Project Title: Herbicide Injury Potential to Montana Wheat Varieties

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Objective: To evaluate herbicide tolerance and the expression of stem solidness among genetically diverse spring wheats

Results:

Two studies were conducted to evaluate spring wheat cultivar susceptibility to herbicides. In the first study, eight spring wheat cultivars (Reeder, McNeal, Choteau, Outlook, Hank, MTHW0202, MT0260, and MT0245) were evaluated for their tolerance to the wild oat herbicides, Everest and Silverado. This study was conducted at Kalispell and Huntley. At Kalispell, the cultivars were planted in a wild oat-free area on April 16, 2005 at a seeding rate of 90 lb/ac, on 6 inch row spacings, to a depth of 2 inches. At Huntley, the cultivars were planted in a wild oat infested area on April 8, 2005. Everest (0.026 lb ai/a) and Silverado (0.0028 lb ai/a) were applied with $CO_2$ backpack sprayers in 20 GPA of water using XR11002 nozzles on May 6, 2005 at Huntley and May 11, 2005 at Kalispell. Wheat plants were at three leaf stage and about 4 inches when herbicides were applied. Non-treated controls were included for each cultivar.

At Kalispell, maximum crop injury was observed at 2 weeks after herbicide application, and ranged from 11 to 33% (Table 1). Injury was primarily observed in the form of plant height reduction. Height reductions were most severe for Silverado, but were also observed with Everest. The degree of crop injury varied and appeared to be greater for specific varieties. Using a 20% crop injury rating as a benchmark, both Everest and Silverado initially caused greater than 20% injury in Choteau, Hank, McNeal and Outlook. While crop injury was noticeable early in the season, the extent of the symptoms decreased as the season progressed. Nonetheless, both herbicides reduced yields in some varieties when compared to the non-treated controls. Specifically, the yields of Reeder and MT0260 were decreased by both herbicides. However, Everest also tended to reduce the yields of Choteau, Outlook, MT0245, and MTHW0202. Neither herbicide appeared to affect test weight, thousand kernel weight, lodging, or the degree of stripe rust infection.

Injury was minimal at Huntley during the entire season (Table 2). This response underscores the impact that environment has on the degree of herbicide injury. Nonetheless, Silverado tended to cause greater injury than Everest. The extent of this injury varied by variety, with Choteau having the greatest damage (12.5%). Since weeds were present in the non-treated control plots, the direct effect of herbicide damage on yield is not possible. Accordingly, yields were highest when the herbicides were applied. However, the extent of the yield increase was minimal with Reeder and indicates that Reeder was more sensitive to both herbicides.

While the first study evaluated the obvious effects of herbicide damage, the second study investigated the impact that herbicides might have on stem solidness. This second study was conducted at Kalispell and consisted of fifteen herbicide treatments. Scholar spring wheat was planted on April 27, 2005 at a seeding rate of 75 lb/ac, on 7 inch row spacing, and seeded to a depth of 2 inches. Four representative herbicides from the auxinic, ALS, and ACCase herbicide classes were applied at the 3 to 4 leaf stage. Additionally, an individual representative of each herbicide class was applied during the flag leaf stage. Herbicides were applied using a backpack sprayer with Teejet XR11002 nozzles in 20 GPA.

The individual effects of herbicides on stem solidness were only observed in the fifth internode. For the early applications, Ally, and to a lesser extent Express, tended to increase stem solidness the most (Table 3). This conclusion was further substantiated when the analysis considered herbicides grouped based on their mode of action (Table 4). Treatments consisting of the ALS herbicide group had the highest stem solidness rating. This was observed for the fourth as well as the fifth internode. Moreover, early applications of auxinic herbicides tended to result in lower stem solidness ratings for the fifth internode as compared to the ALS herbicide class. The late application of Discover also increased stem solidness.

Summary:

The extent of crop injury from wild oat herbicides varied by location, with herbicide damage being more apparent at Kalispell compared to Huntley. Crop injury also varied between the herbicides, and was generally more severe with Silverado as compared to Everest at both locations. Certain cultivars also appeared to have greater susceptibility to herbicide injury. This was most apparent at Kalispell, where both products injured Choteau, Hank, McNeal, and Outlook. Although crop injury was greatest with these varieties, yield reductions were observed with Reeder and MT0260. The yield of Reeder also appeared to be suppressed at Huntley.

