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Title The Influence on Winter Wheat Yields of Competitive Weedy Species

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A study was conducted to compare the competitive ability with weeds of the short-strawed Gaines variety wheat and taller growing varieties under different fertility levels at three experimental locations. The experiments were designed so that the effects of variety, nitrogen fertilization, and weed competition could be evaluated. The interactions between these factors were also studied. Ryegrass (*Lolium spp.*) and downy brome (*Bromus tectorum*) were the two weed species studied.

Under high winter rainfall and ryegrass competition yields of wheat were seriously impaired in both the short and tall growing wheat varieties tested. As rates of nitrogen increased yields of wheat did not increase

where a medium or heavy stand of ryegrass was present. Yield of wheat was reduced under high nitrogen and high ryegrass competition. A response to 60 pounds of nitrogen per acre was noted where no ryegrass competition was present. One hundred twenty pounds of nitrogen did not increase yields appreciably, especially in the Gaines variety.

In the two remaining experiments, response to nitrogen fertilization was not as prominent due to lack of moisture throughout the growing season. However, downy brome competition decreased yields at one location under all three fertility levels. At the other location a poor stand of downy brome and arid conditions accounted for the lack of competitive effects.

No differences were noted in competing abilities of the tall vs. the short growing varieties. In general it was concluded that in order to get maximum response from nitrogen fertilization in wheat, weeds would have to be controlled.

THE INFLUENCE ON WINTER WHEAT YIELDS OF COMPETITIVE WEEDY SPECIES

by

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INTRODUCTION

Gaines, a new semi-dwarf variety of wheat, has been released in the Pacific Northwest for commercial production. This variety has a characteristic short-stiff straw which prevents lodging under high fertility and optimum moisture conditions.

Previous work has shown that shorter-growing varieties will out-yield taller-growing varieties when levels of nitrogen are increased. In these studies the taller-growing varieties lodged while the semi-dwarf varieties stood up well at high levels of nitrogen fertilization. Repeated trials have shown that Gaines will out-yield the taller varieties with less production of straw. This indicates the variety is more efficient at utilizing moisture and nutrients. Therefore, the semi-dwarf characteristic is a definite advantage.

This characteristic could also be a disadvantage since the plant is limited genetically in the height it can grow. Short straw could hinder its ability to compete with weeds. Limited information is available on the relative competitive ability of the semi-dwarf varieties. There is no information regarding the influence of fertility level on the relative competitive ability of the new variety.

It is the purpose of this thesis to study the effects nitrogen fertilization and different levels of weed competition have on the Gaines variety of wheat compared with standard varieties. The interactions between these factors are also studied.

REVIEW OF LITERATURE

Semi-dwarf Growth Habit

The semi-dwarf varieties originated from a cross between a semi-dwarf Japanese variety, Norin 10, and Brevor (33, p. 76). Previous published studies on semi-dwarf wheats have been carried out with selections from this cross. In these studies date of seeding, response to fertilization, growth habits, efficiency of moisture utilization and weed competition were investigated (2, p. 74), (31, p. 87).

In general the semi-dwarf varieties can be seeded earlier in the fall without danger of lodging during the later stages of growth. This is advantageous in areas where erosion is a problem (31, p. 78). Planting wheat early in the fall assures a soil cover by the time late fall and early winter rains occur, thus reducing erosion on sloping fields. The disadvantage of early seeding is that wheat plants are more susceptible to foot rot infection during the early fall when temperatures are favorable (20, p. 3).

One of the main factors responsible for increased yields of the semi-dwarf varieties compared with taller growing varieties under high fertility conditions is their ability to resist lodging. Beutler (2, p. 74) reported lodging resistance of semi-dwarf varieties at high rates of nitrogen fertilization. Likewise, Swearingin, (31, p. 88) in trials grown under higher moisture conditions, concluded that semi-dwarf selections were outstanding in their lodging resistance, and that nitrogen response could be related to economic response without appreciable risk of lodging.

The growth pattern of semi-dwarf varieties is somewhat different from that of taller growing varieties. Differences in emergence have been shown by Mallory (17, p. 54), Morrison and Vogel (20, p. 3), and Beutler (2, p. 74). In general the semi-dwarf selections did not emerge as uniformly as the standard varieties. The reason for this difference has not been shown or explained.

After emergence and establishment the growth of semi-dwarf selections is similar to taller varieties until they reach a height of six inches (2, p. 74). At maturity the plants may be as much as 18 inches shorter than other varieties under high rainfall, and about 4 inches shorter in lower rainfall areas (20, p. 1). Root penetrations of the shorter growing varieties are about the same as the standard varieties (21, p. 43).

Of particular economic importance is comparison of semi-dwarf and tall varieties from a moisture utilization standpoint. With special evapo-transportation techniques it has been shown that it takes approximately as much moisture to grow both varietal types (2, p. 32). Repeated trials (31, p. 77), (33, p. 78) have shown the semi-dwarf varieties are higher in grain yields and lower in straw yield than taller growing varieties. This evidence supports the contention that shorter growing varieties will yield more grain than standard varieties when moisture is the limiting factor.

The ability of the semi-dwarf selections to compete with weeds has not been extensively studied. It has been reported that semi-dwarf lines planted later in the fall do not have the same ability to compete with spring weeds as taller varieties, because of a smaller increase in height during the spring months (21, p. 42). It also has been suggested that the main effects of competition on yield are exerted late in the growing season (31, p. 89).

The Gaines variety used in this study is of the semi-dwarf type. It was developed by Vogel *et al* (33, p. 76) in a breeding program starting with a cross made at Pullman in 1949, between progeny of Norin 10 and Brevor. A selection from this cross was then crossed with a selection from a cross of Orfed and a sister selection of Brevor. A selection from the progeny was crossed with Burt in 1952. Selection for the variety was made at Pullman in 1956, (20, p. 5).

The Gaines variety uses nutrients and moisture more effeciently than other wheats. Under four years of testing in Washington and two years in Oregon and Idaho, Gaines outyielded Omar, Brevor, Burt, and Columbia (20, p. 3).

Effect of Nitrogen Fertilization on Performance of Wheat

Response of wheat to nitrogen fertilization has been given considerable attention by investigators. Available soil nitrogen has been shown to be an important factor limiting wheat yields in many parts of the world (10, p. 33). Amount and time of nitrogen application is determined by local conditions. The efficiency of nitrogen applications in increasing yields is largely dependent upon the available soil moisture supply during the growing season (13, p. 311).

