ADAPTATION OF COMMERCIAL WHEAT CULTIVARS TO FALL-SEEDING

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Most areas of the Prairies would benefit from earlier maturing wheat cultivars. Using the traditional approach of attempting to shorten the life cycle of the wheat plant plant breeders have not been very successful in combining appreciable gains in earliness with current or increased yield levels. An alternative approach is to establish the crop as early as possible after spring thaw so as to maximize the length of the growing season. In some years this can be achieved by early spring seeding. However, it can be achieved in all years if the seed was in the ground prior to the spring thaw, i.e. by seeding in late fall just prior to soil freeze-up.

Other advantages the fall-seeded crop would provide are availability of early spring moisture; the vegetative growth phase occurs during the period of maximum daylength; the crop heads prior to the hot, dry periods frequently encountered during July; and redistribution of farm operations.

The performance of fall-sown spring wheat has been reported by Austenson (1972) and by Briggs and Faris (1973). Both studies found that yields were variable from year to year and averaged less than yields of spring-sown wheat. Austenson did report a gain in maturity of 4-7 days.

As the number of wheat cultivars used in their studies was small, this study was begun to determine whether differences in adaptation to fall-seeding existed among spring wheat cultivars. The ultimate goal was to identify cultivars which would serve as parents in a breeding program designed to develop cultivars specifically adapted to fall-seeding. A secondary objective was to evaluate the performance of current licensed cultivars with the view of introducing fall-seeding of spring wheat as a recommended agronomic practice in the near future.

The results presented in this report deal with this secondary objective, the adaptation of licensed spring wheat cultivars to fall-seeding.

MATERIALS AND METHODS

In the late fall of 1973, 200 spring wheat cultivars of diverse origin were seeded in an unreplicated preliminary trial at Saskatoon to determine whether differences existed in ability to survive through the winter. Based on visual estimates of plant stand in the following spring, 28 cultivars were selected for further study.

The 1974-75 experiment included these 28 cultivars plus 8 licensed cultivars, Manitou, Neepawa and Napayo bread wheats, Glenlea, Norquay and Pitic 62 utility wheats, and Wascana and Macoun durum wheats. In the subsequent two years of this study, the number of cultivars was reduced to 30, including the elimination of Maco

Tests were sown at two seeding dates, one in late fall shortly after the daily maximum soil temperature at the 5 cm depth remained below 3 C, the other as early as possible in the following spring. Seeding dates in the fall varied from October 28 to November 19, the spring seeding dates from April 30 to May 13. For each seeding date a separate test was seeded, one adjacent to the other.

A lattice design with four replications was used. Plot size was 4 rows, 30 cm apart and 4.8 m long. Seeding rates were 300 seeds per row in 1974-75 and 1976-77, and 400 seeds per row in 1975-76. Plant emergence, heading date, height and yield were recorded in all three years and tillering in two.

The data presented here were extracted from these larger trials. Due to a seeding error in the fall-sown trial of 1974, no data is available for Napayo and Pitic 62 for the first year of this study.

RESULTS

Grain yields, fall-sown yield as a percentage of spring-sown, for the five cultivars tested over three years are shown in Table 1. Cultivars varied in their yield response when fall-sown, but in no case was this response significantly greater than in the spring-sown yields.

Table 1. Effect of fall-seeding on yield of 5 spring wheat cultivars during the period 1974-1977.

CULTIVAR	1974-75	Yield[a] 1975-76	1976-77	MEAN
Glenlea	119	93	81*	98
Neepawa	99	84	100	94
Manitou	95	85	82*	88
Wascana	113	89	53*	85
Norquay	82	77*	68*	76
MEAN	100	86	77	88

[a] Fall-sown yield expressed as a percentage of spring-sown yield.

*Spring-sown yield significantly greater than fall-sown yield (P=0.05).

Comparison of 3-year averages shows that fall-seeding caused a yield reduction which varied from 2% (Glenlea) to 24% (Norquay). The yields of fall-sown Norquay were significantly less than the yields when spring-sown in two of the three years, and those of Glenlea, Manitou and Wascana were less in one year. The relative magnitude of these yield reductions varied also with years. Glenlea and Wascana were much less stable in performance than the other three cultivars. The overall high performance of Glenlea reflects the high yield from fall-seeding in the 1974-75 experiment.

In terms of minimal yield reduction and maximal yield stability, Neepawa appears superior to the other cultivars.

Fall-seeding caused a marked reduction in plant emergence (Table 2). Three-year averages ranged from 27% (Wascana) to 50% (Manitou).

Although all cultivars showed a significant reduction in plant emergence when fall-sown, real differences existed also in the magnitude of this reduction. Manitou was statistically superior to either Glenlea or Wascana, and this difference remained when adjustment was made for germination differences as based on plant emergence in the spring-seeded tests. Within each seeding date, the cultivar x year interaction was not significant.