Herbicide effects were also observed with stem solidness. Preliminary results indicate that the ALS herbicides may potentially increase stem solidness, while auxinic herbicide may decrease pith development.

Future Plans:

Repeat both studies to confirm these preliminary results.

Table 1. Crop injury and agronomic data in spring wheat cultivars as influenced by Everest and Silverado herbicides at Kalispell, MT during 2005.

| Cultivar | Treatment | Plant height (cm) | | | Crop injury (%) | | Yield | Test weight | Grain moisture | TKW | Heading | Lodging | Stripe rust 7/8/05 | Protein |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 5/24/05 | 6/9/05 | 7/22/05 | 5/26/05 | 6/9/05 | bu/ac | lb/bu | % | g | Julian | % | % | % |
| Choteau | Control | 25.8 | 36.5 | 78.3 | 0.0 | 0.0 | 91.1 | 58.7 | 11.2 | 27.50 | 172.0 | 1.3 | 26.3 | 13.6 |
| | Everest | 19.0 | 33.3 | 78.8 | 30.0 | 10.0 | 86.5 | 59.6 | 11.2 | 28.90 | 173.3 | 0.0 | 23.8 | 13.3 |
| | Silverado | 18.5 | 33.8 | 78.8 | 26.3 | 11.3 | 91.5 | 59.1 | 11.2 | 28.92 | 173.0 | 0.0 | 21.3 | 13.6 |
| Hank | Control | 27.8 | 40.8 | 80.0 | 0.0 | 0.0 | 88.8 | 55.4 | 10.4 | 33.38 | 171.0 | 0.0 | 10.0 | 13.5 |
| | Everest | 21.3 | 36.0 | 80.5 | 23.8 | 6.3 | 86.9 | 56.4 | 10.8 | 34.69 | 172.3 | 0.0 | 12.5 | 12.9 |
| | Silverado | 21.5 | 36.5 | 79.8 | 25.0 | 10.0 | 89.2 | 55.5 | 10.4 | 32.72 | 172.0 | 0.0 | 12.5 | 13.3 |
| McNeal | Control | 26.5 | 37.0 | 89.3 | 0.0 | 0.0 | 54.8 | 53.1 | 9.2 | 26.05 | 173.5 | 0.0 | 57.5 | 13.3 |
| | Everest | 20.0 | 33.5 | 86.3 | 25.0 | 3.8 | 53.2 | 54.7 | 9.5 | 26.97 | 174.8 | 0.0 | 57.5 | 12.7 |
| | Silverado | 19.8 | 35.0 | 86.5 | 27.5 | 6.3 | 54.4 | 53.4 | 9.3 | 26.21 | 175.0 | 0.0 | 55.0 | 13.0 |
| Outlook | Control | 25.3 | 34.3 | 88.8 | 0.0 | 0.0 | 83.5 | 54.3 | 9.7 | 27.97 | 174.5 | 0.0 | 10.0 | 13.0 |
| | Everest | 18.8 | 33.3 | 86.8 | 21.8 | 5.0 | 79.2 | 54.8 | 9.8 | 27.08 | 176.0 | 0.0 | 11.3 | 12.4 |
| | Silverado | 17.3 | 31.3 | 89.5 | 33.3 | 11.3 | 82.7 | 54.4 | 9.8 | 26.47 | 175.8 | 0.0 | 12.5 | 12.5 |
| Reeder | Control | 28.3 | 40.8 | 89.0 | 0.0 | 0.0 | 109.2 | 60.1 | 12.1 | 32.28 | 172.0 | 2.5 | 11.3 | 13.0 |
| | Everest | 24.3 | 38.3 | 87.5 | 12.5 | 3.8 | 100.1 | 60.1 | 12.4 | 32.44 | 172.8 | 2.5 | 10.0 | 12.7 |
| | Silverado | 23.0 | 32.3 | 87.5 | 15.0 | 2.5 | 102.7 | 59.6 | 11.7 | 31.94 | 172.8 | 1.3 | 13.8 | 13.4 |
| MT0245 | Control | 28.3 | 40.3 | 84.3 | 0.0 | 0.0 | 94.6 | 57.4 | 11.0 | 29.56 | 172.8 | 3.8 | 16.3 | 13.4 |
| | Everest | 23.0 | 37.8 | 83.5 | 10.8 | 2.5 | 86.7 | 57.2 | 11.0 | 29.32 | 173.5 | 5.0 | 20.0 | 13.8 |
| | Silverado | 21.5 | 38.8 | 83.3 | 15.8 | 3.8 | 94.4 | 56.7 | 10.7 | 29.93 | 173.0 | 5.0 | 11.3 | 14.0 |

