Row spacing and seeding rate effects in wheat and barley under a conventional fallow management system

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Lafond, G. P. and Derksen, D. A. 1996. **Row spacing and seeding rate effects in wheat and barley under a conventional fallow management system.** Can. J. Plant Sci. **76**: 791–793. Varying seed row spacing had no effect on the yield of spring wheat (*Triticum aestivum* L.) or barley (*Hordeum vulgare* L.) when grown under a conventional-tillage fallow-management system. Grain yields were improved with increased seeding rates by 14% in wheat and 32% in barley. The absence of a row-spacing-by-seeding-rate interaction suggests that adjustments in seeding rates are not required with changes in row spacing. The presence of surface residues and standing stubble cannot explain the lack of a row-spacing effect when using a zero-tillage stubble-cropping system, since similar results were obtained with a conventional-tillage fallow management system in this study.

Key words: Yield, yield components, plant density

Lafond, G. P. et Derksen, D. A. 1996. **Effets de la largeur de l'interligne et de la densité de semis chez le blé et l'orge en régime de jachère classique.** Can. J. Plant Sci. **76**: 791–793. La variation de la largeur de l'interligne n'a pas manifesté d'effets sur le rendement du blé de printemps (*Triticum aestivum* L.) ni de l'orge (*Hordeum vulgare* L.), cultivés selon une jachère classique. On constatait une amélioration du rendement de 14% sur le blé et de 32% sur l'orge, lorsqu'on augmentait le taux de semis. L'absence d'interaction largeur de l'interligne-densité de semis porte à conclure qu'il n'est pas nécessaire de modifier le taux de semis selon l'écartement des lignes. La présence des restes de culture en surface et de chaume sur pied ne peut donc pas expliquer l'absence d'effet de la largeur de l'interligne observé en régime de culture sur chaume sans labour, puisque la même observation est faite ici en système de jachère classique.

Mots clés: Rendement, composante du rendement, densité de peuplement

The adoption of conservation tillage management on the Canadian prairies requires refinements in production practises to enhance its suitability. The current understanding with conventional tillage management systems is that reduced grain yield can be expected as seed row spacing increases (Doyle 1988; Epplin et al. 1992). Recently, the use of 30-cm row spacings in spring cereals under zero-tillage did not result in lower yields relative to 10- and 20-cm spacings (Lafond 1994). In fact, the yields of durum wheat (*T. aestivum* L.) and barley (*H. vulgare* L.) were slightly improved at 30 cm. It was postulated that the presence of standing stubble and surface residues was favoring grain yields with wide row spacings under the ZTSC.

The objective of this research was to determine the effect of row spacing and seeding rate on yields of spring wheat (*T. aestivum* L.) and barley when grown under a CTFC in which residues and standing stubble were absent, and to compare these findings to those obtained in a previously completed ZTSC study (Lafond 1994).

The study was conducted from 1993 to 1995 at the Agriculture and Agri-Food Canada Research Farm near Indian Head, Saskatchewan. The soil was an Indian Head heavy clay, a Rego Black Chernozem. The plots were seeded on land that had been fallowed 2 yr, therefore, no residues or standing stubble were present on the soil surface at the time of seeding. The plots were seeded and maintained under weed free conditions. Three row spacings (10, 20, and 30 cm) and six seeding rates (34, 67, 100, 134, 168, and 202 kg ha^{-1} for spring wheat, and 27, 54, 81, 108, 134, and 161 kg ha^{-1} for barley) were investigated. A Canada Prairie Spring wheat (cv. Biggar) and a malting-type barley (cv. Harrington) were used.

The seeding dates for 1993 to 1995 were 23 April, 24 May, and 15 May, respectively. A small-plot seeder equipped with hoe openers on a tool bar spaced 10 cm apart was used for planting. The two outside openers seeded the border rows at a rate of 134 kg ha^{-1} for wheat and 108 kg ha^{-1} for barley. The distance between adjacent plots was 30 cm. All 13 openers were in the soil at all times. Row spacing was varied by directing the seed from a rotating cone mechanism to the desired openers.

Monoammonium phosphate fertilizer was placed with the seed at the same rate per hectare for the three row spacings used (14 kg ha^{-1} P in 1993 and 1994, and 19 kg ha^{-1} P in 1995); therefore, the fertilizer was three times more concentrated per row at the 30-cm spacing than the 10-cm spacing.

