2 | 49 | 2339 | 65.0 | 23.8 | 10.2 |
| Cooper | 1.7 | 3.6 | 14.2 | 54 | -- | -- | -- | -- |
| Cruiser | 1.9 | 4.9 | 11.6 | 47 | 3139 | 64.4 | 21.9 | 9.6 |
| DS Admiral | 4.3 | 6.4 | 14.9 | 49 | 2471 | 64.9 | 22.6 | 13.1 |
| Eclipse | 1.6 | 5.8 | 11.6 | 50 | 2173 | 64.8 | 23.2 | 13.9 |
| Majoret | 2.8 | 5.6 | 13.6 | 49 | 2349 | 64.9 | 23.5 | 10.7 |
| Medora | 2.1 | 4.8 | 14.7 | 50 | -- | -- | -- | -- |
| Miami | 0.0 | 0.0 | -- | 50 | -- | -- | -- | -- |
| NDP080102 | 1.6 | 3.9 | -- | 50 | -- | -- | -- | -- |
| NDP080106 | 0.8 | 2.1 | -- | 50 | -- | -- | -- | -- |
| PS07100091 | 0.6 | 1.5 | -- | 50 | -- | -- | -- | -- |
| Spider | 2.3 | 4.6 | -- | 47 | 2346 | 65.1 | 22.6 | 13.6 |
| Mean | 2.2 | 4.3 | 13.7 | 49 | 2509 | 64.8 | 22.8 | 11.6 |
| C.V.% | 37.1 | 16.1 | 10.3 | -- | 5.4 | 0.6 | 22.6 | 22.6 |
| LSD.05 | 1.7 | 1.0 | 2.0 | -- | 197 | 0.6 | 0.7 | 3.8 |

[1]The field experiment was established by seeding plots on 18 May in a field seeded to buckwheat in 2010.
[2]Plants in each plot counted on 02 June (count 1) and 09 June (count 2).
[3]Plant height measured just prior to grain harvest.

Table 4. Potato cultivar trial results during 2011 at the Carrington Research Extension Center in North Dakota.[1]

| Cultivar | Type | Skin/flesh color | Days to emergence[2] | Vigor[3] | Plant disease[4] | Tuber weight | B | Yield #1 | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | -days- | -1-10- | -1-10- | ---g--- | --------- cwt./acre -------- | | |
| Burbank | russet | brown russet/white | 33.0 | 6.3 | 6.8 | 127.7 | 51.5 | 131.0 | 182.5 |
| Butte | russet | brown russet/white | 35.3 | 4.5 | 9.5 | 124.1 | 56.6 | 116.2 | 172.8 |
| Caribe | specialty | purple/white | 32.5 | 7.5 | 4.0 | 137.6 | 23.4 | 167.1 | 190.5 |
| Defander | white | white/white | 32.0 | 6.8 | 8.3 | 95.0 | 100.6 | 88.9 | 189.4 |
| Kennebec | white | white/white | 31.8 | 8.3 | 6.8 | 186.5 | 16.0 | 234.1 | 250.1 |
| Missaukee | white | white netted/white | 33.3 | 5.5 | 9.8 | 94.9 | 64.7 | 194.7 | 259.3 |
| Russian Banana | fingerling | golden/golden | 34.5 | 1.8 | 9.0 | 42.2 | . | 104.1 | 104.1 |
| Prairie Blush | yellow | golden/golden | 31.8 | 8.8 | 2.3 | 138.5 | 13.5 | 165.5 | 179.0 |
| Yukon Gem | yellow | golden/golden | 31.3 | 6.5 | 4.3 | 105.1 | 25.4 | 100.5 | 126.0 |
| Yukon Gold | yellow | golden/golden | 32.3 | 8.5 | 3.3 | 156.3 | 10.1 | 194.3 | 204.4 |
| Jacqueline Lee | yellow | golden/golden | 37.5 | 3.8 | 9.8 | 110.9 | 112.7 | 147.3 | 260.0 |
| Sangre | red | red/white | 34.8 | 2.5 | 8.0 | 145.6 | 39.2 | 158.2 | 197.4 |
| Dark Red Norland | red | red/white | 32.0 | 7.0 | 1.8 | 134.4 | 17.0 | 161.5 | 178.5 |
| Red Cloud | red | red/white | 35.8 | 2.0 | 7.5 | 160.8 | 17.9 | 255.8 | 273.7 |
| Red Norland | red | red/white | 29.5 | 8.0 | 1.0 | 123.0 | 22.2 | 152.4 | 174.6 |
| Red Pontiac | red | red/white | 30.3 | 6.3 | 4.0 | 194.7 | 16.5 | 162.1 | 178.6 |
| Mean | | | 32.9 | 5.9 | 6.0 | 129.8 | 39.2 | 158.4 | 195.1 |
| C.V.% | | | 3.6 | 27.8 | 19.4 | 16.1 | 34.1 | 18.6 | 15.1 |
| LSD.05 | | | 1.7 | 2.3 | 1.7 | 29.9 | 19.1 | 41.9 | 42.1 |

[1]The field experiment was established by seeding plots on 10 May and harvested tubers on 19 September, 2011; the previous crop was a cover crop cocktail.
[2]Days after seeding until plants had emerged from 75% of planted tubers.
[3]Plants become infected with a disease that remained undiagnosed causing premature dry down and death; plants were rated on 16 August with 1 = heavily diseased and 10 = slightly diseased.
[4]Fingerlings were not sized but all tubers were reported as #1.

