EFFECT OF SEEDING DATE ON YIELD AND QUALITY OF WINTER WHEAT (cv. NORSTAR) GROWN ON STUBBLE AND CHEMICAL FALLOW IN SOUTHWESTERN SASKATCHEWAN

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ABSTRACT

Winter wheat (cv. Norstar) was seeded at 1 site (clay loam stubble) in 1984-85, and 3 sites (clay loam stubble and chemical fallow, sandy loam stubble and heavy clay stubble) in 1985-86 and 1986-87. Conditions were very different in each year. In 1984-85 freeze up occurred in mid-October resulting in poor hardening. This was followed by severe winter temperatures and a very dry summer. In 1985-86 hardening conditions in fall were good followed by a fairly mild winter and good early spring moisture. In 1986-87 fall conditions were moist, the winter was mild, but spring was warm and dry and the rains came late in summer. Conditions in the summer of 1986 also resulted in severe rust infestation on certain treatments (late dates of seeding).

In all experiments, when winter wheat was seeded into stubble (stubble crop or chemical fallow) adequate plant stands were established to produce a good crop although high yields were not realized in all cases.

A strong year x seeding date interaction was observed. Delayed seeding decreased yields in all tests in both years; yields were decreased more by late seeding in 1986 than in 1987. Stubble crop yields were on average only 77% of those on chemical fallow (at the clay loam site) when the seeding was done at the optimum time of September 1. Both heading and maturity were delayed in both years by late seeding. This was beneficial for late seeded crops in 1987 since they benefited from late season rains, while in 1986 the late seeded crops on clay loam suffered from severe rust infestation.

A strong year effect on protein level was observed at all sites. In 1986, a wet year, protein levels were significantly lower than those of 1985 or 1987 where comparisons can be made. The effect was probably due to the early season drought conditions in 1985 and 1987 (April, May and June) compared to 1986. Seeding date had no effect on protein level except in one test. In all except two treatments, loss of grade on the basis of test weight could be attributed to rust infection in 1986 (Grade of #3 CWRW or Canada Feed). However, additional loss of grade was observed in 1986 because of low protein. The results so far strongly support the recommendation for seeding winter wheat in early September in this area.

INTRODUCTION

Until recent times, winter wheat production in southwestern Saskatchewan was done mainly on conventional summerfallow. In such a system, survival of
the crop through the winter was rather unreliable. As a result, production was localized to 2 or 3 very small areas where the microclimate would allow survival in most winters. Survival to a large degree depends on the severity of low temperatures between fall and spring. Other factors such as depth of seeding, firmness of the seedbed, moisture at seeding time and fertilization are also important.

Optimization of seeding time is probably the single most important factor in production of winter wheat over which the farmer has control. By optimizing seeding time the crop will reach maximum cold stress tolerance by freeze up, on average. Most date of seeding recommendations have been developed using data from time-series experiments conducted on conventional fallow (Table 1). The results for such an experiment with winter rye at Swift Current (1924-1930) are summarized in Figure 1. Seven station years of data indicates that the best time to seed winter rye is between mid-August and mid-September, with September 1 being optimum, on average.

![Graph: Effect of time of seeding winter rye on subsequent grain yield](image)