Table 1 (Continued). Crop injury and agronomic data in spring wheat cultivars as influenced by Everest and Silverado herbicides at Kalispell, MT during 2005.

| Cultivar | Treatment | Plant height (cm) | | | Crop injury (%) | | Yield | Test weight | Grain moisture | TKW | Heading | Lodging | Stripe rust 7/8/05 | Protein |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 5/24/05 | 6/9/05 | 7/22/05 | 5/26/05 | 6/9/05 | | | | | | | | |
| | | | | | | | bu/ac | lb/bu | % | g | Julian | % | % | % |
| MT0260 | Control | 26.8 | 39.8 | 88.8 | 0.0 | 0.0 | 96.2 | 57.0 | 11.8 | 31.60 | 173.5 | 16.8 | 37.5 | 12.3 |
| | Everest | 22.3 | 34.8 | 87.8 | 12.5 | 2.5 | 92.5 | 55.6 | 12.0 | 31.10 | 174.8 | 20.5 | 47.5 | 12.5 |
| | Silverado | 22.5 | 36.8 | 89.8 | 15.0 | 4.5 | 90.9 | 55.6 | 11.5 | 30.68 | 175.0 | 23.8 | 42.5 | 12.9 |
| MTHW0202 | Control | 29.8 | 43.0 | 83.8 | 0.0 | 0.0 | 94.4 | 60.4 | 11.1 | 34.92 | 165.5 | 0.0 | 8.8 | 13.1 |
| | Everest | 21.8 | 40.0 | 83.3 | 16.3 | 7.5 | 90.6 | 60.7 | 11.2 | 34.91 | 166.0 | 0.0 | 8.8 | 12.7 |
| | Silverado | 23.0 | 41.3 | 82.8 | 19.5 | 10.0 | 99.4 | 60.8 | 11.1 | 35.59 | 166.0 | 0.0 | 8.8 | 12.7 |
| LSD (0.05) | Herbicide (A) | 0.9 | 1.8 | NS | 1.6 | 1.3 | 2.1 | NS | 0.2 | NS | 0.2 | NS | NS | |
| | Cultivar (B) | 1.5 | 3.0 | 2.4 | 2.6 | 2.1 | 3.4 | 0.7 | 0.4 | 0.77 | 0.4 | 3.0 | 5.5 | |
| | AxB | NS | NS | NS | 4.5 | 3.6 | NS | NS | NS | NS | NS | NS | NS | |

NS: Not significant (P>0.05).

Table 2. Crop injury and agronomic data in spring wheat cultivars as influenced by Everest and Silverado herbicides at Huntley, MT during 2005.

| Cultivar | Treatment | Crop injury (%) | | | | Yield | Test weight | Grain moisture | TKW | Protein |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 5/20/05 | 6/6/05 | 6/24/05 | 7/8/05 | bu/ac | lb/bu | % | g | |
| Choteau | Control | 0.0 | 0.0 | 0.0 | 0.0 | 80.8 | 60.4 | 14.1 | 27.1 | 9.1 |
| | Everest | 5.0 | 3.8 | 3.8 | 3.3 | 95.0 | 61.5 | 14.0 | 26.4 | 10.2 |
| | Silverado | 12.5 | 11.3 | 10.0 | 12.3 | 92.1 | 61.6 | 14.1 | 28.7 | 9.9 |
| Hank | Control | 0.0 | 0.0 | 0.0 | 0.0 | 87.2 | 60.2 | 13.4 | 33.0 | 9.7 |
| | Everest | 3.8 | 0.0 | 0.0 | 0.0 | 99.8 | 60.7 | 13.5 | 33.8 | 10.4 |
| | Silverado | 5.0 | 2.5 | 0.0 | 0.0 | 103.5 | 60.7 | 13.5 | 34.4 | 10.3 |
| McNeal | Control | 0.0 | 0.0 | 0.0 | 0.0 | 76.0 | 61.8 | 13.3 | 29.8 | 10.3 |
| | Everest | 7.5 | 5.0 | 5.0 | 4.5 | 89.9 | 61.8 | 13.4 | 29.5 | 11.1 |
| | Silverado | 7.5 | 6.3 | 6.3 | 5.8 | 86.5 | 61.9 | 13.0 | 30.1 | 10.7 |
| Outlook | Control | 0.0 | 0.0 | 0.0 | 0.0 | 89.2 | 61.0 | 13.3 | 27.9 | 10.0 |
| | Everest | 5.0 | 1.3 | 3.8 | 2.5 | 100.4 | 61.5 | 13.1 | 27.9 | 10.2 |
| | Silverado | 1.3 | 1.3 | 2.5 | 2.5 | 97.3 | 61.3 | 13.3 | 28.9 | 10.0 |
| Reeder | Control | 0.0 | 0.0 | 0.0 | 0.0 | 83.8 | 61.2 | 13.8 | 28.0 | 10.4 |
| | Everest | 2.5 | 3.8 | 7.5 | 7.5 | 86.8 | 61.8 | 13.5 | 28.3 | 10.8 |
| | Silverado | 7.5 | 7.5 | 8.3 | 8.8 | 87.4 | 61.8 | 13.4 | 28.8 | 10.4 |
| MT0245 | Control | 0.0 | 0.0 | 0.0 | 0.0 | 85.1 | 60.8 | 13.6 | 27.8 | 9.9 |
| | Everest | 2.5 | 1.3 | 1.3 | 1.3 | 96.5 | 61.0 | 13.6 | 27.4 | 10.3 |
| | Silverado | 5.0 | 0.0 | 1.3 | 1.3 | 98.4 | 61.2 | 13.7 | 28.5 | 10.1 |

