Project Title: Spring Wheat Seed Quality Effects on Competitive Ability with Wild Oat

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Objective: To evaluate effects of seed size, protein content and gibberellic acid (GA) on spring wheat/wild oat competition

Results:

Treatments consisted of two protein levels (high and low), two seed size classes (large and small), two GA concentrations (treated and nontreated), and two wild oat densities (0 and 16/ft$^2$). Wild oat monoculture treatments also were included as controls for emergence and yield component measurements. Seed of differing protein levels was produced by growing Jefferson spring wheat under two different nitrogen regimes during the previous year. Seed from each nitrogen regime was separated into two seed size classes, for a total of four treatments (2 N levels x 2 seed sizes). The seed size classes were obtained by passing bulk, unprocessed seed over 7/64, 6/64 and 5/64 inch sieves. Seed retained on the 7/64 inch sieve were considered large and those which passed through 6/64 inch sieve but were retained on 5/64 inch sieve were considered small. Seed from each of the four protein-seed size combinations were treated with the GA seed treatment, Release, at 0 and 3 oz/100 lb of seed, for a total of eight treatments. These eight treatments were either grown in the presence or absence of wild oat competition.

The spring wheat treatments were planted to a depth of 2 inches on April 13, 2007 at a seeding rate of16 plants/ft$^2$, in 6 inch row spacings. Broadleaf weeds were controlled with an application of Harmony Extra (0.6 oz/ac) plus NIS (0.25%) on May 17, 2007. Wheat main stem Haun stage and plant height were determined in all treatments. Spring wheat emergence, ground cover, leaf area index (LAI) and light penetration (DIFN) were determined in the monoculture plots. Spring wheat and wild oat plant density and biomass were determined by harvesting two 1.46 ft$^2$ quadrats at jointing. A second quadrat sampling occurred prior to wild oat seed shattering in order to determine spring wheat and wild oat yield components. Spring wheat yield, test weight, dockage and grain protein content were determined by combine harvest.

Seed size affected all of the early growth traits under spring wheat monoculture conditions (Table 1). Plants grown from large seeds emerged earlier (lower median emergence time, MT), produced greater ground cover, and had larger leaf areas (LAI) as compared to plants grown from small seeds. With the exception of a slight GA effect on enhanced seedling emergence (lower MT), GA and seed protein treatments did not affect any early growth traits.

Among the 4 treatment factors, seed size and GA were the only factors to affect wheat developmental rate (Table 2). In general, plants grown from large seeds had faster leaf appearance rates (greater Haun values) than those grown from small seeds. However, plants treated with GA had reduced leaf appearance rates as the season progressed.

Wild oat density had a negative effect on all spring wheat variables (Table 3). Nevertheless, spring wheat plant density, biomass, spikes, and yield all increased as seed size increased, regardless of the presence or absence of wild oat. The positive effect of large seed was generally more pronounced when grown in the presence of wild oats. Plants derived from large seed also had improved grain quality characteristics. The one exception was protein, which tended to be higher for plants established from small seed. This is probably a result of increased competition from wild oat and a corresponding reduction in seed size and starch content.

Surprisingly, GA treatments caused a general reduction in spring wheat stand densities, which in turn resulted in reduced spring wheat spikes and biomass. The reduction in spring wheat competitiveness resulted in higher wild oat densities and biomass in some instances. Nevertheless, wild oat stem weight, total biomass, and seed production was reduced when grown in the presence of spring wheat derived from large seed (Table 4).

[See tables on following pages.]

Table 1. Effects of spring wheat seed size (SS), protein content (Pro) and gibberellic acid (GA) treatment on spring wheat median emergence time (MT), maximum emergence rate (MR), ground cover, leaf area index (LAI), and light penetration (DIFN) when grown under monoculture conditions during 2007 at Kalispell, MT.

