Agronomic Studies in Hybrid Spring Canola Rapeseed (*Brassica napus* L.)

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INTRODUCTION

There has been considerable interest in the development of hybrid canola rapeseed (*Brassica napus* L.) cultivars since the discovery of a range of pollen control systems such as genic male sterility (Takagi 1970, Lee and Zhang 1983), recessive self-incompatibility (Thompson 1979) or cytoplasmic male sterility (Thompson and Hughes 1986) systems. These pollen control systems provide the potential for production of large quantities of hybrid canola rapeseed seed in the field.

The next step towards the development of hybrid canola rapeseed cultivars was the reporting of significant levels of heterosis for yield (in the 40 to 60% range) in spring and winter hybrids derived from crosses of rapeseed or canola rapeseed (Schuster and Michael 1976, Shiga 1976, Morice 1978, Buson 1980, Lefort-Buson 1982, Sernyk and Stefansson 1983 and Grant and Beversdorf 1985).

Canadian canola rapeseed breeders have developed the *pol* cytoplasmic male sterility system (Fu 1981) to the point where large quantities of hybrid seed have been produced in the field in 1985 and 1986. The quality of the seed produced has been so satisfactory that commercial production of hybrid canola rapeseed in Canada is contemplated for the near future.

Two questions relevant to the commercialization of hybrid canola rapeseed have arisen recently. The first deals with the need to define the optimum seeding rate for hybrid canola rapeseed to ensure maximum yield performance. While several researchers have determined the optimum seeding rate for open pollinated canola rapeseed cultivars grown in western Canada (Kondra 1975, Clarke and Simpson 1978, Degenhardt and Kondra 1981 and Christensen and Drable 1984), none have been able to do this for hybrid canola rapeseed cultivars because of a shortage of seed. The second question deals with the purity requirements for hybrid canola rapeseed cultivars to ensure maximum yield performance. No published reports on this topic in canola rapeseed are available at the present time.

The objectives of this research were therefore to determine the optimum seeding rate for hybrid canola rapeseed cultivars grown in western Canada and to determine the purity requirements of hybrid canola rapeseed seed lots which will ensure maximum yield performance.

METHODS AND MATERIALS

Four different F_1 hybrid canola rapeseed cultivars, 1 x 2, 3 x 2, 4 x 5 and 4 x 6 were used for the seeding rate experiments. The first two hybrids were produced in the field using the pol cytoplasmic male sterility system while the latter two hybrids were produced by hand crossing of appropriate lines in a growth room using the nap cytoplasmic male sterility system. Seeding rates of 3.0, 4.5, 6.0 and 9.0 kg/ha were used. Two additional F_1 hybrid canola rapeseed cultivars, 4 x 7 and 4 x 8 were used for the purity requirement trials. These two hybrids were produced by hand crossing of appropriate lines in a growth room using the nap cytoplasmic male sterility system. Hybrid seed was blended with A line seed in blends of 100%/0%, 90%/10%, 80%/20%, 70%/30%, 60%/40% and 50%/50% hybrid seed/A line seed respectively. Hybrid seed was also blended with R line seed in blends of 100%/0%, 90%/10% and 80%/20% hybrid seed/R line seed respectively.

For both sets of experiments, 3 replicate randomized complete block design trials using 4 row plots, 5.5 m long with 30 cm row spacing, were grown at the point and arboretum field locations at Winnipeg, Manitoba.

Days to flowering was estimated when approximately half of the plants were flowering. Days to maturity was estimated when seeds in the pods of the lower third of the main raceme had turned color. The inside two rows of each plot were trimmed to 5 m prior to hand harvesting at ground level. Yield, total dry matter and harvest index were determined on all samples after they had dried to constant weight in a drier room. Analysis of variance techniques were used to detect statistically significant treatment effect differences while Duncan's multiple range test was used for mean separation.