Table 2. Effect of fall-seeding on certain agronomic traits (3-year averages)

Cultivar	Time of seeding	Plant stand (plants/m^2)	Heading date	Height (cm)
Manitou	Fall	80	June 26	84
	Spring	162	July 3	90
Neepawa	Fall	69	June 26	83
	Spring	179	July 3	87
Glenlea	Fall	46	June 28	89
	Spring	148	July 6	89
Norquay	Fall	62	June 27	68
	Spring	149	July 4	68
Wascana	Fall	33	June 27	89
	Spring	120	July 6	91

Fall-seeded plants headed 7 to 9 days earlier than the spring-seeded plants. This varied from year to year depending upon the rate at which the soil warmed in early spring. In 1975, the average gain in earliness was only 4 days, whereas in 1977 the average gain was 12 days. In these same years, germination in the fall-sown test was estimated to have commenced 13 and 33 days earlier, respectively, than in the corresponding spring-sown test.

Fall-seeding caused a quite different response in heading time for Pitic 62 than for the other cultivars. When fall-sown, Pitic 62 headed at the same time as Napayo but, when seeded in the spring, it headed 5 days later. In other studies, I have found that Pitic 62 does respond to mild vernalization in the form of earlier maturity but, unfortunately, also reduced tillering capacity. Vernalization in these studies was provided by the cool soil and air temperatures experienced early in the season.

In general, plant height was reduced by fall-seeding but this reduction was small.

Table 3 allows comparisons among yield, tillering and plant emergence for the two years in which all three traits were measured.

Table 3. Effect of fall-seeding on yield, plant emergence and tillering, 1975-1977. (Data expressed as percentage of spring-sown data.)

Cultivar	Yield	Plant Emergence	Heads per m^2
Napayo	93	41*	87
Neepawa	91	41*	84
Glenlea	87	28*	90
Norquay	85*	42*	91
Manitou	84*	49*	71*
Pitic 62	83*	40*	65*
Wascana	72*	25*	55*

*Significant decrease (P=0.05) caused by fall-seeding.

Despite the large reductions in plant emergence, only Manitou, Pitic 62 and Wascana produced significantly fewer heads per m^2 when fall-sown. Cultivars showed a marked ability to compensate for reduced stand by increased tillering. Compared to spring-seeding, Glenlea showed the largest increase in the amount of tillering while Manitou and Pitic 62 showed the smallest. This relationship did not change when tillering was adjusted for differences in plant stand.

No relationship existed between yield and either tillering or plant emergence, although a high positive correlation (r=0.91) was found between emergence and tillering in the fall-sown cultivars. Multiple regression analysis indicated that these two components accounted for only about 25% of the total variability for yield among the fall-sown cultivars. In both these years, the fall-sown trial appeared to be under greater stress at and shortly after heading than the spring-sown trial.

DISCUSSION

This study supports earlier studies in indicating that fall-seeding of spring wheat is feasible but that with the cultivars currently available, yield will be sacrificed for gain in maturity. The study has shown also that differences do exist among cultivars in their adaptation to fall-seeding.

Of the cultivars reported on here, Neepawa and Napayo appear to possess the greatest potential. By fall-seeding either of these cultivars, a farmer, on the average, might expect to forfeit 10% yield for one week's gain in maturity; a trade-off, I believe, farmers in certain areas of Saskatchewan would consider acceptable.

However, these are results which have been obtained from plots which were kept essentially weed-free. The consistent reduction in plant stands caused by fall-seeding would provide ideal conditions for severe weed infestation. Therefore, some means of increasing plant stands is needed.

The most obvious solution would be to increase the seeding rate. This was investigated last year and a seeding rate approximately 112 kg/ha gave not only acceptable plant stands but also yields at least equal to and, in some cases, greater than spring-sown wheat.

The cause of reduced plant emergence is not known. Preliminary data suggests that reduction occurs between germination of the seed and emergence of the seedling above ground. Emergence was increased significantly by treating seed with a fungicide. There also appears to be a positive relationship between rate of germination at low temperatures and plant emergence. These findings suggest disease attack of the seed or the developing seedling as one important cause of reduced emergence.

Identification of differences among cultivars in at least three components of adaptation to fall-seeding, i.e. plant emergence, tillering ability and yield itself suggests that breeding cultivars specifically for this practice is possible. Such a program has been commenced at Saskatoon. However, until such cultivars become available, work should continue on cultural methods designed to optimize the performance of existing cultivars when fall-sown. All results obtained so far have convinced me fall-seeding can be a viable option for the western Canadian farmer.

LITERATURE CITED

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