SEED RATE AND ROW SPACING STUDIES ON WINTER WHEAT IN NORTHEAST SASKATCHEWAN

by D.K. Tompkins, A.T. Wright and D.B. Fowler

ABSTRACT

Winter wheat seed rate and row spacing combinations were studied with two cultivars on five sites in northeast Saskatchewan over the period 1986-1988. Increasing seed rate and decreasing row spacing resulted in an increase in grain yield for both tall and semi-dwarf cultivars. Increasing the seed rate from 70 to 140 kg/ha resulted in a 14% yield increase. Decreasing the row spacing from 18 to 9 cm resulted in a 9% yield increase. The combination of 140 kg/ha seed rate together with 9 cm row spacing produced a 19% yield increase over the more conventional combination of 70 kg/ha seed rate and 18 cm row spacing. The tall cultivar, Norstar, outyielded the semi-dwarf, Norwin, by 10% and the difference was greatest on dry sites.

A study of soil moisture depletion showed that prior to anthesis, a higher seed rate used more soil moisture, but after anthesis, more soil moisture was used by a lower seed rate. This pattern of soil moisture depletion was reflected in the fact that higher kernel weight was associated with lower seed rate.

INTRODUCTION

Optimum seed rate varies for different growing environments as well as for different agronomic practices. For example, optimum seed rate varies for different moisture and soil nitrogen conditions (Fischer et al, 1975) as well as for cultivar (Anderson, 1986) and tillage practice (Read and Warder, 1982). During the early part of the growing season, much of the incident radiation falls on bare ground and doesn’t contribute to crop growth. Consequently, higher seed rates favour interception of more incoming radiation. However, if the plant density is so high that water and nutrients become limiting, much of the early dry matter production is lost (Puckridge and Donald, 1967). Consequently, dry matter production is often maximized at a higher seed rate than grain production.

It may also be necessary to reduce row spacing to achieve optimum yields in environments where moisture is not a severely limiting factor. For example, Joseph et al (1985) reported an 8-10% yield increase with 10 cm as compared to 20 cm row spacing. Frederick and Marshall (1985), reported an 8% yield increase when row spacing was decreased from 17.8 cm to 12.7 cm. An advantage of narrower row spacings is that the point in time at which overlapping leaves reduces light penetration is delayed (Holiday, 1963).

The Parkbelt area of Saskatchewan tends to have better moisture conditions than many other areas in the Saskatchewan grain growing regions. Winter wheat, in particular, may benefit from high seed rates as winter wheat is better able to make use of spring moisture than spring wheat. Unfortunately, while spring tends to be the time of the year when moisture is least limiting, this is also the time of the year when seedlings are small and most of the incoming solar radiation falls on bare ground. One way to partially alleviate this problem is to not only increase seed rate, but to also utilize narrower row spacing. This study was undertaken to determine whether high seed rates and narrow row spacings would increase grain yield in the Parkbelt.
MATERIALS AND METHODS

1) Agronomy Test

Field experiments were established using a split plot design with four replicates. Cultivars, Norstar and Norwin, were main plots and sub plots were a factorial of 35, 70, 105, and 140 kg/ha seed rates and 9, 18, 27, and 36 cm row spacings.

An offset double disk press drill, custom built to allow different seed rate and row spacing combinations, was used. After seeding in late August or early September, 75 kg/ha P₂O₅ from monoammonium phosphate fertilizer was broadcast. In early May, all plots received 100 kg N/ha as broadcast ammonium nitrate fertilizer. Plots at the Carrot River site in 1987 were also broadcast fertilized with 20 kg S₀₄/ha applied as ammonium sulfate and 80 kg K₂O/ha applied as potash. Plots were harvested in the late summer with a Hége plot combine.

Five sites were established over the period 1986-1988: Aylsham and Melfort in 1986, Carrot River in 1987 and Aylsham and Carrot River in 1988.