Most recommendations for rate of nitrogen application are based on trials over a period of years in a particular area. Hunter et al (14, p. 1) reported responses to nitrogen in the Columbia Basin of Oregon based on four years data from 173 experimental sites. Approximately 75% of these sites showed yield increases, 15% showed yield decreases and 10% showed neither an increase nor a decrease (14, p. 6). Pumphrey (25, p. 1) concluded that winter wheat in the Columbia Basin planted on summer fallow land will need 30-60 pounds of nitrogen per acre. In the Palouse area in Washington a ten-year study (1, p. 138) showed rates of 20, 30, and 40 pounds of nitrogen per acre increased yields 6.4, 11.0, and 12.8 bushels respectively. The most economical rate for the period was 30 pounds of nitrogen. Increased yields have also been reported from nitrogen fertilization in Iowa in 12 of 15 experiments conducted during the crop years of 1944, 1945, and 1946 (3. p. 396).

Until the introduction of the short-strawed wheat, lodging was always a problem in obtaining optimum yield response from nitrogen. Laude and Arland (15, p. 452) found yields were reduced about one-third due to lodging 1 to 2 weeks before heading or 1 to 2 weeks after heading. Black et al (3, p. 396) concluded that wheat plants showed a tendency to lodge after rates of nitrogen neared or exceeded the amount required for maximum yield.

Few studies have been carried out to compare semi-dwarf selections with taller growing varieties in response to nitrogen fertilization. Early studies indicated the advantage of having a stiff strawed variety where increased rates of nitrogen were used (36, p. 17). Beutler (2, p. 75) compared some semi-dwarf selections and concluded they responded differently especially at early seeding dates. Swearingin (31, p. 88) concluded that no direct differences in ability to respond to nitrogen were observed between the semi-dwarf selections and the standard varieties. Indirectly lodging and disease resistance were considered important factors in determining yield responses.

Time of nitrogen application could be a critical factor in obtaining maximum grain yields. In pot cultures in the greenhouse it was found that later times of application resulted in smaller increases in total dry matter and straw (35, p. 413). The increase in the yield of grain on the other hand, was constant for early applications, but after ear emergence no increase in yield was noted. Generally, in higher winter rainfall areas an autumn application is not as effective as spring application due to leaching (3, p. 22). In lower rainfall areas (10-20 inches) a comparison of fall- and spring- applied nitrogen indicated the latter was least efficient (14, p. 9).

Effect of Weed Competition on Performance of Wheat

Decrease in cereal yields due to weed competition has been studied by Blackman and Templeton (5, p. 247), Mann and Barnes (18, p. 32), Pande (22, p. 297), Pavlychenko (23, p. 77) and Walcott (34, p. 482). In all cases cereal yields were decreased where weed competition was present.

The most prevalent weeds in cereal crops are annuals (23, p. 79). However, Walcott (34, p. 486) reported that quackgrass (*Agropyron repens* L. Beauv.) is a particular problem in some cereal growing areas. An apparent 28% infestation of quackgrass (based on green plant material) reduced grain yields as much as 30 percent.

Nearly all competition studies are designed with practical ends in view, and limited information is available to explain plant competition (8, p. 34). Pumphrey (26, p. 159) from an experiment in root development of weeds and crops grown in competition concludes, "The competition (between weeds and crop) commences under the soil surface when the root systems overlap in their search for water and nutrients. The competition immediately manifests itself in the retarded development of the top growth and becomes intensified by top growth competition for light once shading of one plant species by the other takes place".

Investigation has shown that competition for moisture, nutrients, and light is responsible for decreased grain yields. Pumphrey (26, p. 159) found that moisture was the predominate limiting factor in the open plains of Western Canada when considering weed versus crop competition. Blackman and Templeton (5, p. 271) concluded that during a year of normal rainfall competition between the crop and the weed is principally for nitrogen and light. Pande (22, p. 302) found that competition of weeds was more serious when plant nutrients were scarce.

<u>Ryegrass (Lolium Species)</u> Ryegrass is a common weed in western Oregon grain fields. It has also been a

problem in grain fields throughout Europe and Asia (6, p. 280). Most of the cultivated land in western Oregon is contaminated with ryegrass due to previous use as pasture or for ryegrass seed production. This ryegrass is known locally as Oregon common ryegrass (28:338). The seed and plant characteristics indicate a combination of characters of both Lolium multiflorum Lam. and Lolium perenne L.. One study showed ryegrass overseeded in winter wheat at the rate of 4, 8, and 16 pounds per acre decreased wheat grain yields 19, 36, and 50 percent, respectively, over a two year period in western Oregon (31, p. 88). In this same study grain yield was reduced about 5% more in the semi-dwarf varieties at given ryegrass levels.

No information is available on the relationship between increasing levels of nitrogen at different levels of ryegrass competition.

Downy brome (Bromus tectorum L.) Downy brome is an annual grass which was introduced into this country approximately 70 years ago from Europe (11, p. 20). It has been commonly referred to as cheatgrass, bronco grass, june grass (11, p. 1), downy brome, slender chess, early chess, and frequently spoken of in Michigan as wild oats (20, p. 153). Hitchcock's manual of grasses (12, p. 54) refers to Bromus tectorum commonly named downy chess, and reports it occurs in every state except the four most southern states (12, p. 55).

Megee (19, p. 154) has shown that downy brome will germinate from September to October 15 and also from April to June if moisture is present. These plants will go on to produce luxuriant growth and heavy seed production. Fleming et al (11, p. 5) found if there was not enough moisture for late summer or fall germination the seeds did not germinate until the following spring. Germination may also occur during mild periods in winter. In general a dry fall followed by a cold spring results in scanty growth, and opposite conditions result in heavy production (24, p. 5). Downy brome along with being a pest in cereals (7, p. 261), is also a problem on rangeland (24, p. 5). In 1946, competitive effects of downy brome were measured on transplants of bluestem wheatgrass (27, p. 162). Yields of the downy brome-free plots were five times greater than where downy brome was a competitor. Carter (7, p. 267) concluded that downy brome stands can be reduced if a sufficiently uniform thick stand of wheat exists. Under these conditions the downy brome did not tiller and sent up single slender stems.