**Figure 1.** Effect of time of seeding winter rye on subsequent grain yield

Thomson (1947) wrote in his progress report "winter wheat has not been a successful crop at Swift Current, since, in the majority of years it has been badly thinned or completely killed by winter injury ... when it survives the winter it usually yields more than spring wheat and, when July droughts are severe, the difference in favour of winter wheat is frequently very great". This was written in reference to winter wheat under fallow conditions.
<table>
<thead>
<tr>
<th>Authors</th>
<th>Location</th>
<th>Conditions and Comments</th>
<th>Optimum Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taggart (1924-1930)</td>
<td>Southwest Saskatchewan</td>
<td>Fallow (winter rye)</td>
<td>Sept. 1</td>
</tr>
<tr>
<td>Martin et al. (1926)</td>
<td>Western U.S.</td>
<td>Summary</td>
<td>Variable</td>
</tr>
<tr>
<td>Janssen (1929)</td>
<td>Wisconsin</td>
<td>Fallow</td>
<td>Around Sept. 21</td>
</tr>
<tr>
<td>Slykhuis et al. (1957)</td>
<td>Lethbridge, Alberta</td>
<td>Delay if root rot, WSMV</td>
<td>Sept. 1-Sept. 15</td>
</tr>
<tr>
<td>Ferguson &amp; Finkner (1969)</td>
<td>New Mexico</td>
<td>Dryland fallow</td>
<td>Late Sept.-Early Oct.</td>
</tr>
<tr>
<td>Kolp et al. (1973)</td>
<td>Wyoming</td>
<td>Fallow</td>
<td>Sept. 4-Sept. 11</td>
</tr>
<tr>
<td>Peck &amp; Croy (1973)</td>
<td>Oklahoma</td>
<td>Irrigated</td>
<td>Oct. 1-Oct. 15</td>
</tr>
<tr>
<td>Bruehl et al. (1974)</td>
<td>Washington</td>
<td>Fallow</td>
<td>Around Sept. 16</td>
</tr>
<tr>
<td>Freyman (1978)</td>
<td>S. Alberta</td>
<td>- 4 wks &lt; vernalization cond.</td>
<td>Sept. 1-Sept. 15</td>
</tr>
<tr>
<td>Smid &amp; Jenkinson (1979)</td>
<td>Ontario</td>
<td>Varietal differences</td>
<td>Sept. 24-Oct. 9</td>
</tr>
<tr>
<td>Fowler (1983)</td>
<td>Northern Saskatchewan</td>
<td>Fallow, stubble</td>
<td>Aug. 15-Sept. 1</td>
</tr>
<tr>
<td>Fowler (1986)</td>
<td>Northern &amp; Eastern Saskatchewan</td>
<td></td>
<td>Sept. 1</td>
</tr>
</tbody>
</table>
Denike (1954) reported that both fall rye and winter wheat tend to respond in a similar manner to various cultural practices. Factors influencing survival included snow cover, date, method and depth of seeding, and the amount of reserve soil moisture. Seeding should be shallow into a firm, moist seedbed. The optimum time to seed winter wheat was late August to early September.

Anderson (1969) first described a system of summerfallow for the southwest of Saskatchewan whereby weeds could be controlled chemically and stubble preserved for snow trapping to protect the winter wheat crop. He compared the chemical fallow system with minimum tillage and conventional fallow. Chemical fallow outyielded minimum till by 15% and conventional fallow by 40% from 1966-1968. Winters were described as having uniform snow cover and higher than average late winter temperatures. Recent interest in extended rotations raises the possibility of winter wheat as a stubble crop. The possibility of snow trapping and more assured winter survival makes winter wheat an alternative to spring wheat to be considered. As a stubble crop, optimum seeding times have not been thoroughly worked out, and, in particular, the severity of the consequences of seeding at some time other than optimum.

Under conventional fallow conditions the optimum time of seeding for both fall rye and winter wheat has been shown to be in the first part of September (Taggart 1923-1929; Slykhuis et al. 1957; Pitman and Andrews 1961; Freyman 1978; Fowler 1983). Delays of seeding past the middle of September usually led to a severe decline in yields.

Under irrigation, a delay of seeding of 1 to 2 weeks can produce successful crops (Ferguson and Finkner 1969; Finkner et al. 1974; Pitman and Andrews 1961). Slykhuis et al. (1957) reported that a delay of seeding could help avoid severe effects of root rot and WSMV. Freyman (1978) concluded that seeding should be done 4 to 6 weeks prior to the onset of conditions for vernalization. This time has considerable variation, but in most years in southwestern Saskatchewan should occur in the first 2 weeks of September.

The effects of date of seeding on stubble vs summerfallow have been investigated by Fowler (1983, 1986). Most locations were in the Parkland and eastern Saskatchewan areas. Comparison of 2 years of data (Fowler 1983) showed much less drastic yield reductions for stubbled-in winter wheat than for summerfallow winter wheat with delayed seeding dates. Data from a different set of environments (Fowler 1986) showed about a 46% reduction in yield of both stubbled-in winter wheat and winter rye between seeding in the first week of September and the first week of October.