| SS | Pro | GA | MT | MR | Ground cover (%) | | LAI ($m^2/m^2$) | | DIFN | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cd | % / Cd | 5/22/07 | 5/31/07 | 5/22/07 | 6/5/07 | 5/22/07 | 6/5/07 |
| Large | Low | U | 148 | 2.5 | 61.3 | 73.8 | 0.68 | 2.38 | 0.59 | 0.19 |
| Large | Low | T | 139 | 2.5 | 58.8 | 68.8 | 0.56 | 1.96 | 0.65 | 0.24 |
| Large | High | U | 150 | 2.4 | 53.8 | 67.5 | 0.60 | 2.28 | 0.63 | 0.19 |
| Large | High | T | 140 | 2.4 | 57.5 | 68.8 | 0.49 | 1.97 | 0.69 | 0.25 |
| **Mean** | | | **144** | **2.5** | **57.8** | **69.7** | **0.58** | **2.15** | **0.64** | **0.21** |
| Small | Low | U | 152 | 2.4 | 35.0 | 43.8 | 0.22 | 1.28 | 0.84 | 0.41 |
| Small | Low | T | 148 | 2.5 | 37.5 | 45.0 | 0.24 | 1.46 | 0.83 | 0.33 |
| Small | High | U | 147 | 2.1 | 43.8 | 52.5 | 0.33 | 1.62 | 0.77 | 0.31 |
| Small | High | T | 149 | 2.3 | 38.8 | 50.0 | 0.27 | 1.48 | 0.81 | 0.36 |
| **Mean** | | | **149** | **2.3** | **38.8** | **47.8** | **0.26** | **1.46** | **0.81** | **0.35** |
| LSD (0.05) | Main effect | | 5.2 | NS | 7.7 | 8.7 | 0.13 | 0.31 | 0.07 | 0.06 |
| ANOVA | SS | | 0.07 | NS | *** | *** | *** | *** | *** | *** |
| | Pro | | NS | NS | NS | NS | NS | NS | NS | NS |
| | GA | | 0.07 | NS | NS | NS | NS | NS | NS | NS |
| | SS x Pro | | NS | NS | NS | NS | NS | NS | NS | NS |
| | SS x GA | | NS | NS | NS | NS | NS | NS | NS | NS |
| | Pro x GA | | NS | NS | NS | NS | NS | NS | NS | NS |
| | SS x Pro x GA | | NS | NS | NS | NS | NS | NS | NS | NS |

NS: not significant; ***: significant, P<0.001.

Table 2. Effects of wild oat density (WD), and spring wheat seed size (SS), protein content (Pro) and gibberellic acid (GA) treatment on spring wheat main stem Haun stage, Haun stage regression parameters, and phyllochron number when grown under monoculture conditions during 2007 at Kalispell, MT.

| WD | SS | Pro | GA | Main stem Haun stage | | | | Intercept | Slope | Phyllochron |
|---|---|---|---|---|---|---|---|---|---|---|
| No./ft$^2$ | | | | 253 GDD 5/9/07 | 347 GDD 5/16/07 | 435 GDD 5/23/07 | 507 GDD 5/30/07 | | x $10^{-2}$ | Cd / leaf |
| 0 | Large | Low | U | 2.3 | 3.7 | 5.2 | 6.0 | -1.45 | 1.49 | 67 |
| 0 | Large | Low | T | 2.2 | 3.7 | 4.9 | 5.9 | -1.31 | 1.42 | 70 |
| 0 | Large | High | U | 2.2 | 3.8 | 5.2 | 6.2 | -1.68 | 1.56 | 64 |
| 0 | Large | High | T | 2.3 | 3.7 | 5.0 | 5.9 | -1.38 | 1.45 | 69 |
| **Mean** | | | | **2.2** | **3.7** | **5.1** | **6.0** | **-1.45** | **1.48** | **68** |
| 0 | Small | Low | U | 2.1 | 3.4 | 4.8 | 5.9 | -1.71 | 1.49 | 67 |
| 0 | Small | Low | T | 2.2 | 3.5 | 4.8 | 5.8 | -1.45 | 1.43 | 70 |
| 0 | Small | High | U | 2.1 | 3.5 | 4.9 | 5.9 | -1.84 | 1.54 | 65 |
| 0 | Small | High | T | 2.1 | 3.5 | 4.8 | 5.7 | -1.51 | 1.43 | 70 |
| **Mean** | | | | **2.1** | **3.5** | **4.8** | **5.8** | **-1.63** | **1.47** | **68** |
| 16 | Large | Low | U | 2.3 | 3.8 | 5.1 | 6.1 | -1.52 | 1.51 | 66 |
| 16 | Large | Low | T | 2.2 | 3.8 | 4.9 | 6.0 | -1.40 | 1.46 | 69 |
| 16 | Large | High | U | 2.3 | 3.8 | 5.1 | 6.1 | -1.43 | 1.49 | 67 |
| 16 | Large | High | T | 2.3 | 3.8 | 4.9 | 5.9 | -1.10 | 1.39 | 72 |
| **Mean** | | | | **2.3** | **3.8** | **5.0** | **6.0** | **-1.36** | **1.46** | **69** |
| 16 | Small | Low | U | 2.1 | 3.5 | 4.7 | 5.8 | -1.66 | 1.47 | 68 |
| 16 | Small | Low | T | 2.2 | 3.5 | 4.8 | 5.6 | -1.28 | 1.38 | 73 |
| 16 | Small | High | U | 2.2 | 3.7 | 4.9 | 5.9 | -1.49 | 1.47 | 68 |
| 16 | Small | High | T | 2.2 | 3.5 | 4.8 | 5.8 | -1.50 | 1.45 | 69 |
| **Mean** | | | | **2.1** | **3.5** | **4.8** | **5.8** | **-1.48** | **1.44** | **70** |