MATERIALS AND METHODS

Experimental Design

Basically the experimental design used was a split-plot factorial design with four replications per block. Treatments consisted of varieties, rates of nitrogen fertilizer and weed levels. The varieties were randomized within replications. Nitrogen rates and weed levels were randomized within varietal blocks. The general design for all three experiments is shown in Figure I.

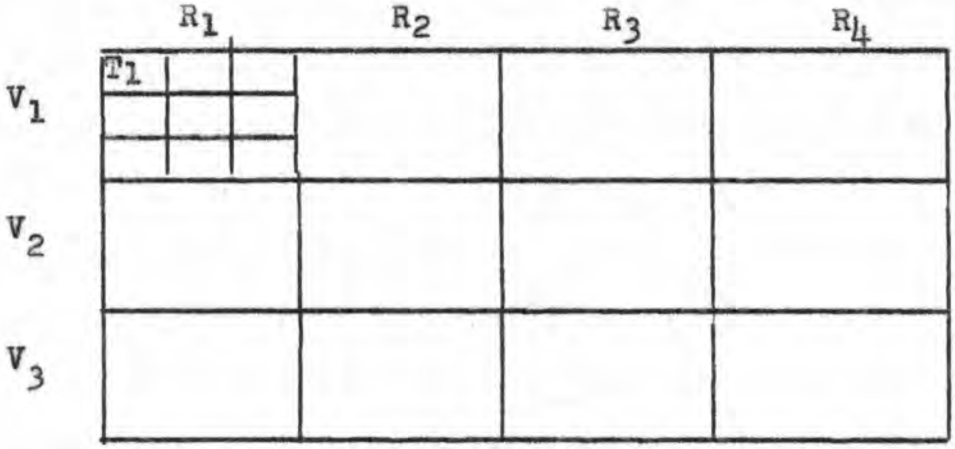

Figure I. General field plot design used in all three locations.

The analysis of variance was used to determine significant differences between treatment means and interaction means. The least significant difference

(LSD) was used to determine (16, p. 234) significant differences within the treatments. Only treatment means that showed significance in the analysis of variance were tested by the use of LSD. All analyses of variance for the three variables measured are reported in the appendix.

Weight of grain yield, weight of wheat straw, plant height, and weight of weed straw were measured. An analysis of variance was not calculated for weight of weed straw since no weeds were present at the zero level. One of the assumptions underlying the analysis of variance is that the variances are equal. In this case one of the variances is known to equal zero making the analysis invalid.

Plant Materials

The Gaines variety of wheat was used in all three experimental areas. To compare its performance, standard varieties for each area were used for comparisons. Gaines was compared with Omar and Burt at the Pendleton and Sherman Branch Experiment Stations in eastern Oregon. At Hyslop Agronomy Farm, Corvallis, Druchamp, Burt and Gaines were the varieties planted.

Ryegrass was overseeded at 0, 10, and 20 lbs. per acre at the Hyslop Agronomy Farm. Common ryegrass seed with a germination of 85% was used. Downy brome was overseeded at the Sherman and Pendleton stations at rates of 0, 15, and 30 lbs. per acre. The seed used for this purpose turned out to be poor in germination. The plots were reseeded with a new lot of seed in March of 1962.

Experiment I - Hyslop Agronomy Farm

Originally, this experiment was designed to test the performance of three varieties under three levels of fertility, three levels of ryegrass competition, and three levels of wild oat competition. The varieties Druchamp, Burt, and Gaines were planted in varietal blocks 50' x 70' with a commercial planter. A planting rate of 60 pounds of wheat seed per acre was used. Three varietal blocks were randomized within each four replications giving a total of (3 var. x 4 rep.) 12 varietal blocks. Fifteen 10' x 25' plots were measured within each varietal block for fertilizer and weed levels treatments. The fifteen treatments (3 rates of nitrogen x 5 levels of weed competition) were randomized within each varietal block.

Nitrogen fertilizer was added to the designated plots at a rate of 60 and 120 pounds of actual nitrogen per acre applied with a 10 foot commercial fertilizer spreader. The nitrogen was in the form of ammonium nitrate, and applied as a top dressing after planting the wheat varieties.

Two species of weeds were hand broadcast at five rates in the designated plots. The five weed level treatments consisted of:

1. No weed seed.
2. 10 lbs. of ryegrass seed per acre.
3. 20 lbs. of ryegrass seed per acre.
4. 100 lbs. of wild oat seed per acre.
5. 200 lbs. of wild oat seed per acre.

The experimental site was on Range 15 on the Hyslop Agronomy Farm near Corvallis, Oregon. The soil is Woodburn silty-clay-loam of generally high fertility and good drainage. The field had been in red clover since 1957, and was plowed in the spring of 1961 and left in fallow until this experiment was established in the fall. The only commercial fertilizer that had been applied to this site in previous years was in

1959 when 200 pounds of single super-phosphate was applied uniformly per acre. The field was essentially free of either ryegrass or wild oats.

The plots were harvested during the second and third weeks of September, 1962. Sub-samples of two rows eight feet long were cut at ground level. From this sample the wheat straw and weed straw were separated and weighed. The ryegrass straw had shattered its seed and no attempt was made to measure ryegrass seed yield. Height of wheat plants was measured by averaging five randomly chosen stems from this sample.

The rest of the plot was harvested with a seven-foot plot combine. This served as a sample to estimate yield of grain.

Experiment II - Pendleton Branch Experiment Station

Experiment II was similar to Experiment I in design. Omar, Burt, and Gaines were the varieties planted in varietal blocks at the rate of 30 pounds of seed per acre. Ammonium nitrate fertilizer was used at rates of 0, 30, and 60 pounds of actual nitrogen per acre. Downy brome, Bromus tectorum was over-seeded at three rates of seeding, 0, 10, and 20 pounds of seed per acre.

The experiment was replicated four times with three varietal blocks within each replication. Within each varietal block nine 10' x 25' plots were measured and subsequently treated at the three levels of nitrogen and the three levels of weed seed.

The plots were planted during the third week in October. Earlier seeding was not feasible because of dry conditions. The nitrogen was applied as a top dressing after planting.

Downy brome seed was planted in the designated plots after the wheat was planted and fertilized. It was found later that this seed had been run through a hammer mill and had a germination of 1%. Therefore, a new source of downy brome seed was found which had a germination of 98% and this was planted during the second week in March.

