**2002 Annual Report**

**Grassland Section**

**Dickinson Research Extension Center**
**1089 State Avenue**
**Dickinson, ND 58601**

# Small-Grain Cultivar Selection for Organic Systems

Patrick M. Carr - NDSU - Dickinson Research Extension Center
Bradley T. Drummond - ND Extension Service
Tonya Haigh and Theresa Podoll - Northern Plains Sustainable Agriculture Society
Hans J. Kandel - University of Minnesota - MN Extension Service
Paul M. Porter - Department of Agronomy and Genetics
Steve F. Zwinger - Carrington Research Extension Center

## Research Summary

The selection criteria used for the development of modern small-grain varieties is based on performance in environments where synthetic fertilizers and biocides are applied to minimize nutrient deficiencies and pests. Variety performance in these environments may not be applicable to purchased low-input/organic environments where synthetic fertilizers and biocides are not used. Our objective is to identify small-grain varieties from existing germplasm that are adapted to purchased low-input/organic environments. Eight seed lots representing five spring wheat cultivars and fifteen seed lots representing thirteen oat cultivars were sown in replicated and randomized, small-plot adaptation trials in a certified organic field approximately 25 mi east of Dickinson near Richardton, North Dakota. Crop development and weed biomass data were collected. The hard red spring wheat (*Triticum aestivum* L.) cultivar 'Stoa' and the durum spring wheat (*T. turgidum* L.)) cultivar 'Meier' produced equal or greater amounts of grain compared with other spring wheat cultivars. However, protein content was greater in grain produced by 'Coteau' than either Stoa or Meier. There was a range in yield of 27 bu/acre between cultivars in the oat adaptation trial, but statistical restrictions prevented differentiating oat cultivars on the basis of yield. Mean biomass production by grass and broadleaf weeds when combined was <600 lb/acre.

## Introduction

North Dakota leads the nation in organic production of small grains. However, little effort has been made at identifying small grain cultivars adapted to organic environments in the state or even the nation. Conversely, the adaptation of small grain cultivars under organic

management has been considered in Europe. Richards (1988) compared grain yield and other traits of six oat cultivars in a field transitioning to organic management in Scotland during 1987. He concluded that ranking of the varieties for yield was similar to their ranking in fields managed conventionally, with one exception. Yield of the shortest and possibly least-competitive cultivar was lower relative to the yield of other cultivars when grown under organic management than conventional management. Results of this study indicate that the relative performance of oat cultivars may be different under organic management compared with conventional management.

Nine spring-wheat cultivars were compared under conventional and organic management in Poland during 1989 and 1991(Poutala et al., 1993). No differences in yield occurred among the cultivars when managed organically, while yields were different between some of the cultivars when managed conventionally. Results of this study indicate that the management system (organic and conventional) did affect cultivar performance. However, cultivar selection was not affected by management system since the highest yielding cultivars under conventional management also performed as well as other varieties under organic management.

Small-grain cultivar performance has been compared under organic management elsewhere in Europe (e.g., Richards, 1988; Samuel and Young, 1989; Storey et al., 1993; Gooding et al., 1999). Unfortunately, none of the cultivars included in these studies are grown in North America and probably are not adapted to growing conditions in North Dakota. Moreover, many of the studies were conducted at only one location for a single year (e.g., Rydberg, 1986; Richards, 1988) and are of limited scientific value. Other studies compared cultivar performance in fields in transition to organic management and were not in certified organic fields (e.g., Richards, 1988). Our objective is to identify wheat and oat cultivars that are adapted to organic environments in North Dakota and Minnesota. This paper summarizes the application of this objective to southwestern North Dakota.

## Materials and Methods

A limited comparison of spring wheat and oat varieties was done on in a certified organic field on a commercial farm southeast of Richardton, ND, in 2001. Eight seed lots representing five spring wheat cultivars and fifteen seed lots representing thirteen oat cultivars each were sown in plots arranged in a randomized complete block with cultivar treatments replicated six times. The plots were established using a small-plot planter after the seedbed was prepared by the participating organic farmer using standard practices on his farm. Wheat was sown at 1.8 million pure live kernels/acre (41 live kernels/$ft^2$) and oats at 1.4 million pure live kernels/acre (32 live kernels/$ft^2$) in 6 by 27 ft plots will be at least 4 by 20 ft and arranged in a randomized complete block with treatments replicated four to six times. Data on crop emergence and stand, seedling vigor, weed biomass production, grain yield, test weight, kernel weight, and protein concentration were collected from each wheat plot. These same data except for protein concentration also were collected from each oat plot. The data were analyzed statistically so differences in agronomic performance between cultivars could be identified.