The effect of seeding date under stubble conditions in southwestern Saskatchewan needs to be thoroughly evaluated as to effects on survival, development, moisture use, maturity, yield and quality parameters. This information may be useful to farmers in the decision-making process on the farm, considering such factors as the severity of grasshopper infestations, soil moisture levels, late harvests and distribution of labour. This data is also useful for economic analysis to determine the profitability of the crop.

**MATERIALS AND METHODS**

This study was conducted on clay loam stubble for 3 years (1985-1987),
clay loam chemical fallow for 2 years (1986 and 1987), clay loam continuous winter wheat in 1986 (lost in 1987 due to volunteer problems), sandy loam stubble for 2 years (1986 and 1987), and on heavy clay stubble for 2 years (1986 the crop was lost to hail, 1987 the crop was lost to drought).

Weather conditions were very different in each year. In 1984-85 freeze up occurred in mid-October resulting in poor hardening. This was followed by severe winter temperatures and a very dry summer. In 1985-86 hardening conditions in fall were good followed by a fairly mild winter and good early spring moisture. In 1986-87 fall conditions were moist, the winter was mild, but spring was warm and dry and the rains came late in summer.

In 1985 on clay loam stubble only 3 seeding times were achieved (mid-September, early October and mid-October) due to late start up of the project and early freeze up. In the 2 subsequent years the treatments were expanded to 5 seeding times at about 15-day intervals, commencing in early September with the final date as close to freeze up as possible. The experiment was laid out in a randomized complete block design with 4 replications.

The seed source used was pedigreed seed of certified class, cv. Norstar. The seeding rate was 60 kg/ha at all seeding dates. Plots were seeded with the Swift Current 0-till offset disc drill at about 1 inch depth. Weeds were controlled using 2,4-D (ester 700) and Hoegrass II and insects were controlled using Hopperstopper, Decis and Furadan as required.

All treatments were fertilized with 30 kg P₂O₅/ha, placed with the seed as 11-51-0, and 60 kg N/ha broadcast in the spring as 34-0-0.

Data collected was stand density in the spring (plants/m²), days to heading and maturity, grain yield, test weight, kernel weight and protein content (percentage).

RESULTS

1. Yield and Agronomic Characteristics

1.1 Clay Loam Stubble

Stand density on clay loam stubble was very low in 1985 (53 plants/m², on average) compared to 1986 and 1987 (Figure 2), especially for the mid-September seeding time. The reason for this is that the winter of 1984-85 was very severe and the plants did not harden to their usual level in the fall of 1984. In 1986 and 1987 plant density decreased significantly with late seeding dates. Plant density on average was greater in 1987 than in 1986 probably due to the mild winter conditions.

Yields were higher in 1986 than in 1987 for early seeding times and similar at late seeding times (Figure 3). Two factors were probably instrumental in this observation. Firstly, late seeding times in 1986 were severely infected with rust, thus limiting yield potential of these seedings; secondly, early seedings in 1987 were probably limited in their yield potential by early season drought (pre anthesis). The significant year x date of seeding interaction is of little practical interest since
the general trend in yield is downward in both years with later seeding dates (Figure 3).

Kernel size (Figure 4) showed about a 50% decrease with late seedings in 1986 (due to rust infections), while in 1987 it increased slightly with later seeding, probably due to the combination of early season drought which decreased early seedings kernel weight and July rains which increased slightly the kernel weight of late seedings.