The experimental site was located on the Pendleton Branch Experiment Station. The soil type is Walla Walla silt loam. The previous cropping system on this site since 1959 included:

1958-1959	Fallow
1959-1960	Wheat
1960-1961	Fallow

A soil analysis of total nitrogen previous to setting up this experiment showed 0.1% present.

The plots were harvested July 25 and 26, 1962 by randomly cutting two head rows eight feet long out of each plot. Weight of threshed grain, height of wheat plants, amount of downy brome straw, and amount of wheat straw were measured from this sample. Estimates of downy brome seed yield were not measured because the seed head shattered at the time of harvest.

<u>Experiment III - Sherman Branch Experiment Station</u>

The design and treatments for this experiment are exactly as outlined in Experiment II. The only difference is in method of harvesting. Since a plot combine was available in the area, yield data were taken by harvesting the plot after a sub-sample of two eight foot rows were cut and bundled as outlined in Experiment I. From the sub-sample five random wheat stalks were chosen and averaged, and this served as an estimate of height of the wheat plants. The wheat and downy brome straw also was separated from this sample and weighed. No attempt was made to measure downy brome seed yield.

The site of this experiment was on the Sherman Branch Experiment Station. The soil type is Walla Walla silt loam. The experiment was planted during the third week in October 1961, and harvested during the third week in July, 1962. Previous to this experiment the land was in summer fallow during 1960-1961, Omar winter wheat during 1959-1960, and summer fallow during 1958-1959.

EXPERIMENTAL RESULTS

Experiment I - Hyslop Agronomy Farm

Precipitation for the crop year 1961-1962 is shown in Table I. Adequate moisture was available in the fall, winter and spring for optimum growth. As is usually the condition in the Willamette Valley, moisture was limiting during the summer months of June, July and August.

Good germination and establishment of all the varieties was noted approximately three weeks after the planting date. The wild oats and ryegrass also germinated and established about the same time. However, due to a freezing period from December 9 to 12 when temperatures were as low as 19°F, the wild oat plants died from frost damage. Therefore, the wild oat plots were deleted from the experiment.

Upon observation of the wheat plants in early June, all the Burt varietal blocks showed symptoms of stripe rust. By August this variety was so infected with stripe rust its reddish-brown color stood out among the other varieties. In mid-August the 60 pound and 120 pound nitrogen plots of this variety lodged badly. During the second week in September just prior to harvest a heavy rain occurred. Lodging left this variety in such condition that accurate yield data appeared impossible to obtain.

Table 1 Precipitation at Hyslop Agronomy Farm 1961-1962

Month	1961-1962 Crop Year	Normal
September	1.18	1.30
October	3.73	3.53
November	6.79	5.44
December	6.21	6.15
January	1.21	6.42
February	3.82	5.10
March	6.37	4.06
April	2.90	2.10
May	2.31	1.85
June	.39	1.29
July	Trace	.32
August	.57	.38
Totals	35.48	37.94

The analysis of variance for the three variables measured in this experiment is shown in Appendix Table 1. Summary tables for the four variables measured are shown in Appendix Tables 2, 3, 4 and 5. Treatment means that are significantly different are presented in this section.

Wheat Yields Response to nitrogen fertilization is shown in Table 2. A significant decrease with the high rate of nitrogen is noted. The indirect effects of disease and lodging appeared to account for the decrease at the 120 pounds of nitrogen level.

Effect on yield from different levels of ryegrass competition was most pronounced in the experiment. Table 3 shows that as ryegrass competition increased yield of grain decreased. The amount of ryegrass straw present at the 10 and 20 pound seeding level exemplifies the reason for this decrease. An average ryegrass straw yield of over one and two tons respectively was measured. A summary table of ryegrass straw for the two seeding levels is shown in Table 4.

Table 2 Mean yields of grain under three levels of nitrogen fertilization. Mean of four replications

Pounds of Nitrogen Per Acre	Yield of Grain in Bushels Per Acre
0	72.3
60	76.4
120	65.5

$LSD_{.05} = 6.1$

Table 3 Mean yields of grain under three levels of weed competition. Mean of four replications.

Weed level	Yield of Grain in Bushels Per Acre
0	85.6
10	71.6
20	57.1

LSD $_{.05}$ = 6.1

Table 4 Summary table of ryegrass straw yield in pounds per acre at two ryegrass seeding levels and three rates of nitrogen fertilization. Mean of four replications.

Rate of Nitrogen/acre	Pounds of Ryegrass Seed/Acre 10	20	Ave.
0	1427.0	4319.0	2873.0
60	2573.8	4485.0	3529.4
120	2927.5	6798.8	4863.2
Average	2309.4	5200.9	

Interactions of weed levels with fertility levels as reported in Table 5 show similar yield decrease trends due to ryegrass competition at the different fertility levels. At the higher seeding levels the yield decrease with increased levels of fertility is much greater. At zero weed

Table 5 Mean yields of grain under three levels of nitrogen fertilization and three levels of weed competition. Mean of four replications.

Pounds of Nitrogen Per Acre	Weed Level 0	Weed Level 10	Weed Level 20
		Bushels Per Acre	
0	79.7	77.2	60.2
60	93.7	72.2	63.3
120	83.4	65.3	47.9

$LSD_{.05} = 10.5$

level a response to nitrogen is noted, but at the other two levels, yields decrease, especially at the high rates of nitrogen. The lack of response to nitrogen when ryegrass is present as a competitor can be best explained by examining the amount of ryegrass straw present under different fertility levels (Table 4).

The interaction between rate of nitrogen fertilization and variety (Table 6) is confounded by a negative response of the Gaines variety at the 120 pound rate of nitrogen fertilization. Whether this response was due to disease is not known. However, it was suspected by the investigator that a serious infection of foot rot existed in the high fertility Gaines plots.

Table 6 Mean yields of grain in bushels per acre under three levels of fertility across two varieties. Mean of four replications.

Pounds of Nitrogen Per Acre	Variety	
	Druchamp	Gaines
0	69.4	75.2
60	75.5	77.3
120	73.4	57.6

LSD $_{.05}$ = 8.6

<u>Weight</u> <u>of</u> <u>Wheat</u> <u>Straw</u> Weed level and nitrogen x weed level interaction were calculated and found to be significantly different from the estimated error mean square. Upon individual evaluation of weed level treatments by use of the LSD as shown in Table 5, weight of wheat straw shows the same trend as did the grain yields in the previous section. As the ryegrass level increased, weight of wheat straw decreased significantly.