## Results and Discussion

### *Wheat*

More plants occurred at 14 days after seeding (DAS) in plots where Coteau kernels from coded seedlots Boehm, Schmaltz, or Kudrna was seeded compared with kernels from the Gustafson seedlot (Table 1). Fewer plants also were counted at 21 DAS when the Coteau was established using the Gustafson seedlot. These data indicate that importance that seedlot quality can have on plant stand.

Coteau seedlings were less vigorous at 14 DAS when established with the Gustafson seedlot compared with other seedlots of Coteau, as well as with seedlots of other wheat cultivars (Table 1). No differences occurred between seedlings established with other seedlots or cultivars.

Coteau plants established with the Boehm seedlot were equal in height or taller than plants established from other seedlots at 14 DAS (Table 1). No differences in plant height were detected at 21 DAS among plants established from the various seedlots.

Less grain generally was produced when Coteau was seeded compared with other spring wheat cultivars, except when the Boehm seedlot of Coteau was used (Table 1). Conversely, protein content generally was elevated in grain produced by Coteau compared with other spring wheat cultivars, and grain protein content of the Coteau cultivar was lower when produced from the Boehm seedlot than from the other three seedlots. Test weight of grain produced by Parshall was equal or heavier than the test weight of grain produced by other cultivars, but the test weight of grain produced by all cultivar/seedlot treatments was >60 lb/bu. Heavier kernels were produced by Kyle, Maier, and Coteau when the Boehm seedlot was used compared with other cultivar/seedlot treatments.

Mean biomass production by grass and broadleaf weeds was < 200 lb/acre when weeds were harvested at 30 DAS (Table 2). Mean biomass production was < 600 lb/acre when weeds were harvested around 90 DAS. By comparison, biomass production across the wheat cultivar/seedlot treatments averaged almost 1400 lb/acre at 30 DAS and almost 4000 lb/acre around 90 DAS. The data indicate that weeds contributed about 9% of total plant dry-matter at 30 DAS and around 12% of total plant dry-matter at 90 DAS.

The preliminary results of this trial suggest that the hard red spring wheat cultivars Parshall and Stoa may be better adapted than Coteau for production in organic environments similar to the one encountered in this study, if the only criterion used to determine adaptation is grain yield. However, an exception to this hypothesis exists since no differences in yield between Coteau and the other two cultivars occurred when the Boehm seedlot of Coteau was used. Coteau may be better adapted than the other cultivars included in this trial if the criterion for determining adaptation is grain protein concentration. A more thorough and multi-year study is needed before cultivar recommendations for spring wheat can be provided to organic agriculturists in southwestern North Dakota.

***Oats***

Equal or greater numbers of plants occurred at 14 and 21 DAS when Wabasha was seeded compared with other cultivars (Table 3). Conversely, fewest plants occurred at 21 DAS when Paul from the coded Gustafson seedlot was seeded, and at 14 DAS when this seedlot or Hytest from the conventional seedlot was used. Plant numbers were similar at 21 DAS when Hytest from both conventional and organic seedlots were compared, but fewer plants occurred at 14 DAS when Hytest from the conventional seedlot was used.

Paul seedlings were less vigorous than seedlings of other cultivars at 14 DAS (Table 3). Seedling vigor was rated 'high' at 14 DAS for eight of the fifteen seedlots included in the study. However, plants were less vigorous when established with conventional compared with organic seedlots of Hytest oats.

Seedling height ranged from 2.8 in for Paul to 3.8 in for organic Hytest at 14 DAS (Table 3). No difference in plant height was detected between oat cultivars at 21 DAS.

Grain yield averaged almost 49 bu/acre for the cultivar and seedlot treatments included in this study with oats (Table 3). However, the high coefficient of variation percentage (CV%) prevented differences in yield between treatments from being detected statistically. There were differences in grain kernel weight and test weight between cultivars and seedlots. Heaviest kernels were produced by AC Assiniboia and organic Hytest. Heaviest test weights of grain were produced by Hytest (both conventional and organic sources) and Paul.