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Figure 2. Effect of seeding time on plant density in 1986 and 1987 when winter wheat (cv. Norstar) was seeded on sandy loam stubble and clay loam stubble and chemical fallow

1.2 Sandy Loam Stubble

Stand density was highest (on average) at this site; 128 plants/m² compared to 115 on clay loam chemical fallow and stubble crops. The difference is due mainly to late dates of seeding having greater numbers of plants on sandy loam (Figure 2). This site also had the tallest stubble (31 cm) which may have afforded the crop more protection during the winter.
Yields (Figure 3) and kernel size (Figure 4) followed the same trends in both years as those obtained at the clay loam stubble site, although the decrease in kernel mass was not nearly as severe on the sandy loam site as on the clay loam site (no rust infection was observed at the sandy loam site). Yields of early seeded treatments on sandy loam were greater in 1986 than in 1987, but the reverse was true for late seeded crops. This was due to the delayed maturity of late seeded crops in 1987 actually benefiting late seeded crops as they were able to use the late rains which the earlier seeded, earlier maturing crops missed.

Figure 3. Effect of seeding time on grain yield in 1986 and 1987 when winter wheat (cv. Norstar) was seeded on sandy loam stubble and clay loam stubble, chemical fallow and continuous winter wheat stubble (1986 only)

### 1.3 Heavy Clay Stubble Site

In 1986 good plant stands were established, ranging from 128
plants/m² for early seeding to 97 plants/m² for late seeding. Excellent crops were produced but were destroyed by hail just prior to harvest.

1.4 Clay Loam Continuous Winter Wheat

This site was only successfully harvested in 1986. Yields paralleled closely those obtained on chemical fallow (Figure 3); as did plant densities (Figure 2). The crop was lost at this site in 1987 due to severe volunteer problems resulting from the severely rusted crop in 1986.

Figure 4. Effect of seeding time on kernel weight in 1986 and 1987 when winter wheat (cv. Norstar) was seeded on sandy loam stubble and clay loam stubble and chemical fallow

1.5 Clay Loam Chemical Fallow

Stand density decreased less rapidly on chemical fallow with late seeding in 1986 than on the stubble seeding (Figure 2), probably due to a more uniform moisture supply at this site. In 1987 stands were slightly lower on chemical fallow than on stubble. This could be due to two factors: the mild winter of 1986-87 and the taller stubble on the stubble crop area (23 cm) compared to the chemical fallow site (15 cm). Yields averaged 2062 kg/ha on chemical fallow versus 1367 kg/ha on stub-
ble - a 50% yield advantage on chemical fallow vs stubble crop. Although yields were higher on stubble in 1986 than in 1987 due to the higher growing season precipitation in 1986, on chemical fallow the reverse was true. This was likely because moisture limitations were not as critical to this system in 1987 (due to stored moisture), but later development of the 1986 fallow crop exposed the later seeded treatments to rust damage resulting in decreased yields with delayed seeding as was found for the stubble crops.

Kernel mass was generally greater for chemical fallow than for stubble treatments and followed the same pattern in both 1986 and 1987 (Figure 4). Heading was earlier in 1987 than in 1986 (9 d on average) reflecting differences in early season moisture.

2. Quality of Grain

2.1 Clay Loam Stubble

Most dates of seeding would result in a No. 2 CWRW grade or better (Figure 5) with the exception of treatments seeded after mid-September in 1986 and the early November seeding in 1987. In 1986 dates of seeding after mid-September led to severe rust infection resulting in low test weight and kernel weight. Early seeded stubble crops matured early and were affected by early season drought in 1987. Both kernel weight and test weight were reduced by early seeding (Figures 4 and 5) in 1987. For practical grading purposes all seeding dates except early November would receive a No. 2 CWRW grade (Figure 5).

Seeding date had no effect on protein in either year (Table 2); however, a strong year effect was observed on protein level. The presence of a high percentage of piebald kernels would have led to downgrading of the 1986 crop at all dates of seeding even though test weight was good.

2.2 Sandy Loam Stubble

All dates of seeding in both years, with the exception of the early September date in 1987, would result in a No. 1 or 2 CWRW grade (Figure 5). The early seeding date treatment in 1987 matured early and probably suffered from early season drought. This is seen also in the low kernel weight (Figure 4) for the treatment.

Protein levels at this site were high (averaging 13.5%), were not affected by seeding date but were significantly higher in the drier year 1987 (Table 2).