Table 7 Mean weight of wheat straw under three levels of ryegrass competition.

Weed Level	Weight of Wheat Straw in Tons Per Acre
0	4.2
10	3.5
20	3.2

LSD $_{.05}$ = 0.3

The interaction of nitrogen with weed rate is more difficult to explain. As might be expected at zero weed level weight of straw was increased by the nitrogen treatments. There is no significant difference from increased nitrogen level up to 60 pounds at a weed seeding rate of 10 pounds per acre. However, at the high level of nitrogen an increased weight of wheat straw is noted. The data show just the opposite at high nitrogen rates and high weed levels. The general trend of straw weight at a given fertility level is downward as the weed level is increased.

Table 8 Mean weight of wheat straw in tons per acre at three levels of nitrogen fertilization and three weed levels. Mean of four replications.

Pounds of Nitrogen Per Acre	Weed Level 0	10	20
0	3.8	3.5	3.3
60	4.5	3.2	3.6
120	4.4	3.9	2.7

$LSD_{.05} = 0.5$

Plant Height Gaines variety wheat averaged 9.4 inches shorter than Druchamp. The analysis of variance for height of wheat plants is shown in Appendix Table 1.

Experiment II - Pendleton Branch Experiment Station

The 1961-1962 crop year was a relatively dry year in the Columbia basin area. Table 9 summarizes the precipitation by months for the year as compared to a normal year. Particularly noticeable is the dry fall in 1961. At planting time little soil moisture was available in the top three inches of soil. However, by March a good stand of wheat was noticeable in all varietal blocks.

Table 9 Precipitation at Pendleton Branch Experiment Station. Pendleton, Oregon, 1961-1962

Month	1961-1962 Crop Year	Normal*
September	0.39	0.67
October	0.86	1.43
November	1.59	1.74
December	2.23	2.08
January	0.91	1.87
February	0.73	1.58
March	2.49	1.63
April	1.12	1.51
May	3.40	1.44
June	0.26	1.50
July	Trace	0.26
August	0.67	0.28
Totals	14.65	16.01

* 1931-1955 (Used by U.S. Weather Bureau as Normal)

The downy brome was planted in March and germinated soon afterward. A sparse stand resulted. Upon close investigation it was found that the downy brome plants did not tiller but sent up one stem per plant. There was no significant response to nitrogen in any of the three variables analyzed. This is probably due to the high fertility of the experimental site as previously reported or to the lack of moisture.

Yield of Grain A definite varietal difference existed in yield of threshed grain as shown in the analysis of variance in Appendix Table 6. Upon investigation of the individual varietal means Omar yields averaged 31.85 bushels per acre as compared with 38.53 bushels for Burt, and 41.95 bushels for Gaines. The LSD at the 5% level between these varieties is 7.14 bushels.

Level of downy brome also had an effect on the treatment mean as reported in Table 10. Even though a thin stand of downy brome was present in the plots it had a definite effect by decreasing grain yields. Average amount of downy brome straw measured at the 0, 15, and 30 pound seeding levels was 41.9, 367.3 and 1876.8 pounds per acre respectively.

Table 10 Mean yield of threshed grain at three levels of downy brome competition. Mean of four replications.

Weed Level	Threshed Grain in Bushels Per Acre
0	45.8
15	41.9
30	37.2

LSD $_{.05}$ = 3.2

Weight of wheat straw

As in Experiment I the amount of downy brome competition and also the interaction between nitrogen levels and fertility had a significant effect on the treatment means. Table 11 summarizes the effect of weed level on the amount of wheat straw. The general trend indicates decreased straw with increased weed levels. Increased levels of weed competition at a given rate of nitrogen fertility tended to decrease straw yields (Table 12).

Table 11 Mean amount of wheat straw at three levels of downy chess competition. Mean of four replications.

Weed Level	Tons of Wheat Straw Per Acre
0	2.34
15	2.19
30	2.12

LSD $_{.05}$ = 0.13

A significant third order interaction between nitrogen, weed level, and variety is shown upon analysis. No attempt is made to analyze this interaction further due to its complexity.

Table 12 Mean weight of wheat straw in tons per acre at three levels of nitrogen. Mean of four replications.

Pounds of Nitrogen Per Acre	Weed Level		
	0	15	30
0	4.94	4.20	4.84
30	4.56	4.23	3.67
60	4.24	4.13	3.84

LSD $_{.05}$ = 0.80

Although the weight of wheat straw showed no variation between varieties, difference in grain yield indicates the efficiency of the Gaines variety. This is brought out by comparing the "straw to grain ratio" of the varieties. The average straw/grain ratios for the three varieties tested were as follows: Omar 19.5, Burt 16.5, and Gaines 14.1.

Plant Height

The only treatment that showed a significant effect on plant height was varietal effects. Omar averaged 47.2 inches in height, Burt 40.0 inches, and Gaines 27.4 inches. The least significant difference between mean, at the 5% probability level, was calculated as 1.7 inches.

Experiment III - Sherman Branch Experiment Station

Due to a dry crop year no response to nitrogen fertilization was noted. The precipitation for the crop year 1961-1962 by months is compared to a normal year and reported in Table 13. Over two inches less rain fell during the months from September to August than during a normal year.

Table 13 Precipitation at Sherman County Experiment Station. Moro, Oregon, 1961-1962

Month	1961-1962 Crop Year	Normal*
September	.07	.49
October	.44	1.15
November	1.48	1.71
December	1.72	1.74
January	.22	1.75
February	1.04	1.23
March	.74	.98
April	.75	.78
May	1.96	.76
June	.05	.90
July	.00	.18
August	.87	.16
Totals	9.44	11.83

* 1931-1955 (Used by U.S. Weather Bureau as Normal)

Especially noticeable were the fall months when the arid condition was not conducive to good germination and establishment of wheat. However, good germination and establishment did occur in early winter.

Downy brome was planted in the designated plots in early spring, and a thin stand was noticed soon after planting.

Yield of Grain

Varietal differences were the only thing that affected wheat grain yields, although there was a significant interaction noted between nitrogen and weed rate.

Omar variety wheat yield averaged 24.1 bushel, Burt 28.4 bushel, and Gaines 31.4 bushel per acre. The least significant difference between varietal means was calculated to be 5.24 bushel.

Interaction between varietal means is summarized in Table 14. The nitrogen X weed level means are confounded at the high rates of nitrogen and weed levels. A negative response to nitrogen fertilization is shown at the zero weed level.

