EFFECT OF SEEDING DEPTH ON THE PERFORMANCE OF WINTER WHEAT

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INTRODUCTION

Shallow seeding has been recognized as an important management factor in the production of winter wheat. Recent research reported by Lafond and Fowler (1986) has shown that small increases in seeding depth can have a significant effect on the emergence of winter wheat. In addition, cooler mean ambient temperatures, associated with seeding later than the optimum date, increase the differences due to the seeding depth. Poor emergence and establishment mean that seedlings do not have enough time prior to winter to accumulate sufficient energy reserves in the crown tissue. Insufficient crown development often results in reduced winter survival, poor weed competition, late maturity and low yields. The objective of these studies was to determine the effect of seeding depth on the emergence, establishment and yield of a "stubbled in" winter wheat crop.

MATERIALS AND METHODS

This report outlines the experiments seeded in the fall of 1984, 1985 and 1986. In the fall of 1984, seeding depth trials were seeded at Watrous and Outlook on Aug. 29 and Sept. 2 respectively. In the fall of 1985 and 1986 the number of sites were increased to include Watrous, Carlyle, Clair, Porcupine Plain and Saskatoon. Seeding dates in the fall of 1985 were Aug.

29 at Watrous, Sept. 11 at Carlyle, Sept. 14 at Clair, Sept. 17 at P. Plain and Sept. 26 at Saskatoon. In the fall of 1986, seeding dates were Aug. 27 at Watrous, Aug. 30 at P. Plain, Sept. 3 at Clair, Sept. 6 at Saskatoon and Sept. 10 at Carlyle.

A randomized complete block design with four replications was used for these experiments. Norstar winter wheat was direct seeded into stubble at all locations using an Edwards HD912 hoedrill in the fall of 1984 and an Edwards HD812 hoedrill in the fall of 1985 and 1986. Standard hoe openers were used on the drill for all sites. Seeding rate was 80 kg/ha with seed placed P205 @ 29 kg/ha. Nitrogen fertilizer was broadcast in spring at soil test recommendations and post-emergent herbicides were applied as required. Seeding depths of 2 cm, 5 cm and 8 cm were attempted in fall 1984 and fall 1985. In the fall of 1986 six depths were attempted starting at very shallow and moving down 0.5 to 1 cm per treatment.

Plots at all sites (except Watrous 1984) were sampled prior to freeze-up. Sampling included plant counts per unit area and x1 whole plant samples per plot for measurement of seeding depth (as determined by the distance between the seed and the initial appearance of stem tissue chlorphyll), Haun scale, primary leaf length and oven dry weight.

Plots were harvested using a Kincaid or Hege small plot combine.

1. X = number of plants sampled per plot

RESULTS AND DISCUSSION

1984-85 RESULTS

Table 1. Average emergence from three seeding depths at Outlook. Measurements made on plants sampled on Oct. 13, 1984.

Location	Depth (cm)	Emergence (plants/m2)	
Outlook	4.4	115	(100%)
	6.4	36	(31%)
	8.0	5	(4%)

Dry conditions at Outlook delayed germination of the seed until after a Sept. 15 rainfall. Actual seeding depth, as determined from plant measurements, was deeper than intended at the shallow 2 cm target depth (Table 1). The difference in actual seed depth compared to intended seed depth (2,4 and 8 cm) appeared to be due to soil "cave-in" into the furrow row. Differences in emergence due to seeding depth were highly significant. The delay in germination caused by dry soil at seeding was also a probable factor in the reduced emergence of the plants at the deeper seed placements.

Unusual fall and winter weather conditions in 1984-85 resulted in severe winter injury to the winter wheat crop. The plots at Watrous were 100% winterkilled and some winter injury occurred at the Outlook site. As a result, data is available from the Outlook site only.

Table 2. Effect of seed depth on yield at Outlook, 1984-85.