Abbreviations: **CTFC**, conventional-tillage fallow-cropping system; **ZTSC**, zero-tillage stubble-cropping system

Table 1. The effects of row spacing on plant density and yield components of spring wheat and barley[z]

Row spacing (cm)	Plants m^{-2}	Spikes m^{-2}	Kernels $spike^{-1}$	1000-seed weight (g)	Grain yield (kg ha^{-1})
		Spring wheat			
10	215	450	26.2	40.3	4453
20	191	431	27.3	39.8	4444
30	176	423	28.3	39.5	4423
SE	8.9	13.4	0.8	0.4	54
Contrast					
10 and 20 vs. 30 cm	*	NS	NS	NS	NS
10 vs. 20 cm	NS	NS	NS	NS	NS
		Barley			
10	158	757	17.1	40.7	4809
20	144	745	17.8	40.5	4892
30	128	744	17.3	40.4	4816
SE	6.1	26.9	0.7	0.4	62.0
Contrast					
10 and 20 vs. 30 cm	**	NS	NS	NS	NS
10 vs. 20 cm	NS	NS	NS	NS	NS

[z]Each value represents the mean of 72 observations.
*,** and NS correspond to $P = 0.05$, $P = 0.01$ and not significant, respectively.

Plots were trimmed to 6.1 m in length at heading time and border rows were removed just prior to harvest. The areas used to calculate yield for the 10-, 20- and 30-cm spacings were 6.81, 6.11, and 5.57 m^2, respectively. The number of rows present for the 10, 20, and 30 cm row spacings were 11, 5, and 3, respectively.

Plant density and spike density were determined by counting 1-m row lengths in each plot at the two-leaf and soft-dough stages of plant development. Seed weight was measured by randomly selecting and weighing 200 seeds from each plot after harvest. Grain yield was determined by harvesting the whole plot area, and the number of kernels per spike was determined using the relationship [(kg grain ha^{-1}) × 100]/[spikes m^{-2} × 1000 seed weight]. All harvested grain was dried to the same moisture content before weighing. A combined analysis over years was used for each crop with years considered a random variable. The year × treatment interaction was used to test the main effects and their interactions. The response of seeding rate to grain yield was described using the function $y = a + (b/x)$, where y is grain yield (kg ha^{-1}); x is seeding rate (kg ha^{-1}); and a and b are constants.

Varying row spacing from 10 to 30 cm did not affect spike density, kernels per spike, seed weight or grain yield for wheat and barley (Table 1). Crop density was reduced by increasing row spacing for both crops. Yield relationships, as a function of seeding rate, were generally similar for the two crops, but a greater impact of increasing seeding rate on grain yield was observed for barley (Fig. 1). Grain yield increases of 13% and 32% were observed from the lowest to the highest seeding rate in wheat and barley. The first increment in seeding rate accounted for 11% of the yield increase for wheat (or 85% of the total increase), while it accounted for 17% of the yield increase for barley (or only 53% of the total increase). A row-spacing-by-seeding-rate interaction was not observed in either crop.