Table 14 Mean yields of grain in bushels per acre under three levels of fertility across three levels of downy brome competition. Mean of four replications.

Pounds of Nitrogen Per Acre	Weed level		
	0	15	30
0	31.2	29.5	26.9
30	29.6	25.8	25.3
60	25.8	27.6	28.6

$LSD_{.05} = 3.2$

Weight of Wheat Straw

Wheat varieties were the main cause of variation in straw yields. The average straw yields of Omar, Burt, and Gaines were 1.42, 1.68 and 1.70 ton per acre respectively. The LSD between treatment means is calculated as 0.20 tons per acre.

Variation due to the interaction of nitrogen and weed level; weed level and variety; and nitrogen, weed level, and variety is also significant as shown in Appendix Table 11.

The average straw/grain ratios for the three varieties tested are as follows: Omar 16.6, Burt 17.6 and Gaines 16.0. As in the previous experiment Gaines produced grain more efficiently than the other varieties.

Plant Height

As in Experiment I and II variation within height of the three varieties tested was noted. In this experiment Omar averaged 28.3 inches in height, Burt 30.3 inches, and Gaines 23.7 inches. the LSD between treatment means is calculated to be 1.3.

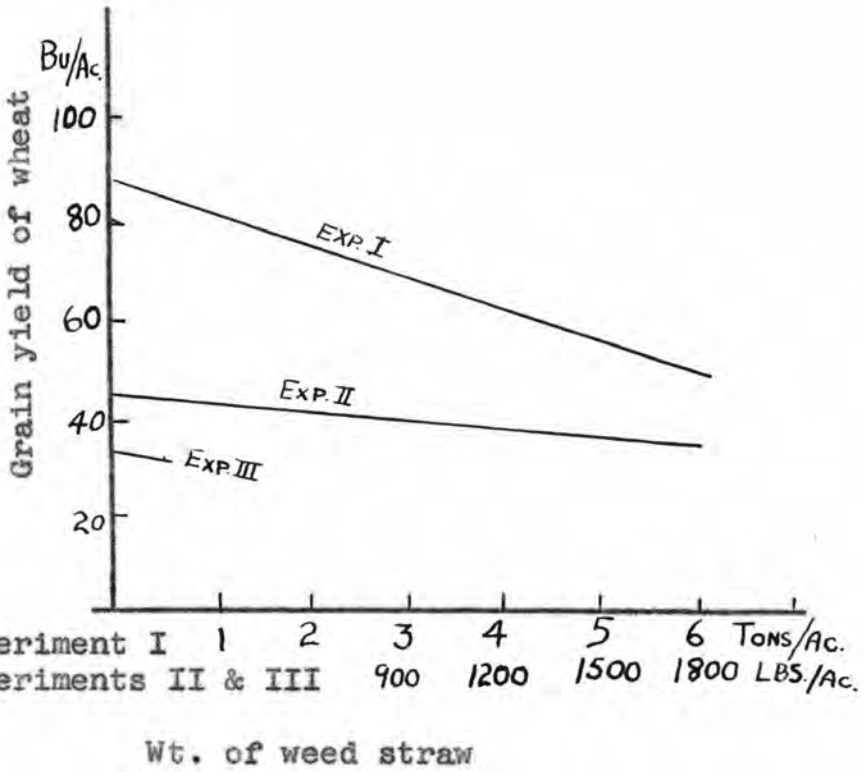

Figure II. Effect of ryegrass and downy brome competition on wheat grain yields at three locations

DISCUSSION

The field experiments were conducted to study interrelationships of variety, fall applied nitrogen, and weed competition from ryegrass and downy brome on the performance of wheat at three different locations. The recently introduced Gaines wheat variety was compared with the standard varieties grown in each area. The three experimental areas were chosen because of difference in rainfall. Experiment I was conducted in a rainfall area which annually receives about 40 inches of precipitation, Experiment II in an area normally receiving 16 inches of precipitation, and Experiment III in an arid area receiving only 12 inches of annual rainfall.

Weeds studied for competitive effects were ryegrass (*Lolium spp.*) in Experiment I, and downy brome (*Bromus tectorum*) in Experiments II and III. These weeds are problems in winter wheat fields in the areas where the experiments were conducted. Their life cycles follow closely that of wheat.

Even though moisture was not a limiting factor in the ryegrass competition study, wheat yields were seriously reduced due to ryegrass competition. Yields of grain were decreased 16.4% and 33.3% due to medium and heavy stands of ryegrass respectively. Under no ryegrass competition, a significant wheat yield response to nitrogen fertilization was noted at the 60 pound level. This increment of nitrogen had no effect on increasing yield when a medium or heavy stand of ryegrass was present. Even at 120 pounds of nitrogen, wheat yields were not increased under ryegrass competition. At this rate of nitrogen, a heavy seeding of ryegrass produced over three ton of ryegrass straw per acre. The data indicate that when ryegrass was present, nitrogen fertilization enhanced ryegrass competition and had no effect on increasing grain yields of wheat. One could conclude from this that in order to get maximum grain yield response nitrogen fertilization, ryegrass competition would have to be minimized.

Where moisture was limiting, nitrogen fertilization did not increase yields appreciably. Due to a relatively dry crop year in the Columbia Basin and high original fertility status of the soil, the wheat at the Pendleton Experiment Station showed no response to nitrogen. However, downy brome competition decreased grain yields at all three fertility levels.

The competition afforded by the weed was definitely for moisture since this was the main limiting factor in growth. This again points out the importance of weed competition in cereal crop production.

At the Sherman Experiment Station downy brome competition did not impair wheat yields, but the amount of weed growth was small (Appendix Table 15). Low soil moisture and poor quality weed seed accounted for the sparse stands present. Fall germinated downy bromegrass in a more normal rainfall year could give different results.

Wheat yields in this experiment showed a negative response to nitrogen fertilization, which is not uncommon during a dry year (14, p. 8) (3, p. 393). It can be reasoned that nitrogen fertilization increased foliar growth using up available soil moisture prior to ear emergence.

Gaines outperformed Omar at both the Pendleton and Sherman stations. Since moisture was limiting at both experimental sites, and since the straw to grain ratio of Gaines is less than the taller growing varieties, this supports previous evidence that Gaines produced grain more efficiently than the taller varieties (20, p. 2).