Mean biomass production by grass and broadleaf weeds was < 100 lb/acre when weeds were harvested at 30 DAS (Table 4). Mean biomass production was < 500 lb/acre when weeds were harvested around 90 DAS. By comparison, biomass production across the oat cultivar/seedlot treatments averaged over 800 lb/acre at 30 DAS and almost 3400 lb/acre around 90 DAS. The data indicate that weeds contributed about 9% of total plant dry-matter at 30 DAS and around 11% of total plant dry-matter at 90 DAS.

## Conclusions/Implications of Research

Readers are cautioned to infer much from this preliminary study. However, results of wheat and oat cultivar comparisons in a certified organic field indicate that some cultivars may be adapted better than others to organic environments, based on agronomic performance. This work will continue in 2002, thanks to the support of both the Organic Farming Research Foundation and the Wheat Subcommittee of the North Dakota State Board of Agricultural Research and Education.

## Acknowledgments

The authors gratefully acknowledge the assistance of Glenn Martin, Burt Melchior, Lori Pavlicek, Amanda Heath, Carrie Sailer, Rachel Kraft, Tara Deseth, Kate Hammer, and Tim Kraft in establishing this experiment and in data collection and processing. A special thanks is extended to Duane Boehm for allowing this work to occur on his organic farm and for his enthusiasm, interest, and support for this project.

## Literature Cited

**Goodling, J.J., N.D. Cannon, A.J. Thompson, and W.P. Davies. 1999**. Quality and value of organic grain from contrasting breadmaking wheat varieties and near isogenic lines differing in dwarfing genes. Biol. Agric. Hort. 16:335-350.

**Hwu, K., and .R.E. Allan. 1992.** Natural selection effects in wheat populations grown under contrasting tillage systems. Crop Sci.

32:605-611.

**Poutala, R.T., J. Korva, and E. Varis. 1993**. Spring wheat cultivar performance in ecological and conventional cropping systems. J. Sust. Agric. 3:63-83.

**Richards, M.C. 1988**. The performance of six spring oat cultivars grown without synthetic chemical inputs. Ann. Appl. Biol. 112 (supplement):106-107.

**Rydberg, T. 1986.** The response of barley varieties in conventional and biological growing. p 310-316. *In* IFOAM International Scientific Conference: the importance of biological agriculture.

**Samuel, A.M., and R.J. Young. 1989**. Yield, grain quality and disease incidence of milling wheat varieties grown organically. Ann. Appl. Biol. 114 (supplement):172-173.

**Scott, J. 1999**. Selecting milling wheat for organic production in New Brunswick. Seeds of Diversity magazine, May issue.

**Storey, T., R. Hogan, and J. Humphreys. 1993**. The growth, yield, and quality of winter wheat and winter oats grown under an organic conversion regime. Aspects of Applied Biol. 36:199-204.

**Table 1.** Performance of eight seed lots representing five spring wheat cultivars in southwestern North Dakota during 2001.

| | Days after sowing | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | -14- | -21- | -14- | -14- | -21- | Grain | | | |
| **Cultivar (Source)** | **--Plant stand--** | | **Vigor** | **Plant height** | | **Kernels** | **Yield** | **Protein** | **Test weight** |
| | million plants/acre | | | -inches- | | -number/lb- | bu/ac | ---%--- | lb/bu |
| | | | | | | | | | |
| Coteau (Boehm) | 1.49 | 1.60 | 1.0 | 4.4 | 6.2 | 15,284 | 20.2 | 11.7 | 60.9 |
| Coteau (Schmaltz) | 1.57 | 1.59 | 1.0 | 3.7 | 6.4 | 17,637 | 19.0 | 12.3 | 61.0 |
| Coteau (Kudrna) | 1.47 | 1.66 | 1.2 | 3.5 | 6.1 | 17,529 | 19.1 | 12.1 | 61.3 |
| Coteau (Gustafson) | 1.23 | 1.32 | 2.0 | 3.9 | 6.4 | 16,959 | 19.5 | 12.5 | 60.5 |
| Parshall (Boehm) | 1.25 | 1.58 | 1.0 | 4.0 | 7.2 | 17,286 | 22.4 | 10.6 | 62.1 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Stoa (Boehm) | 1.41 | 1.48 | 1.0 | 3.9 | 7.1 | 18,091 | 23.0 | 10.6 | 60.5 |
| Kyle (Larson) | 1.29 | 1.43 | 1.0 | 4.9 | 7.4 | 14,722 | 23.7 | 9.3 | 61.1 |
| Maier (Schmaltz) | 1.37 | 1.51 | 1.0 | 4.6 | 6.8 | 14,688 | 23.0 | 9.4 | 61.8 |
| | | | | | | | | | |
| Trial Mean | 1.39 | 1.52 | 1.2 | 4.1 | 6.7 | 16,525 | 21.2 | 11.1 | 61.1 |
| C.V. % | 12.7 | 7.5 | 12.6 | 11.9 | 14.5 | 3.9 | 9.8 | 2.0 | 0.6 |
| LSD .05 | 0.21 | 0.13 | 0.2 | 0.6 | NS | 758 | 2.4 | 0.3 | 0.5 |