Location	Depth (cm)	Yield (kg/ha)	
Outlook	4.4	1810	(100%)
	6.4	1497	(83%)
	8.0	386	(21%)

Precipitation at the Outlook site was much below normal during the growing season. The dry growing conditions combined with sandy soil texture required the addition of 25 mm of irrigation water to alleviate the severe drought stress. The total growing season rainfall plus irrigation did not bring the total available water up to the thirty year average precipitation.

Yield differences due to seeding depth were highly significant with the shallow depth yielding almost five times as much as the deep depth (Table 2). Yield differences were not as dramatic as the emergence differences which indicates the ability of the plant to partially compensate for a low plant population by tillering.

The dramatic emergence and yield differences obtained in this experiment are not likely typical, however, the data indicates the significant effect that seeding depth can have on the emergence and yield of winter wheat.

1985-86 RESULTS

Soil conditions at seeding time were very dry at Watrous; very wet at Carlyle; and moist at Clair, Porcupine Plain and Saskatoon. The means for the shallow, intermediate and deep seeding depths were as follows: 3.0 cm, 4.1 cm and 6.4 cm. Intended seeding depths were 2 cm, 5 cm and 8 cm. Soil "cave-in" was the reason for the deeper than intended shallow depth of seeding treatment. The depth of the deep treatment was limited by the tendency of the V shaped packer to follow the opener into

the furrow and limit effective seed depth.

Table 3. Average emergence from three seeding depths. Measurements made on plants sampled in late October, 1985.

Location	Depth (cm)	Emergence (plants/m2)	
Watrous	3.6	216	(100%)
	4.7	166	(77%)
	6.7	105	(49%)
Carlyle	2.8	258	(100%)
	3.2	189	(74%)
	5.8	252	(98%)
Clair	3.1	221	(100%)
	3.5	287	(130%)
	5.8	158	(72%)
P. Plain	3.0	208	(100%)
	5.0	139	(67%)
	7.4	115	(55%)
Saskatoon	2.5	242	(100%)
	3.9	127	(53%)
	7.0	12	(5%)
Means	3.0	229	(100%)
	4.1	182	(80%)
	6.4	128	(56%)

The first seeding date was August 31 and the last seeding date was Sept. 26. As a result, the differences in emergence due to seeding depths was exaggerated at the later seeding dates due to cooler ambient temperatures (Table 3). Saskatoon and Porcupine Plain had the greatest differences in emergence due to the interaction of cool ambient temperatures and seeding depth. At Clair there was an increase in emergence between the shallow and intermediate seed depths which could indicate that small differences in seed depth may not be as critical at earlier seed dates. When the combined means from the five sites are calculated, the medium and deep seeded treatments had a

reduction in emergence of 20% and 44% compared to the shallow seeded treatment. The reduction in emergence of 20% occurred with a measured seeding depth difference of only one cm. This points out the critical importance of shallow seeding depth and the large effect that small differences in seeding depth can have on the emergence of the winter wheat seedlings.

Table 4. Effect of seed depth on yield, 1985-86.

Location	Depth (cm)	Yield (kg/ha)	
Watrous	3.6	1032	(100%)
	4.7	954	(92%)
	6.7	749	(73%)
Carlyle	2.8	3535	(100%)
	3.2	3512	(99%)
	5.8	3598	(102%)
Clair	3.1	2334	(100%)
	3.5	2227	(95%)
	5.8	1624	(70%)
P. Plain	3.0	2115	(100%)
	5.0	1753	(83%)
	7.4	1031	(49%)
Means	3.1	2254	(100%)
	4.1	2112	(94%)
	6.4	1751	(78%)

Severe winterkill occurred at Saskatoon resulting in the loss of that site. The late seeding date at Saskatoon was a probable cause of the extensive winter injury. Some winterkill also occurred at Watrous, however the other three sites were not effected by winter injury. The winter injury at Watrous resulted in weed problems at that site.

A lack of precipitation, especially during June, caused a reduction in yields at Watrous, Clair and P. Plain (Table 4). At Watrous severe stem rust further reduced yields and resulted in

15 g/1000 kernel weights. Rust did not cause yield reductions at any of the other locations. Excellent moisture conditions at Carlyle, throughout the 1986 growing season, resulted in high yields at that location. The rust epidemic which effected central Saskatchewan did not arrive in Carlyle until the crop was past the critical stage and therefore did not effect yield. Later seeded crops in the Carlyle area did suffer yield reductions due to stem rust.