There was no difference in the varieties tested for their ability to compete with weeds. As postulated earlier the semi-dwarf habit of Gaines may seriously hinder the plants ability to compete with weeds. If height of the plant were a criterion in competing ability then it can be assumed that competition was for light. This was not the case in any of the three experiments. In Experiment I competition was mainly for nutrients and in the other two experiments moisture was the main limiting factor.

This study clearly points out the seriousness of weed competition in limiting grain yields of wheat. The amount of ryegrass and downy chess straw demonstrates the magnitude of the problem, especially when one considers that this straw when measured had already shed its seed. These weeds utilized moisture and nutrients, that otherwise would have been available to the wheat plants.

Although competitive effects of downy brome were shown, this study did not give an accurate measure of competition. The downy bromegrass used for overseeding the plots in the fall turned out to be poor in germination. This was particularly detrimental to downy brome establishment because dry conditions were not conducive to good establishment. The plots were overseeded with a new seed lot of downy brome in the spring but at this time, the plants produced did not give a normal competition pattern. Further studies are needed on this weed and other weedy species that cannot be controlled by cultural or chemical practices. It is hoped this research will bring about further investigations on the importance of weed competition from various species. Such information should stimulate use of effective weed control practices or research on control measures.

SUMMARY

This study was initiated with the purpose of comparing standard tall wheat varieties with the short-strawed Gaines variety in response to nitrogen fertilization, and ability to compete with weeds. The interactions of the factors variety, nitrogen and weed competition were studied. The results of these experiments are summarized as follows:

1. Both Druchamp and Gaines varieties showed superior resistance to lodging as compared to the Burt variety.

2. In western Oregon 60 pounds of nitrogen increased yields significantly where no ryegrass competition was present. Nitrogen fertilization where ryegrass was present had no effect on yield of wheat.

3. As ryegrass competition was increased, yield of wheat decreased. The same effect was observed with downy brome.

4. The data on ryegrass competition indicates that under high fertility and high weed competition, wheat yields are reduced.

5. No difference in the competing ability of Gaines and the taller growing varieties was observed at any of the three locations.

6. Gaines variety responded negatively to the high rate of nitrogen, whereas Druchamp variety did not.

7. Gaines was significantly different in height from the taller varieties in all three experiments.

8. As weed level increased weight of wheat straw decreased in two of the three experiments.

9. No response to nitrogen was observed at two locations. This lack of response was explained by the lack of adequate soil moisture and/or fertility level of the soils prior to conducting the experiment.

10. Gaines outyielded the taller varieties when tested under low rainfall conditions.

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APPENDIX

Appendix Table 1 Analysis of Variance for the Three Variables of Experiment I. Hyslop Agronomy Farm

Variation Due To	D.F.	Mean Squares: Yield of Grain	Mean Squares: Yield of Wheat Straw	Mean Squares: Plant# Height
Replication	3	308.378	.088	0.0104
Variety	1	137.024	.390	19.6356**
Error A	3	250.572	.469	0.0139
Treatment	17	840.597**	1.522*	1.2467**
Nitrogen	2	724.130**	.377	0.3626
Weed Rate	2	4871.432**	8.161**	0.0906
N x W	4	256.129	1.459**	0.0420
N x V	2	795.105**	.642	0.0518
W x V	2	107.468	.327	0.0606
N X W x V	4	32.585	.148	0.0649
Error B	51	109.437	.218	0.0164
Total	71	292.915	.525	0.3108

** Significant at the 1% probability level
* Significant at the 5% probability level
# The total mean square was used to make the data more meaningful

Appendix Table 2 Wheat Grain Yields in Bushels per Acre at Hyslop Agronomy Farm. 1961-1962. Mean of Four Replications.

Variety	Rate of N	Rate of Ryegrass Seed Planted 0	10	20
Druchamp	0	76.0	78.2	54.1
	60	90.6	73.4	62.4
	120	89.1	74.2	57.0
Gaines	0	83.3	76.1	66.2
	60	96.8	71.0	64.1
	120	77.6	56.4	38.7

Appendix Table 3 Weight of Wheat Straw in Tons Per Acre at Hyslop Agronomy Farm. 1961-1962. Mean of Four Replications.

Variety	Rate of N	Rate of Ryegrass Seed Planted 0	10	20
Druchamp	0	4.0	3.1	3.1
	60	4.7	3.3	3.7
	120	4.2	4.1	2.5
Gaines	0	3.6	3.8	3.4
	60	4.3	3.0	3.5
	120	4.6	3.6	2.8

Appendix Table 4 Plant Height in Inches at Hyslop Agronomy Farm 1961-1962. Mean of Four Replications.

Variety	Rate of N	Rate of Ryegrass Seed Planted 0	10	20
Gaines	0	37.0	38.0	38.0
	60	38.3	38.3	39.8
	120	38.5	39.3	40.0
Druchamp	0	46.0	48.8	47.5
	60	48.3	51.3	47.0
	120	50.5	50.0	51.8

Appendix Table 5 Weight of Ryegrass Straw in Pounds per Acre at Hyslop Agronomy Farm 1961-1962. Mean of Four Replications

Variety	Rate of N	Rate of Ryegrass Seed Planted 0	10	20
Druchamp	0	0	1777.5	3920.5
	60	0	1722.5	3775.0
	120	0	3325.0	6850.0
Gaines	0	0	1076.5	4717.5
	60	0	3425.0	5195.0
	120	0	2530.0	6747.5

Appendix Table 6 Analysis of Variance for the Three Variables of Experiment II. Pendleton Experiment Station

Variation Due To	D.F.	Yield of Grain	Weight of Wheat Straw	Plant Height
Replication	3	306.89	.3200	8.580
Variety	2	1173.17*	.03011	3623.774**
Error A	6	153.47	.07228	8.840
Treatment	26	217.66**	.19608**	281.781**
Nitrogen	2	32.38	.060925	9.176
Weed Rate	2	676.28**	.451910**	.645
N x W	4	58.55	.40887**	6.804
N x V	4	40.17	.04825	1.893
W x V	4	138.63	.13311	1.495
N x W x V	8	113.61	.20761**	2.294
Error B	78	46.10	.07640	4.157
Total	107	95.10	.11231	71.741

** Significant at the 1% probability level
* Significant at the 5% probability level

Appendix Table 7 Yield of Grain in Pounds Per Acre at Pendleton Branch Experiment Station. 1961-1962 Mean of Four Replications.