2.3 Heavy Clay Stubble

Although the crop was differentially destroyed by hail and yields were not taken in 1986, samples were taken from the plots to determine test weight, kernel weight and grain protein percentage. Kernel weight and test weight were high (No. 2 CWRW), but protein levels were very low (8.6%) on average (Table 2). These samples would, in all likelihood, be downgraded on the basis of low percentages of hard vitreous kernels to a
Table 2. Effect of seeding date, year and soil texture on protein content of winter wheat (cv. Norstar) in southwestern Saskatchewan (1985-1987)

<table>
<thead>
<tr>
<th>Date</th>
<th>Sandy Loam Stubble</th>
<th>Clay Loam Stubble</th>
<th>Clay Loam Chemical Fallow</th>
<th>Clay Loam Cont. W.W.</th>
<th>Heavy Clay Stubble</th>
<th>OA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Sept.</td>
<td>12.5</td>
<td>13.8</td>
<td>13.2</td>
<td>9.4</td>
<td>12.5b</td>
<td>11.0</td>
</tr>
<tr>
<td>Mid Sept.</td>
<td>12.7</td>
<td>14.4</td>
<td>13.6</td>
<td>12.5</td>
<td>9.3</td>
<td>13.2ab</td>
</tr>
<tr>
<td>Early Oct.</td>
<td>13.1</td>
<td>14.0</td>
<td>13.6</td>
<td>12.8</td>
<td>9.4</td>
<td>13.5a</td>
</tr>
<tr>
<td>Mid Oct.</td>
<td>12.9</td>
<td>13.8</td>
<td>13.4</td>
<td>13.0</td>
<td>9.2</td>
<td>13.2ab</td>
</tr>
<tr>
<td>Early Nov.</td>
<td>12.9</td>
<td>14.2</td>
<td>13.6</td>
<td>9.1</td>
<td>12.9ab</td>
<td>11.0</td>
</tr>
<tr>
<td>Mean</td>
<td>12.8b</td>
<td>14.1a</td>
<td>13.5</td>
<td>12.8b</td>
<td>9.3cd</td>
<td>13.0b</td>
</tr>
</tbody>
</table>
No. 3 CWRW or Feed. No effect of seeding date on protein percentage was detected.

![Figure 5. Effect of seeding time on test weight and grade in 1986 and 1987 when winter wheat (cv. Norstar) was seeded on sandy loam stubble and clay loam stubble and chemical fallow.](image)

2.4 Continuous Winter Wheat on Clay Loam

Effects on test mass and protein were similar to those of the stubble crop.

2.5 Clay Loam Chemical Fallow

Most seeding times in both years resulted in test weight of No. 1 or 2 CWRW (Figure 5) with the exception of the two late dates of seeding in 1986, which were severely infected with rust. As in the stubble crop treatment, protein levels were low in 1986 (Table 2) and would have resulted in downgrading of even the early dates of seeding. Again, no seeding date effect on protein percentage was observed. There was a large year effect (Table 2) with 1986 being extremely low due probably to the high growing season precipitation.
3. **Summary**

3.1 **Plant Densities**

In all cases when winter wheat was planted into stubble or chemical fallow, adequate plant stands were established to produce a good crop, even in the severe winter of 1984-85.

3.2 **Yields**

A strong year x date of seeding interaction was observed. Stubble crop yields were only 77% of those obtained on chemical fallow at the clay loam site, when seeding was done at the optimum date (Sept. 1). Yields decreased with later seeding dates in both years and at all sites. Delayed seeding decreased yield more in 1986 than in 1987 due to distribution of precipitation in 1987 and the high infestation of rust that affected late seeded treatments in 1986.

3.3 **Quality**

A strong year effect on protein level was observed at all sites. Protein levels in 1986 were significantly lower than in 1987 where comparisons can be made. The effect was probably due to the relatively dry early season conditions in 1987 (April, May, June) compared to 1986. In all except two treatments loss of grade due to low test weight was due to severe rust infestations in 1986. Additional loss of grade would occur in 1986 because of low protein. At less than 10% protein a large percentage of the kernels are piebald and result in degrading.

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