Table 2 (Continued, ANOVA table).

| | Main stem Haun stage | | | | Intercept | Slope | Phyllochron |
|---|---|---|---|---|---|---|---|
| | 253 GDD 5/9/07 | 347 GDD 5/16/07 | 435 GDD 5/23/07 | 507 GDD 5/30/07 | | x $10^{-2}$ | Cd / leaf |
| ANOVA | | | | | | | |
| WD | NS | NS | NS | NS | NS | 0.10 | 0.10 |
| SS | *** | *** | *** | *** | ** | NS | NS |
| Pro | NS | NS | NS | NS | NS | NS | NS |
| GA | NS | NS | * | *** | *** | *** | *** |
| WD x SS | NS | NS | NS | NS | NS | NS | NS |
| WD x Pro | NS | NS | NS | NS | 0.08 | NS | NS |
| WD x GA | NS | NS | NS | NS | NS | NS | NS |
| SS x Pro | NS | NS | NS | NS | NS | NS | NS |
| SS x GA | NS | NS | 0.08 | NS | NS | NS | NS |
| Pro x GA | NS | NS | NS | NS | NS | NS | NS |
| WD x SS x Pro | NS | NS | NS | NS | NS | NS | NS |
| WD x SS x GA | NS | NS | NS | NS | NS | NS | NS |
| WD x Pro x GA | NS | NS | NS | NS | NS | NS | NS |
| SS x Pro x GA | NS | NS | NS | NS | NS | NS | NS |
| WD x SS x Pro x GA | NS | NS | NS | NS | NS | NS | NS |

GDD: growing degree days; NS: not significant; *, **, ***: significant, P<0.05, 0.01, and 0.001, respectively.

Table 3. Effects of wild oat density (WD), spring wheat seed size (SS), protein content (Pro) and gibberellic acid (GA) treatment on spring wheat plant densities, spikes, biomass, yield and grain quality during 2007 at Kalispell, MT.