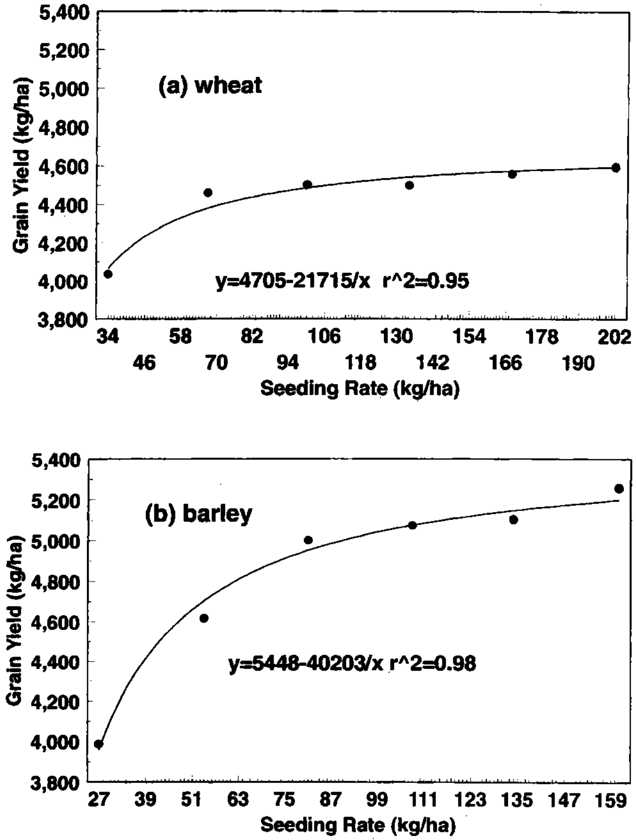

Fig. 1. The response of grain yield to seeding rate in spring wheat and barley.

Recognizing the difference in wheat cultivar used in this study compared to ZTSC (Lafond 1994), the findings in these studies were similar. Increasing row spacing from 10 to 30 cm did not have a negative impact on yield; however, the small, but significant, improvement in yields at the wide row spacing in ZTSC with barley (Lafond 1994) were not observed in this study. The reduction in crop density at wider row spacings and the response of grain yield to seeding rate followed the same patterns in CTFC and ZTSC. The lack of a row spacing effect on spike numbers and kernels per spike in wheat differed from the previous study under ZTSC where spike numbers decreased and kernels per spike increased as row spacing increased. With barley, the only difference was fewer spike numbers as row spacing increased under ZTSC. The reduction in crop density at wider row spacings and the response of grain yield to seeding rate followed the same patterns in CTFC and ZTSC.

The results of this study do not agree with previously published reports that indicate improved yields with narrow row spacing. For example, Briggs (1975) reported that wheat yields were higher with narrow spacings, although the benefits were observed in relatively few cases. However, Yunusa et al. (1993) found that narrowing the distance between planted wheat rows did not provide a yield benefit due to reduced evaporative moisture loss from the soil under the crop canopy because evaporative losses were similar among the row spacings investigated. With barley, in the absence of herbicides and in the presence of weeds, Kirkland (1993) observed a yield reduction when row spacing increased from 11 to 46 cm. The lack of a row-spacing-by-seeding-rate interaction implies that changes in seeding rates are not required when changes in row spacings are made.

The benefits of surface residues and standing stubble for conserving moisture and reducing moisture loss through evaporation are well known (Smika and Unger 1986). The reduced soil disturbance with 30-cm spacings under ZTSC may reduce moisture loss and explain some of the additional yield benefits previously reported (Lafond 1994).

The improvements reported in grain production with narrow row spacings under conventional-tillage systems may be due to differences in crop density, P fertilizer management (Yunusa et al. 1993), weed competition, or experimental methodology. We suggest that the effects of row spacing on grain yield reported in the past with systems like CTFC were due to large differences in plant populations between spacings. Research is required to determine the interaction of row spacing and cropping systems on weed densities and populations in order to evaluate more completely the merits of using wider row spacings for crop production.

Briggs, K. G. 1975. Effects of seeding rate and row spacing on agronomic characteristics of Glenlea, Pitic 62 and Neepawa wheat. Can. J. Plant Sci. **55**: 363–367.

Doyle, R. 1988. Closer spaced rows and type of machinery. J. Agric. W. Aust. **29**: 17–19.

Epplin, F. M., Allread, V. K., Solie, J. B., Peeper, T. F. and Koscelny, J. A. 1992. Economics of ultranarrow row planting for hard red winter wheat production in Oklohoma. J. Prod. Agric. **5**: 427–431.

Kirkland, K. J. 1993. Weed management in spring barley (*Hordeum vulgare*) in the absence of herbicides. J. Sustainable Agric. **3**: 95–104.

Lafond, G. P. 1994. Effects of row spacing, seeding rate and nitrogen on yield of barley and wheat under zero-till management. Can. J. Plant Sci. **74**: 703–711.

Smika, D. E. and Unger, P. W. 1986. Effects of surface residues on soil water storage. Adv. Soil Sci. **5**: 111–138.

Yunusa, I. A. M., Belford, R. K., Tennant, D. and Sedgley, R. R. 1993. Row spacing fails to modify soil evaporation and grain yield in spring wheat in a dry Mediterranean environment. Aust. J. Agric. Res. **44**: 661–676.