Table 5. Potato cultivar trial results during 2011 at the Dickinson Research Extension Center in North Dakota.[1]

| Cultivar | Type | Skin/flesh color | Tuber counts[2] 13 June | 15 June | 17 June | 11 July | Yield[3] |
|---|---|---|---|---|---|---|---|
| | | | ------------ no./ft$^2$ ------------ | | | | cwt./acre |
| Burbank | russet | brown russet/white | -- | -- | 0.1 | 0.3 | 124 |
| Butte | russet | brown russet/white | 0.1 | 0.1 | 0.2 | 0.3 | 146 |
| Caribe | specialty | purple/white | -- | 0.1 | 0.2 | 0.3 | 112 |
| Dark Red Norland | | | 0.1 | 0.1 | 0.2 | 0.2 | 81 |
| Defander | white | white/white | -- | -- | 0.1 | 0.3 | 116 |
| Jacqueline Lee | yellow | golden/golden | -- | -- | -- | 0.1 | 89 |
| Kennebec | white | white/white | -- | -- | 0.1 | 0.2 | 85 |
| Missaukee | white | white netted/white | -- | -- | 0.1 | 0.2 | 125 |
| Prairie Blush | yellow | golden/golden | -- | -- | 0.1 | 0.2 | 100 |
| Red Norland | red | red/white | 0.1 | 0.1 | 0.2 | 0.3 | 111 |
| Red Pontiac | red | red/white | -- | 0.1 | 0.1 | 0.3 | 123 |
| Russian Banana | fingerling | golden/golden | -- | -- | 0.1 | 0.4 | 167 |
| Sangre | red | red/white | -- | -- | 0.1 | 0.3 | 167 |
| Yukon Gem | yellow | golden/golden | -- | -- | 0.1 | 0.2 | 95 |
| Yukon Gold | yellow | golden/golden | -- | 0.1 | 0.1 | 0.2 | 105 |
| | | | | | | | |
| Mean | | | 0.1 | 0.1 | 0.1 | 0.2 | 116 |
| C.V.% | | | 88 | 59 | 40 | 25 | 34.1 |
| LSD.05 | | | -- | -- | 0.1 | 0.1 | 48 |

[1]The field experiment was established by seeding plots on 18 May and harvested tubers in mid- to late-September, 2011, depending on the cultivar; the previous crop was buckwheat.

[2]Number of plants counted in a 50-ft$^2$ plot expressed on a plant/ft$^2$ basis; 20 tubers (0.4 tubers/ft2) were planted in each plot.

[3]Total yield (B plus #1).

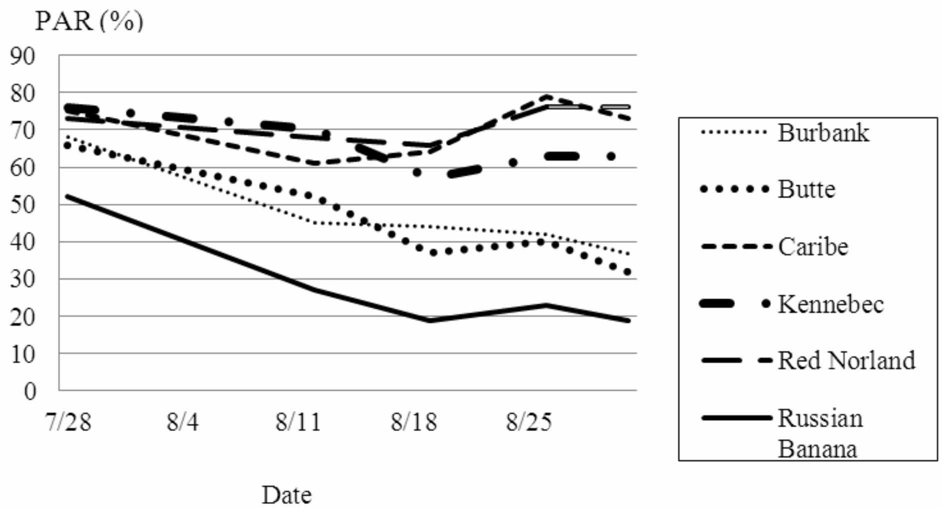


Figure 1. Photosynthetically-active radiation (PAR) intercepted by the plant canopies at Dickinson, North Dakota on five dates in 2011.

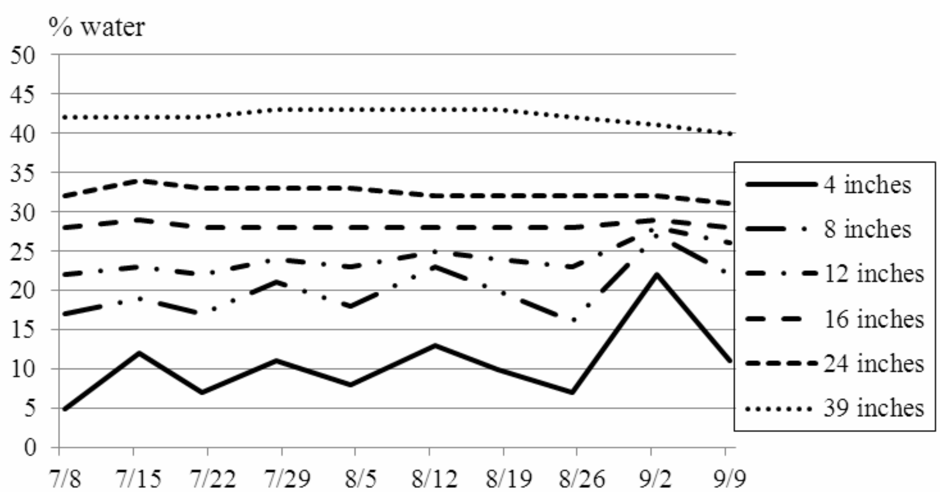


Figure 2. Volumetric soil-water content (% water) at selected soil depths on 10 dates across five potato cultivars at Dickinson, North Dakota in 2011.