RESULTS AND DISCUSSION

There were no significant differences in yield, total dry matter production or harvest index for any of the four hybrids at either the point or the arboretum (Table 1) attributable to varying seeding rates. The numerically highest yield occurred at 4.5 kg/ha for 3 out of 4 hybrids at both the point and arboretum (Table 1) locations. No consistent patterns for either total dry matter production or harvest index in relation to seeding rate were observed. There were however, differences in days to flowering related to variation in seeding rate. The 3.0 kg/ha treatment displayed the greatest number of days to flowering while the 9.0 kg/ha treatment displayed the fewest number of days to flowering in 7 out of 8 cases. Days to maturity was unaffected by seeding rate variation, however. Even though seeding rate variation had some effect on days to flowering, it appears that the overall effects of seeding rate variation on yield, total dry matter production and harvest index of hybrid canola rapeseed cultivars are minimal. Therefore, the 4.5 kg/ha seeding rate, three quarters the normally recommended seeding rate of open pollinated canola cultivars, may be fully satisfactory for hybrid canola rapeseed cultivars.

In the hybrid purity requirement experiments, the yields of all combinations of hybrid and A line or R line seed at the point (except for the 90% hybrid seed/10% R line seed blend treatment), were not significantly different (Table 2). The 90% hybrid seed/10% R line

seed blend treatment yielded significantly less than all other treatments. Yields of all treatments at the arboretum were not significantly different (Table 2). The 90% hybrid seed/10% R line seed blend treatment was the numerically lowest yielding treatment, however. The reason for the low yields of the 90% hybrid/10% R line seed blend treatment is unknown. Minimal total dry matter production differences were noted at the point while no significant differences were observed at the arboretum (Table 2). Harvest index values were largely unaffected by any of the treatments, but tended to be lowest for the 50% hybrid seed/50% A line seed blend treatment. This would be expected since half of the plot is composed of sterile plants with minimal seed set but substantial dry matter production. The 50% hybrid seed/50% A line seed blend treatment was the latest in days to flowering and days to maturity, at both the point and the arboretum (Table 2) because of the high percentage of slow growing, long flowering A line plants in this treatment. The results of these preliminary hybrid purity requirement experiments indicate that hybrid canola rapeseed cultivars are quite tolerant of seed admixtures of A line or R line seed, at least as far as yield, total dry matter production and harvest index are concerned. The increased days to flowering and maturity resulting from seed admixtures may have more dramatic effects on quality of the seed, however, necessitating a high degree of purity of the hybrid seed lot.

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Table 1. Effect of Varying Seeding Rate on Selected Parame... for Hybrid Canola (Brassica napus)

Treatment/ Seeding Rate (kg/ha)	Days to Flowering	Days to Maturity	Yield kg/ha	Total Dry Matter (kg/ha)	Harvest Index (%)
			-Point-		
1x2/3.0	48ab	99a	1,408a	5,838a	24a
1x2/4.5	48ab	100a	1,468a	6,429a	23a
1x2/6.0	48ab	100a	1,390a	5,877a	24a
1x2/9.0	48ab	99a	1,154a	5,586a	21a
3x2/3.0	49a	98a	1,278a	5,692a	22a
3x2/4.5	48ab	98a	1,329a	5,702a	23a
3x2/6.0	48ab	100a	1,164a	5,178a	23a
3x2/9.0	48ab	98a	1,164a	4,907a	25a
4x5/3.0	48ab	98a	1,163a	5,072a	23a
4x5/4.5	48ab	98a	1,482a	5,886a	25a
4x5/6.0	47 b	99a	1,608a	6,342a	25a
4x5/9.0	48ab	99a	1,151a	5,411a	21a
4x6/3.0	49a	99a	1,412a	5,721a	25a
4x6/4.5	49a	99a	1,636a	6,875a	24a
4x6/6.0	49a	98a	1,262a	5,944a	21a
4x6/9.0	49a	98a	1,318a	6,167a	21a
C.V.(%)	1	1	15	14	15
			-Arboretum-		
1x2/3.0	48ab	98a	1,407a	5,906a	24 c
1x2/4.5	47 bc	97a	1,615a	6,226a	26abc
1x2/6.0	47 bc	97a	1,525a	6,400a	24 c
1x2/9.0	46 c	96a	1,362a	5,983a	23 c
3x2/3.0	48ab	99a	1,350a	5,673a	24 c
3x2/4.5	47 bc	98a	1,663a	7,244a	23 c
3x2/6.0	48ab	98a	1,507a	6,129a	25 bc
3x2/9.0	47 bc	97a	1,486a	6,458a	23 c
4x5/3.0	49a	98a	1,873a	7.021a	27abc
4x5/4.5	46 c	97a	2,028a	6,672a	30a
4x5/6.0	46 c	97a	1,957a	6,633a	30a
4x5/9.0	47 bc	97a	1,680a	6,361a	26abc
4x6/3.0	48ab	98a	1,822a	6,807a	27abc
4x6/4.5	49a	98a	1,508a	5,964a	25 bc
4x6/6.0	48ab	97a	1,895a	7,234a	26abc
4x6/9.0	47 bc	98a	1,960a	7,205a	27abc
C.V.(%)	1	1	17	15	10