| WD | SS | Pro | GA | 1st harvest (6/4/07) | | 2nd harvest (7/12/07) | | | Yield | Test | Grain | Dockage | Protein |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No./ft$^2$ | | | | Plants | Biomass | Plants | Spikes | Biomass | | weight | moisture | | |
| | | | | No./m$^2$ | g/m$^2$ | ------ No./m$^2$ ----- | | | g/m$^2$ | bu/ac | lb/bu | ---------- % ---------- | |
| 0 | Large | Low | U | 170.2 | 231.9 | 139.0 | 409.3 | 825.1 | 65.0 | 58.2 | 10.1 | 0.5 | 15.0 |
| 0 | Large | Low | T | 181.3 | 227.2 | 143.5 | 497.1 | 993.7 | 64.7 | 58.9 | 9.8 | 0.4 | 14.6 |
| 0 | Large | High | U | 174.6 | 265.5 | 162.4 | 511.6 | 1053.1 | 66.0 | 58.7 | 10.0 | 0.4 | 14.8 |
| 0 | Large | High | T | 175.7 | 254.7 | 117.9 | 421.5 | 811.6 | 65.8 | 58.9 | 10.3 | 0.5 | 14.8 |
| **Mean** | | | | **175.4** | **244.8** | **140.7** | **459.9** | **920.8** | **65.4** | **58.7** | **10.0** | **0.4** | **14.8** |
| 0 | Small | Low | U | 166.8 | 154.6 | 124.6 | 446.0 | 806.5 | 54.4 | 58.5 | 10.9 | 0.7 | 14.9 |
| 0 | Small | Low | T | 169.0 | 150.1 | 132.3 | 405.9 | 810.3 | 59.8 | 58.8 | 11.1 | 1.0 | 15.1 |
| 0 | Small | High | U | 154.6 | 151.4 | 147.9 | 452.6 | 946.7 | 59.6 | 58.5 | 10.8 | 0.8 | 15.1 |
| 0 | Small | High | T | 173.5 | 156.8 | 111.2 | 340.3 | 639.2 | 61.2 | 58.9 | 10.9 | 0.9 | 14.8 |
| **Mean** | | | | **166.0** | **153.2** | **129.0** | **411.2** | **800.7** | **58.8** | **58.6** | **10.9** | **0.9** | **15.0** |
| 16 | Large | Low | U | 175.7 | 201.5 | 145.7 | 387.0 | 611.5 | 30.1 | 56.6 | 9.1 | 13.5 | 15.9 |
| 16 | Large | Low | T | 170.2 | 164.4 | 136.8 | 332.5 | 471.8 | 28.2 | 56.9 | 9.1 | 15.7 | 15.6 |
| 16 | Large | High | U | 179.0 | 186.3 | 143.5 | 344.8 | 532.0 | 30.6 | 56.7 | 9.2 | 13.4 | 15.9 |
| 16 | Large | High | T | 156.8 | 142.8 | 123.4 | 313.6 | 457.7 | 28.8 | 56.4 | 9.2 | 14.7 | 15.8 |
| **Mean** | | | | **170.4** | **173.7** | **137.3** | **344.5** | **518.3** | **29.4** | **56.6** | **9.2** | **14.3** | **15.8** |
| 16 | Small | Low | U | 145.7 | 99.1 | 124.6 | 245.8 | 331.0 | 18.4 | 55.7 | 9.3 | 20.9 | 16.8 |
| 16 | Small | Low | T | 157.9 | 94.3 | 96.8 | 201.3 | 236.5 | 15.9 | 55.5 | 9.4 | 24.2 | 17.2 |
| 16 | Small | High | U | 159.0 | 109.5 | 129.0 | 241.3 | 310.5 | 20.4 | 55.7 | 9.2 | 18.0 | 17.1 |
| 16 | Small | High | T | 130.1 | 98.0 | 117.9 | 251.3 | 324.3 | 19.5 | 56.3 | 9.4 | 20.2 | 16.4 |
| **Mean** | | | | **148.2** | **100.2** | **117.0** | **234.9** | **300.6** | **18.5** | **55.8** | **9.3** | **20.9** | **16.9** |
| LSD (0.05) | | Main effect | | 13.6 | 19.1 | 10.6 | 27.6 | 57.5 | 2.1 | 0.3 | 0.3 | 1.2 | 0.2 |

Table 3 (Continued, ANOVA table)