Table 2 (Continued). Crop injury and agronomic data in spring wheat cultivars as influenced by Everest and Silverado herbicides at Huntley, MT during 2005.

| Cultivar | Treatment | Crop injury (%) | | | | Yield | Test weight | Grain moisture | TKW | Protein |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 5/20/05 | 6/6/05 | 6/24/05 | 7/8/05 | | | | | |
| | | | | | | bu/ac | lb/bu | % | g | |
| MT0260 | Control | 0.0 | 0.0 | 0.0 | 0.0 | 81.5 | 61.0 | 13.9 | 32.6 | 9.4 |
| | Everest | 3.8 | 6.3 | 6.3 | 4.0 | 103.2 | 61.5 | 13.8 | 32.2 | 9.5 |
| | Silverado | 2.5 | 2.5 | 3.8 | 3.3 | 95.9 | 61.5 | 13.7 | 33.5 | 9.5 |
| MTHW0202 | Control | 0.0 | 0.0 | 0.0 | 0.0 | 86.4 | 62.7 | 13.7 | 30.7 | 9.6 |
| | Everest | 0.0 | 0.0 | 1.3 | 1.3 | 95.1 | 62.9 | 13.6 | 30.6 | 10.8 |
| | Silverado | 7.5 | 0.0 | 0.0 | 0.0 | 90.4 | 62.9 | 13.7 | 31.6 | 9.3 |
| LSD (0.05) | Herbicide (A) | 1.5 | 1.4 | 1.6 | 1.4 | 4.7 | 0.2 | NS | 0.6 | |
| | Cultivar (B) | 2.5 | 2.2 | 2.6 | 2.3 | 7.7 | 0.3 | 0.3 | 1.0 | |
| | AxB | 4.4 | 3.8 | 4.5 | 4.1 | NS | NS | NS | NS | |

NS: Not significant (P>0.05).

Table 3. Effects of herbicides on spring wheat stem solidness and agronomic performance in 2005.