Volunteer barley was a problem at the P. Plain site which required additional cleaning to arrive at the net yields. The barley problem at this site would have been less severe if the seeding date for the winter wheat would have been closer to the optimum date.

When the data from the four sites were combined, there were highly significant differences in yield due to the differences in seeding depth. On average, a 1 cm increase in seeding depth from (3.1 cm to 4.1 cm) resulted in a six percent yield reduction and a 3.4 cm increase in seeding depth (from 3.1 cm to 6.5 cm) resulted in a yield reduction of 22%. The location by seeding depth interaction for the combined analysis was also highly significant for yield. On an individual site basis, yield differences were highly significant at Clair; significant at P. Plain and not significant at Carlyle and Watrous (Table 4). The differences were not significant at Carlyle due to optimum seeding date which resulted in only small differences in plant emergence in the fall of 1985. Differences in yield at Watrous were not significant due to variable winter injury among the

plots.

The 1985-86 results clearly indicate the importance of shallow seeding for best emergence and maximum yields.

1986-87 RESULTS

Soil moisture conditions were adequate for germination and emergence at Watrous, Clair, and P. Plain. The Carlyle site was dry and the Saskatoon site was very dry. Adequate precipitation occurred shortly after seeding at both Carlyle and Saskatoon and ensured good germination and emergence at these sites.

The six treatment depths were grouped into three depths by combining similar depth treatments (Table 5). This allows the results to be compared to the previous two year's data. The combined means for the shallow, intermediate and deep seeding depths were as follows: 1.9 cm, 3.5 cm and 5.1 cm. The depth of the deep seed treatment was limited by the tendency of the V shaped packer wheel to follow the opener into the furrow and limit effective seed depth.

Table 5. Average emergence from three seeding depths. Measurements made on plants sampled in late October, 1986.

Location	Depth (cm)	Emergence (plants/m2)	
Watrous	1.6	182	(100%)
	3.0	119	(65%)
	4.7	86	(47%)
Carlyle	1.8	198	(100%)
	3.3	197	(99%)
	5.7	177	(89%)
Clair	2.2	198	(100%)
	3.6	187	(94%)
	4.7	192	(97%)
P. Plain	1.9	186	(100%)
	3.8	191	(103%)
	5.1	167	(90%)
Saskatoon	2.3	224	(100%)
	3.7	202	(90%)
	5.5	185	(83%)
Means	1.9	198	(100%)
	3.5	179	(90%)
	5.1	162	(82%)

Differences in emergence were not significant at all sites except Watrous where the emergence differences were highly significant (Table 5). However, when the data from the five sites were combined, differences in emergence were highly significant.

When the means from the five sites were combined, the medium and deep seeded treatments had a reduction in emergence of 10% and 18% compared to the shallow seeded treatment. The 10% reduction in emergence occurred with a depth difference of 1.6 cm and the 18% reduction occurred with a depth increase of 3.2 cm. The differences in emergence due to depth are less than occurred in 1985-86 and are likely due the earlier seeding dates

and better conditions for germination that occurred in fall 1986.

Conclusions

Significant differences in plant emergence/m2 due to seeding depth occurred in each of the three years of this study. Relatively small differences in seeding depth resulted in large differences in plant emergence especially under conditions of late seeding date or delayed germination due to dry soil conditions.

Reductions in emergence, due to increased seed depth, resulted in significantly reduced yields in the fall of 1984 and 1985, although the yield reductions were proportionately less than the reduction in emergence.

The data from these experiments indicates that shallow seeding depths result in higher plant emergence and greater yield when compared to deeper seeding depths.

REFERENCES

Lafond, G. and D.B. Fowler. 1986. The effects of temperature, soil moisture and seeding depth on the emergence of winter wheat. In Proceedings 1986 Soils and Crops Workshop pp. 361-376. Extension Div., University of Saskatchewan.

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