Table 2. Effect of Varying Levels of Hybrid Purity on Selected Parameters for Hybrid Canola (Brassica napus)

Treatment	Days to Flowering	Days to Maturity	Yield kg/ha	Total Dry Matter (kg/ha)	Harvest Index (%)
			-Point-		
4x7	48 b	99 cd	2,273abc	8,3791abcd	27abc
4x7+10A	48 b	101abc	2,486ab	8,464abcd	29a
4x7+20A	48 b	101abc	2,452ab	9,217ab	27abc
4x7+30A	48 b	101abc	2,488ab	8,792abc	28ab
4x7+40A	49ab	101abc	2,695a	9,569a	28ab
4x7+50A	49ab	102ab	2,265abc	8,962abc	25abcd
4x7+10R	49ab	101abc	1,983 bc	8,367abcd	24 bcde
4x7+20R	48 b	102ab	2,466ab	8,840abc	28ab
4x8	48 b	98 d	2,050 bc	7,420 d	28ab
4x8+10A	48 b	100 bcd	1,854 c	8,549abcd	22 e
4x8+20A	48 b	101abc	1,789 c	7,808 cd	23 de
4x8+30A	49ab	101abc	1,960 bc	8,755abcd	23 de
4x8+40A	49ab	103a	1,991 bc	8,780abc	23 de
4x8+50A	50a	103a	1,944 bc	9,265ab	21 e
4x8+10R	49ab	99 cd	1,859 c	7,954 bcd	23 cde
4x8+20R	49ab	101abc	2,288abc	8,197abcd	28ab
C.V.(%)	1	1	13	8	10
			-Arboretum-		
4x7	50ab	97 c	1,979a	7,359a	27ab
4x7+10A	50ab	98 bc	2,276a	7,869a	29a
4x7+20A	51a	98 bc	1,934a	8,206a	23 bc
4x7+30A	50ab	98 bc	2,285a	9,727a	24 bc
4x7+40A	50ab	98 bc	2,009a	8,950a	23 bc
4x7+50A	51a	99ab	2,182a	8,974a	24 bc
4x7+10R	49 b	98 bc	1,792a	6,497a	27ab
4x7+20R	49 b	98 bc	1,985a	7,785a	26abc
4x8	49 b	98 bc	2,098a	7,760a	27ab
4x8+10A	50ab	98 bc	1,921a	7,917a	24 bc
4x8+20A	49 b	99ab	2,440a	9,035a	27ab
4x8+30A	49 b	98 bc	1,791a	7,432a	24 bc
4x8+40A	49 b	99ab	2,038a	8,743a	23 bc
4x8+50A	50ab	100a	2,193a	9,945a	22 c
4x8+10R	50ab	98 bc	1,540a	6,472a	24 bc
4x8+20R	49 b	98 bc	1,990a	7,456a	27ab
C.V.(%)	1	1	18	17	9