NS= Not Significant
Vigor: 1 = high vigor, 5 = low vigor at 14 DAS

**Table 2.** Moisture content and dry matter of wheat and weeds at 30 and 90 days after seeding (DAS) in a spring wheat adaptation study in southwestern North Dakota during 2001.

| | 30 DAS | | | | 90 DAS | | | |
|---|---|---|---|---|---|---|---|---|
| | | Dry matter | | | | Dry matter | | |
| **Cultivar (Source)** | **Moisture** | **Wheat** | **Broadleaf weeds** | **Grass weeds** | **Moisture** | **Wheat** | **Broadleaf weeds** | **Grass weeds** |
| | ----%---- | ----------lbs/acre---------- | | | ----%---- | ----------lbs/acre---------- | | |
| Coteau (Boehm) | 72 | 1,363 | 93 | 43 | 37 | 3,233 | 260 | 222 |
| Coteau (Schmaltz) | 73 | 1,232 | 83 | 50 | 39 | 4,084 | 162 | 333 |
| Coteau (Kudrna) | 75 | 1,189 | 88 | 43 | 38 | 3,426 | 370 | 205 |
| Coteau (Gustafson) | 74 | 1,322 | 94 | 53 | 39 | 3,715 | 322 | 179 |
| Parshall (Boehm) | 70 | 1,688 | 118 | 46 | 36 | 4,098 | 226 | 239 |
| Stoa (Boehm) | 72 | 1,571 | 84 | 39 | 37 | 4,187 | 277 | 219 |
| Kyle (Larson) | 72 | 1,256 | 89 | 71 | 36 | 3,873 | 446 | 223 |
| Maier (Schmaltz) | 71 | 1,369 | 100 | 49 | 34 | 3,623 | 281 | 209 |
| | | | | | | | | |
| Trial Mean | 73 | 1,376 | 94 | 49 | 37 | 3,780 | 293 | 229 |
| C.V. % | 2.7 | 24.9 | 56.4 | 47.4 | 6.2 | 24.1 | 54.8 | 49.8 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| LSD .05 | 2 | NS | NS | NS | 3 | NS | NS | NS |