| | 1st harvest (6/4/07) | | 2nd harvest (7/12/07) | | | Yield | Test weight | Grain moisture | Dockage | Protein |
|---|---|---|---|---|---|---|---|---|---|---|
| | Plants | Biomass | Plants | Spikes | Biomass | | | | | |
| | No./$m^2$ | $g/m^2$ | ----- No./$m^2$ ----- | | $g/m^2$ | bu/ac | lb/bu | ---------- % ---------- | | |
| ANOVA | | | | | | | | | | |
| WD | NS | * | NS | ** | ** | *** | *** | * | *** | *** |
| SS | * | *** | ** | *** | *** | *** | * | *** | *** | *** |
| Pro | NS | NS | NS | NS | NS | 0.07 | NS | NS | 0.10 | NS |
| GA | NS | NS | ** | * | ** | NS | NS | NS | * | NS |
| WD x SS | NS | NS | NS | * | 0.09 | * | * | ** | *** | *** |
| WD x Pro | NS | NS | NS | NS | NS | NS | NS | NS | 0.09 | NS |
| WD x GA | NS | NS | NS | NS | NS | 0.11 | NS | NS | 0.07 | NS |
| SS x Pro | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| SS x GA | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| Pro x GA | NS | NS | * | NS | * | NS | NS | NS | NS | NS |
| WD x SS x Pro | NS | NS | NS | 0.09 | NS | NS | NS | NS | NS | NS |
| WD x SS x GA | NS | NS | NS | 0.07 | NS | NS | NS | NS | NS | NS |
| WD x Pro x GA | NS | NS | * | ** | *** | NS | NS | NS | NS | NS |
| SS x Pro x GA | NS | NS | NS | NS | NS | NS | NS | NS | NS | ** |
| WD x SS x Pro x GA | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

NS: not significant; *, **, ***: significant, P<0.05, 0.01, and 0.001, respectively.

Table 4. Effects of spring wheat seed size (SS), protein content (Pro) and gibberellic acid (GA) treatment on wild oat parameters during 2007 season at Kalispell, MT.

| SS | Pro | GA | Plants | Biomass | Plants | Panicles | Biomass | | | Seeds |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Stems | Panicles | Total | |
| | | | No./$m^2$ | $g/m^2$ | --------- No./$m^2$ --------- | | ---------- $g/m^2$ ---------- | | | No./$m^2$ |
| | | | 1st harvest (6/4/07) | | ---------- 2nd harvest (7/12/07) ---------- | | | | | |
| Large | Low | U | 139.2 | 116.4 | 135.5 | 284.8 | 321.3 | 239.7 | 561.0 | 11403.6 |
| Large | Low | T | 90.3 | 74.9 | 128.1 | 271.0 | 336.2 | 236.1 | 572.3 | 11748.3 |
| Large | High | U | 146.6 | 99.0 | 105.1 | 218.5 | 297.6 | 199.6 | 497.1 | 9413.0 |
| Large | High | T | 154.9 | 125.6 | 152.1 | 275.6 | 343.4 | 245.4 | 588.8 | 12191.5 |
| **Mean** | | | **132.7** | **104.0** | **130.2** | **262.5** | **324.6** | **230.2** | **554.8** | **11189.1** |
| Small | Low | U | 142.9 | 115.1 | 136.4 | 315.3 | 412.2 | 272.8 | 685.0 | 13600.2 |
| Small | Low | T | 160.4 | 137.2 | 117.1 | 274.7 | 394.4 | 258.8 | 653.2 | 13663.5 |
| Small | High | U | 129.1 | 164.2 | 140.1 | 330.0 | 438.1 | 288.4 | 726.4 | 14061.0 |
| Small | High | T | 124.4 | 114.1 | 99.6 | 227.7 | 326.2 | 216.7 | 543.0 | 10480.2 |
| **Mean** | | | **139.2** | **132.7** | **123.3** | **286.9** | **392.7** | **259.2** | **651.9** | **12951.2** |
| LSD (0.05) | Main effect | | 27.9 | 21.4 | 25.5 | 46.2 | 56.0 | NS | 96.5 | 2109.6 |
| ANOVA | SS | | NS | ** | NS | NS | ** | NS | * | 0.10 |
| | Pro | | NS | NS | NS | NS | NS | NS | NS | NS |
| | GA | | NS | NS | NS | NS | NS | NS | NS | NS |
| | SS x Pro | | * | NS | NS | NS | NS | NS | NS | NS |
| | SS x GA | | NS | NS | 0.06 | * | 0.09 | NS | 0.10 | NS |
| | Pro x GA | | NS | NS | NS | NS | NS | NS | NS | NS |
| | SS x Pro x GA | | NS | ** | NS | NS | NS | NS | NS | NS |

NS: not significant; *, **, ***: significant, P<0.05, 0.01, and 0.001, respectively.