2) Yield Component Test

Field experiments were established using a split-split plot design with two replicates. Nitrogen fertility treatments, 0 vs 100 kg applied N/ha were main plots, and cultivars, Norstar and Norwin, were subplots. Sub-subplots were a factorial of 35 and 140 kg/ha seed rate and 9 and 36 cm row spacings, providing extreme conditions for Parkland conditions. Seeding and fertilizing were carried out as for the above test. Head counts were taken just prior to harvest. At maturity two square meter samples were harvested from each plot and used to determine dry matter and grain yield. Kernel weight was measured and kernels/head were derived arithmetically from the other yield component measurements.

On the plots set aside for soil moisture measurements, neutron probe tubes were installed in the plots in early May. Soil moisture measurements were taken using a Troxler 3331 depth moisture gauge in early May, at anthesis and just prior to harvest. Gravimetric samples were used to evaluate moisture in the top 10 cm of the soil profile.

Data were collected from seven sites over the period 1987-1988. One site was located at Carrot River in 1987, and the other six sites were established in 1988; three in the Melfort area, one at Aylsham and two at Carrot River. Soil moisture measurements in 1987 were taken at a Melfort site rather than at the Carrot River site.

RESULTS AND DISCUSSION

1) Agronomy Test

The tall cultivar, Norstar, outyielded the semi-dwarf cultivar, Norwin, by 10% (Table 1). Kernel weight of the two cultivars was similar.

Seed rate and row spacing both had a significant effect on grain yield. Grain yield increased as seed rate increased (Figure 1) and as row spacing decreased (Figure 2). There was a significant interaction of seed rate and row spacing; the response to increased seed rate was greater at narrower row spacings (Figure 3).
At the 18 cm row spacing, increasing the seed rate from 70 to 140 kg/ha resulted in a 14% increase in grain yield (Table 2). At the 70 kg/ha seed rate, decreasing the row spacing from 18 to 9 cm resulted in a 9% grain yield increase. The combination of 140 kg/ha seed rate and 9 cm row spacing produced a 19% increase in grain yield over the combination of 70 kg/ha seed rate and 18 cm row spacing.

There was also a significant interaction between seed rate and cultivar (Figure 4), with Norstar showing a greater response to increased seed rate than Norwin.

Table 1. Effect of winter wheat cultivar on grain yield and kernel weight for five sites, 1986-1988.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Grain Yield (kg/ha)</th>
<th>Kernel Weight (1000 Kernel Wt.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norstar</td>
<td>2470a</td>
<td>31.6a</td>
</tr>
<tr>
<td>Norwin</td>
<td>2240b</td>
<td>31.7a</td>
</tr>
</tbody>
</table>

Within a column, means followed by the same letter are not significantly different at p=0.05.

Table 2. Effect of seed rate and row spacing on grain yield of two winter wheat cultivars averaged over five sites, 1986-1988.

<table>
<thead>
<tr>
<th>Seed Rate (kg/ha)</th>
<th>Row Spacing (cm)</th>
<th>Mean¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2130</td>
<td>2120</td>
<td>2000</td>
</tr>
<tr>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2600</td>
<td>2390</td>
<td>2280</td>
</tr>
<tr>
<td>105</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2670</td>
<td>2580</td>
<td>2320</td>
</tr>
<tr>
<td>140</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2850</td>
<td>2720</td>
<td>2390</td>
</tr>
<tr>
<td>Mean²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2560a</td>
<td>2450b</td>
<td>2250c</td>
</tr>
</tbody>
</table>

¹Within a column, means followed by the same letter are not significantly different at p=0.05.
²Within a row, means followed by the same letter are not significantly different at p=0.05.
Figure 1. Effect of seed rate on grain yield for two cultivars of winter wheat on five sites 1986-1988.

Figure 2. Effect of row spacing on grain yield for two cultivars at five sites, 1986-1988.
Figure 3. Effect on seed rate and row spacing on grain yield for two cultivars at five sites, 1986-1988.