NS= Not Significant

**Table 3.** Performance of fifteen seedlots representing thirteen oat cultivars in southwestern North Dakota in 2001.

| Cultivar | Days after sowing Plant Count 14 | 21 | Vigor | Days after sowing Height 14 | 21 | Kernels | Yield | Test Weight |
|---|---|---|---|---|---|---|---|---|
| | million plants/acre | | | -------inches------- | | -no./lb- | -bu/ac- | ---lb/bu--- |
| AC Assinaboia | 1.03 | 1.15 | 1.2 | 3.6 | 7.0 | 11,886 | 56.3 | 37.3 |
| Ebeltoft | 0.88 | 1.12 | 1.8 | 3.3 | 6.0 | 15,478 | 49.3 | 35.8 |
| Organic Paul | 0.66 | 0.73 | 3.3 | 2.8 | 6.2 | 19,525 | 33.2 | 42.3 |
| HiFi | 0.99 | 1.13 | 1.0 | 3.4 | 6.9 | 16,646 | 54.7 | 36.0 |
| Organic Hytest | 0.94 | 1.00 | 1.0 | 3.8 | 7.1 | 14,491 | 39.6 | 42.1 |
| Hytest | 0.77 | 0.94 | 1.7 | 3.9 | 7.0 | 13,966 | 42.0 | 41.1 |
| Organic Otana | 0.96 | 1.17 | 1.3 | 3.0 | 7.0 | 15,619 | 50.0 | 37.7 |
| MN 97239 | 1.08 | 1.23 | 1.0 | 3.7 | 6.9 | 14,142 | 53.4 | 37.9 |
| MN Richard | 1.03 | 1.22 | 1.0 | 3.5 | 6.3 | 12,869 | 51.2 | 37.3 |
| MN Sesqui | 1.11 | 1.33 | 1.0 | 3.0 | 6.8 | 15,818 | 60.4 | 38.3 |
| Morton | 0.85 | 1.07 | 1.2 | 3.7 | 7.2 | 15,427 | 52.0 | 37.6 |
| Sesqui | 1.11 | 1.30 | 1.0 | 3.4 | 6.6 | 15,145 | 49.0 | 38.5 |
| Triple Crown | 1.12 | 1.30 | 1.0 | 3.2 | 6.3 | 18,229 | 40.8 | 27.1 |
| Wabasha | 1.19 | 1.35 | 1.0 | 3.2 | 7.0 | 15,369 | 48.2 | 38.3 |
| Youngs | 0.91 | 1.12 | 1.5 | 3.4 | 6.8 | 13,273 | 50.5 | 35.2 |
| | | | | | | | | |
| Trial Mean | 0.97 | 1.14 | 1.3 | 3.4 | 6.7 | 15,192 | 48.7 | 37.5 |
| C.V. % | 11.6 | 10.7 | 26.0 | 9.3 | 11.9 | 9.7 | 18.4 | 3.5 |
| LSD .05 | 0.13 | 0.14 | 0.4 | 0.4 | NS | 1,690 | NS | 1.5 |

NS= Not Significant
Vigor: 1 = high vigor, 5 = low vigor at 14 days after seeding.

**Table 4.** Dry matter production of oats and weeds at 30 and 90 days after seeding (DAS) in an oat adaptation study in southwestern North Dakota during 2001.

| | | | | 90 DAS | | |
|---|---|---|---|---|---|---|
| | | Weeds | | | Weeds | |
| Cultivar | Oats | Broadleaf Dry Matter | Grass Dry Matter | Oats | Broadleaves | Grass |
| | ----------lbs/acre---------- | | | | | |
| AC Assinaboia | 814 | 51 | 19 | 3,771 | 213 | 148 |
| Ebeltoft | 755 | 65 | 20 | 2,720 | 257 | 162 |
| Organic Paul | 678 | 56 | 34 | 3,270 | 152 | 151 |
| HiFi | 750 | 56 | 27 | 3,809 | 327 | 150 |
| Organic Hytest | 758 | 51 | 27 | 3,014 | 398 | 174 |
| Hytest | 915 | 61 | 27 | 3,334 | 217 | 127 |
| Organic Otana | 880 | 40 | 29 | 3,298 | 250 | 145 |
| MN 97239 | 825 | 31 | 15 | 3,407 | 154 | 102 |
| MN Richard | 1,134 | 57 | 16 | 3,931 | 247 | 133 |
| MN Sesqui | 736 | 34 | 21 | 3,772 | 258 | 104 |
| Morton | 710 | 65 | 34 | 2,600 | 533 | 139 |
| Sesqui | 674 | 28 | 32 | 3,081 | 257 | 146 |
| Triple Crown | 573 | 42 | 24 | 3,883 | 133 | 71 |
| Wabasha | 1,064 | 70 | 23 | 3,224 | 201 | 146 |
| Youngs | 817 | 58 | 28 | 3,513 | 701 | 74 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Trial Mean | 806 | 51 | 25 | 3,375 | 286 | 132 |
| C.V. % | 34.7 | 88.8 | 52.0 | 25.7 | 89.3 | 50.4 |
| LSD .05 | NS | NS | NS | NS | NS | NS |

NS= Not Significant

[ Back to 2002 Annual Report Index ] [ Back to Agronomy Reports ]

[ DREC Home ] [ Contact DREC ] [ Top of Page ]