Variety	Rate of N	Rate of Downy Brome seed planted 0	15	30
Omar	0	42.7	38.0	35.1
	30	27.7	39.4	35.0
	60	36.4	33.0	31.3
Burt	0	46.7	43.2	39.8
	30	51.7	42.3	37.2
	60	44.1	42.9	37.6
Gaines	0	58.9	44.8	39.1
	30	57.4	45.3	38.1
	60	46.7	47.9	46.3

Appendix Table 8 Weight of Wheat Straw in Tons Per Acre at Pendleton Branch Experiment Station. 1961-1962. Mean of Four Replications.

Variety	Rate of N	Rate of Downy Brome Seed Planted 0	15	30
Omar	0	2.44	2.38	1.95
	30	2.26	1.98	2.36
	60	2.07	2.37	2.08
Burt	0	2.39	1.93	2.19
	30	2.65	2.36	2.06
	60	1.97	2.20	2.46
Gaines	0	2.59	2.14	1.83
	30	2.44	2.34	1.89
	60	2.23	2.00	2.24

Appendix Table 9 Height of Wheat Plants in Inches at Pendleton Branch Experiment Station. 1961-1962. Mean of Four Replications

Variety	Rate of N	Rate of Downy Brome Seed Planted 0	15	30
Omar	0	46.7	47.4	46.0
	30	45.8	46.5	47.5
	60	47.9	49.1	48.0
Burt	0	40.6	39.7	39.3
	30	41.5	40.4	39.8
	60	38.8	39.8	40.9
Gaines	0	28.2	27.0	25.9
	30	27.1	28.2	27.9
	60	27.3	27.5	27.7

Appendix Table 10 Weight of Downy Brome Straw in Pounds Per Acre at Pendleton Branch Experiment Station. 1961-1962. Mean of Four Replications

Variety	Rate of N	Rate of Downy Brome Seed Planted 0	15	30
Omar	0	61.8	445.3	1475.5
	30	9.8	224.3	1612.0
	60	6.5	308.8	2067.0
Burt	0	123.5	341.3	1701.3
	30	42.3	360.8	2353.0
	60	55.3	949.0	2050.8
Gaines	0	16.3	188.5	2414.8
	30	22.8	331.5	1391.0
	60	39.0	237.3	1826.5

Appendix Table 11. Analysis of Variance for the Three Variables of Experiment III. Sherman Branch Experiment Station

Variation Due To	D.F.	Yield of Grain	Weight of Wheat Straw	Plant Height
Replication	3	152.91	.50467	9.6142
Variety	2	452.63*	3.44300*	419.5926**
Error A	6	82.68	.45733	5.0865
Treatment	26	61.78**	.54150**	34.3704**
Nitrogen	2	9.30	.11400	2.7523
Weed Rate	2	1.31	.18500	.0370
N x W	4	67.42**	.22400*	4.3044
N x V	4	35.84	.10700	.8498
W x V	4	27.44	.22450*	2.1334
N x W x V	8	19.63	.54638**	2.4593
Error B	78	14.88	.09587	2.5309
Total	107	30.14	.21570	10.4662

** Significant at the 1% probability level
* Significant at the 5% probability level

Appendix Table 12 Yield of Grain in Bushels Per Acre at Sherman Branch Experiment Station. 1961-1962 Mean of Four Replications

Variety	Rate of N	Rate of Downy Brome Seed Planted 0	15	30
Omar	0	27.9	25.3	24.3
	30	22.7	25.9	19.2
	60	23.8	22.7	25.3
Burt	0	30.4	29.0	26.5
	30	29.9	25.7	27.9
	60	28.9	27.3	30.2
Gaines	0	35.5	34.4	29.9
	30	36.2	29.8	28.9
	60	24.9	32.8	30.3

Appendix Table 13 Weight of Wheat Straw in Tons Per Acre at Sherman Branch Experiment Station 1961-1962. Mean of Four Replications.

Variety	Rate of N	Rate of Downy Brome Seed Planted 0	15	30
Omar	0	1.45	1.41	1.40
	30	1.39	1.53	1.31
	60	1.42	1.35	1.47
Burt	0	1.27	1.64	1.54
	30	1.35	1.57	1.55
	60	1.71	1.46	2.00
Gaines	0	1.74	1.61	1.50
	30	1.63	1.64	1.45
	60	1.72	1.39	1.59

Appendix Table 14 Height of Plants in Inches at Sherman Branch Experiment Station. 1961-1962 Mean of Four Replications.

Variety	Rate of N	Rate of Downy Brome Seed Planted 0	15	30
Omar	0	27.8	27.8	27.8
	30	28.3	29.3	27.3
	60	27.5	28.8	30.0
Burt	0	31.8	29.0	29.8
	30	30.5	30.0	30.0
	60	30.0	30.5	31.3
Gaines	0	23.8	23.5	23.0
	30	23.3	24.3	24.3
	60	24.0	23.3	23.5

Appendix Table 15 Weight of Downy Brome Straw in Pounds Per Acre at Sherman Branch Experiment Station. 1961-1962. Mean of Four Replications

Variety	Rate of N	Rate of Downy Brome Seed Planted 0	15	30
Omar	0	3.8	104.0	121.8
	30	1.3	93.0	117.0
	60	0	139.8	132.0
Burt	0	4.8	124.8	161.5
	30	1.0	109.3	104.0
	60	0.5	109.3	123.0
Gaines	0	6.8	89.3	113.8
	30	1.8	99.3	154.3
	60	2.3	124.3	137.5

Figure 1
Hyslop Agronomy Farm site showing varietal blocks.

Figure 2
Pendleton Branch Experiment site at harvest time showing varietal blocks with Gaines variety in the immediate foreground, followed by Burt, and then by Omar

Figure 3
Sherman Branch Experiment Site just prior to harvest. Omar variety is to the left and Gaines variety to the right. Note heavy stand of downy brome in the foreground of the Omar variety.

Figure 4
Plot combine used in harvesting wheat at Sherman Branch Experiment Station. The same kind of combine was used at Hyslop Agronomy Farm.

Figure 4
Burt variety growing in plots at the Sherman Station Site. Note the downy brome and how this variety has the ability to grow taller than the cheatgrass.

Figure 6
Gaines variety growing at the site at the Sherman Station. Note how the downy brome grows taller than the wheat in this case.