| Trt No. | Treatment name | Rate | Appl. code | Stem solidness | | | | | | Yield | Test weight | Grain moisture | Protein |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Internode | | | | | Total | | | | |
| | | (lb a/a) | | 1 | 2 | 3 | 4 | 5 | | bu/ac | lb/bu | % | % |
| 1 | Clarity | 0.1250 | A | 3.2 | 2.5 | 2.9 | 3.0 | 3.1 | 15.0 | 54.9 | 60.5 | 11.9 | 13.2 |
| 2 | 2,4-D ester | 0.9500 | A | 3.0 | 2.6 | 3.0 | 3.2 | 3.5 | 15.3 | 50.5 | 59.5 | 11.3 | 13.6 |
| 3 | Stinger | 0.1240 | A | 3.1 | 2.5 | 2.4 | 2.7 | 2.9 | 14.3 | 56.0 | 59.0 | 11.1 | 14.5 |
| 4 | Starane | 0.1250 | A | 3.3 | 2.6 | 2.7 | 2.8 | 3.1 | 14.7 | 51.1 | 59.0 | 11.3 | 14.2 |
| 5 | Everest | 0.0262 | A | 4.1 | 2.7 | 2.9 | 3.3 | 3.4 | 17.2 | 45.1 | 59.5 | 11.8 | 14.5 |
| 6 | Silverado | 0.0028 | A | 3.6 | 3.0 | 3.1 | 3.4 | 3.3 | 16.6 | 50.9 | 59.7 | 12.1 | 13.5 |
| 7 | Express | 0.0156 | A | 3.0 | 2.4 | 2.6 | 3.1 | 3.8 | 15.3 | 51.0 | 60.8 | 12.1 | 12.6 |
| 8 | Ally | 0.0038 | A | 3.3 | 2.6 | 3.3 | 3.7 | 4.3 | 17.3 | 47.0 | 61.0 | 11.8 | 12.8 |
| 9 | Pinoxaden | 0.0520 | A | 3.6 | 2.5 | 2.3 | 2.5 | 3.1 | 15.0 | 53.9 | 59.2 | 11.4 | 13.7 |
| 10 | Hoelon | 1.0000 | A | 3.8 | 2.9 | 2.8 | 3.1 | 3.4 | 18.1 | 52.7 | 59.4 | 11.4 | 13.6 |
| 11 | Discover | 0.0500 | A | 3.9 | 2.8 | 2.8 | 3.0 | 3.6 | 17.1 | 50.0 | 59.6 | 11.6 | 14.1 |
| 12 | Achieve | 0.1800 | A | 3.7 | 2.7 | 2.7 | 3.0 | 3.4 | 16.9 | 57.4 | 59.9 | 11.5 | 13.5 |
| 13 | Stinger | 0.1240 | B | 3.2 | 2.8 | 3.0 | 3.4 | 3.6 | 17.0 | 49.9 | 60.4 | 11.7 | 13.5 |
| 14 | Express | 0.0156 | B | 3.1 | 2.4 | 2.6 | 3.0 | 3.9 | 15.3 | 50.9 | 60.1 | 11.5 | 13.0 |
| 15 | Discover | 0.0500 | B | 3.6 | 3.0 | 3.0 | 2.9 | 4.2 | 17.6 | 52.6 | 59.2 | 11.0 | 12.5 |
| 16 | Check | | | 3.2 | 2.4 | 2.8 | 3.3 | 3.3 | 15.9 | 52.8 | 60.1 | 11.9 | 12.7 |
| | **Mean** | | | **3.4** | **2.7** | **2.8** | **3.1** | **3.5** | **16.2** | **51.7** | **59.8** | **11.6** | **13.5** |
| | **LSD (0.05)** | | | **NS** | **NS** | **NS** | **NS** | **0.78** | **NS** | **NS** | **1.13** | **0.71** | |

A: 3-4-leaf stage; B: Flag-leaf; NS: Not significant (P>0.05).

Table 4. Effects of herbicides applied at 3-4-leaf stage on spring wheat stem solidness and agronomic performance when grouped by mode of action.

| Treatments | Mode of action | Appl. code | Stem solidness | | | | | | Yield | Test weight | Grain moisture | Protein |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Internode | | | | | Total | | | | |
| | | | 1 | 2 | 3 | 4 | 5 | | bu/ac | lb/bu | % | % |
| Trt: 1-4 | Auxinic | A | 3.1 | 2.6 | 2.7 | 2.9 | 3.2 | 14.8 | 53.1 | 59.5 | 11.4 | 13.9 |
| Trt: 5-8 | ALS | A | 3.5 | 2.7 | 3 | 3.4 | 3.7 | 16.6 | 48.5 | 60.3 | 11.9 | 13.4 |
| Trt: 9-12 | ACCase | A | 3.7 | 2.7 | 2.7 | 2.9 | 3.4 | 16.8 | 53.5 | 59.5 | 11.5 | 13.7 |
| **Mean** | | | **3.4** | **2.7** | **2.8** | **3.1** | **3.4** | **16.1** | **51.7** | **59.8** | **11.6** | **13.7** |
| **LSD (0.05)** | | | **0.49** | **NS** | **NS** | **0.38** | **0.41** | **1.65** | **4.61** | **0.65** | **0.33** | |

A: 3-4-leaf stage; NS: Not significant (P>0.05).