Figure 4. Effect of cultivar and seed rate on grain yield for two winter wheat cultivars at five sites, 1986-1988.
2) Yield Component Test
   a) Grain Yield Components

   The combination of high seed rate and narrow spacing produced the
   highest grain yield (Table 3). High numbers of kernels/head was promoted by
   wide row spacing and low seed rate although row spacing had the greater effect.
   Increased heads/m² was promoted by high seed rate and narrow row spacing, while
   high kernel weight was promoted by low seed rate. The high number of heads/m²
   was the component of grain yield that had the greatest effect on increased yield
   for the high seed rate and narrow row spacing.

   Table 3. Effect of seed rate and row spacing on grain yield and yield components
   for two winter wheat cultivars at six sites, 1987-1988.

<table>
<thead>
<tr>
<th>Row Spacing-Seed Rate (cm)</th>
<th>Grain Yield (kg/ha)</th>
<th>Kernels (no./head)</th>
<th>Heads (no./m²)</th>
<th>Kernel Wt. (g/1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9-140</td>
<td>1610a</td>
<td>17.0c</td>
<td>324a</td>
<td>29.5b</td>
</tr>
<tr>
<td>9-35</td>
<td>1488b</td>
<td>19.3c</td>
<td>276b</td>
<td>30.4a</td>
</tr>
<tr>
<td>36-35</td>
<td>1402bc</td>
<td>28.6a</td>
<td>164c</td>
<td>30.5a</td>
</tr>
<tr>
<td>36-140</td>
<td>1352c</td>
<td>24.7b</td>
<td>184c</td>
<td>29.6b</td>
</tr>
</tbody>
</table>

   Within a column, means followed by the same letter are not significantly
   different at p=0.05.

   b) Soil Moisture Measurements

   Vegetative growth, that occurring prior to anthesis, used more soil
   moisture at high as compared to low seed rate (Table 4). During the
   reproductive growth period, the low seed rate used more soil moisture than the
   high rate. For the growing season as a whole, contrasts showed a significant
   effect due to both seed rate and row spacing. The low seed rate and wide row
   spacing combination used less soil moisture than the other treatments (Figure
   5). The higher water use by the low seed rate during the reproductive period
   resulted in higher Kernel weights (Table 3).

   Table 4. Effect of seed rate and row spacing on water use for one winter wheat

<table>
<thead>
<tr>
<th>Row Spacing-Seed Rate (cm)</th>
<th>Water Use (cm)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vegetative</td>
<td>Reproductive</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>9-140</td>
<td>8.4a</td>
<td>6.8b</td>
<td>15.2a</td>
<td></td>
</tr>
<tr>
<td>36-140</td>
<td>7.9ab</td>
<td>6.9b</td>
<td>14.9a</td>
<td></td>
</tr>
<tr>
<td>9-35</td>
<td>7.0bc</td>
<td>7.7a</td>
<td>14.7a</td>
<td></td>
</tr>
<tr>
<td>36-35</td>
<td>6.6c</td>
<td>7.1ab</td>
<td>13.7b</td>
<td></td>
</tr>
</tbody>
</table>

   Within a column, means followed by the same letter are not significantly
   different at p=0.05.
CONCLUSIONS

1) Increasing seed rate and decreasing row spacing both result in an increase in grain yield. There is an interaction between seed rate and row spacing so that there is a greater response to increased seed rate at narrower row spacings.

2) Under growing conditions present in this study, the tall cultivar Norstar outyielded the semi-dwarf Norwin by 10%. However, there was no problem with lodging in the years this study was undertaken. Also, Norstar exhibited a greater response to increased seed rate than Norwin.

3) Prior to anthesis, the higher seed rate used more soil moisture. Consequently, the lower seed rate had more soil moisture available for reproductive growth.

4) At the end of the growing season, the wide row spacing and low seed rate treatment had used less soil moisture than other treatments.

5) The differential pattern of water use resulted in higher kernal weights for the low seed rate.

6) Increased number of heads/m² was the yield component that had the greatest effect on grain yield at high seed rate and narrow row spacing.
LITERATURE CITED


