Factors Effecting Seed Production in Hybrid Oilseed Rape (*Brassica napus* ssp *oleifera*)

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ABSTRACT

We examined several aspects of F_1 hybrid *Brassica napus* seed production, including pollen movement and post anthesis chemical rogueing as a method of R-line removal. We examined pollen movement at three locations under natural environmental and normal fauna conditions by evaluating yield on twenty individual male sterile rows situated at 50 cm incremental intervals up to 5 m away from a pollen source and determining the correlation between yield and distance from a pollen source. In both years, we detected significant yield decreases as distance from a pollen source increased. We examined hybrid seed production in a mixed planting system where the A-line was resistant to both glufosinate ammonium and glyphosate and the R-line was resistant to only glufosinate ammonium. The test evaluated the efficacy of post anthesis chemical rogueing of glyphosate to eliminate R-line seed set. The test, conducted at three locations and analyzed as a 4 x 4 Latin square, examined four different planting ratios (A-line : R-line; 95 : 5, 90 : 10, 80 : 20 and 60 : 40). We evaluated yield and percent residual R-line for each treatment and hybridity for each location. The 90 : 10 ratio of A-line : R-line produced the highest yield of hybrid seed, and percent residual R-line in the harvested seed increased as percent R-line in the planted seed mixture increased.

Key Words: Hybrid – *B. napus* – seed – production – pollen

INTRODUCTION

Brassica napus exhibits levels of heterosis high enough to warrant large-scale acreage conversion to F_1 cultivars and this realization has resulted in the development of pollination control systems including, but not limited to, cytoplamic male sterility, nuclear male sterility, self-incompatibility, and gametocides. The seed industry has adopted these systems to varying degrees, however observed instability of the female line, linkage to undesirable traits and various impracticalities in their application to commercial production have hampered wide scale adoption. An understanding of pollen movement in *Brassica napus* and the possibility of new unconventional means of hybrid seed production through transgenic traits offers the possibility of higher conversion rates from open pollinated to hybrid varieties.

MATERIALS AND METHODS

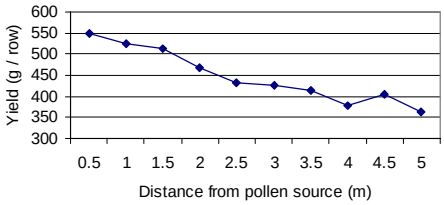
Experiment 1: Pollen flow – We evaluated yield on 20 individual female rows in each of four replicates, situated at 50 cm incremental intervals, up to 5 m away from a pollen source. Rows were seeded at 1.7 g per 12 m row (5.7 kg ha^{-1}), and after emergence, trimmed to 10 m. All locations received 5.7 kg ha^{-1} of Counter 5G™ (terbufos) and 90 kg ha^{-1} of 11-26-0-14 fertilizer placed with the seed. To decrease pollen movement between blocks, a 3.0 m buffer zone of the male sterile canola or a 10 m strip of bare soil separated reps. We straight combined all rows, dried samples to 8.0 per cent moisture, cleaned, and weighed them. We conducted an analysis of variance to determine yield changes in response to distance from a pollen source.

Experiment 2: Mixed hybrid seed production – This trial was a 4 x 4 Latin square, the only factor examined was the ratio of A-line to R-line seed. Four were tested, 95:5, 90:10, 80:20 and 60:40, A-line : R-line respectively. Plots were 225 m^2, and separated by a 1.5 m bare soil border. The seeding rate was 5.7 kg ha^{-1} with 5.7 kg ha^{-1} of Counter 5G™ (terbufos) and 90 kg ha^{-1} of 11-26-0-14 fertilizer placed with the seed. Bee density was constant over treatments and locations at 7.5 hives ha^{-1}, as was post anthesis glyphosate application at 5.0 l ha^{-1} and 150 l ha^{-1} of water at 275 kPa. We performed a general linear model analysis of variance to test for yield responses and differences in residual R-line levels as a function of altering the seeding ratios.

RESULTS

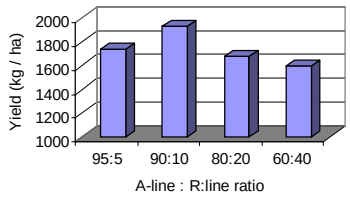
Experiment 1: Pollen flow
We identified significant yield trends at all locations and a negative correlation between yield and distance from a pollen source, the decline was linear.

Figure 1 Seed yield as a function of distance from a pollen source



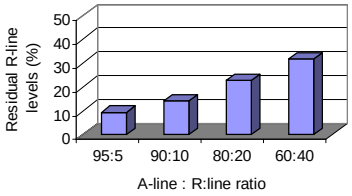
Experiment 2: Mixed hybrid seed production
Altering the seeding ratios had a significant effect on hybrid seed yield at all locations and the 90:10 ratio exceeded all other treatments.

Figure 2 Hybrid seed yield as a function of seeding rate



At all locations, we detected a positive relationship between the amount of R-line seeded and the residual R-line remaining in the harvested seed sample.

Figure 3 Residual R-line levels as a function of seeding rate



DISCUSSION

Experiment 1: Pollen flow

Pollen flow, as measured by yield, decreased in a linear fashion as distance from a pollen source increased and we detected significant yield decline at 1.5 m from a pollen source. These results reflect other *B. napus* seed production experiments conducted in western Canada (Pinnisch and McVetty, 1990) that demonstrate seed yield in male sterile plants declines in a linear fashion as distance from a pollen source increases.

Experiment 2: Mixed hybrid seed production

The 90:10 ratio yielded significantly greater amounts of hybrid seed per hectare than all other treatments over all locations, indicating that the 90:10 mixture is the most effective pollen-ovule ratio tested in this experiment. In the case of the 95:5 ratio, we suspect there was insufficient pollen to fertilize all of the male sterile flowers. Where as in the 80:20 and 60:40 ratios, we suspect there was sufficient pollen, but a dearth of ovules. As well, a high proportion of R-line plants occupying space and not contributing to hybrid seed yield could have contributed to the observed results.

In the 95:5 treatment, residual R-line levels increased from 5.0 per cent in the planted seed to 9.4 per cent in the harvested seed. However, in the 60:40 treatment, levels decreased from 40.0 per cent in the planted seed to 31.8 per cent in the harvested seed. In the remaining treatments, residual R-line levels increased by a decreasing amount. We took no measurements to compare the relative fitness of R-line plants between treatments. If an R-line plant is more vigorous than an A-line plant, then in situations where it is growing among 95 per cent A-line plants and 5 per cent R-line plants, it will be more fit and set more seed than in a situation with 60 per cent A-line plants and 40 per cent R-line plants. Further testing of this seed production method must examine the individual yield components, as a measure of relative fitness, of R-line plants to try and quantify these results.

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REFERENCES

Pinnish, R. and McVetty, P.B.E. 1990. Seed production of hybrid summer rape in the field using the *pol* cytoplasmic male sterility system: a first attempt. Can. J. Plant Sci. 70:611-618.

Damgaard, C. and Loeschcke, V. 1994. Genotypic variation for reproductive characters, and the influence of pollen-ovule ratio on selfing rate in rapeseed (*Brassica napus*). J. Evol. Biol. 7:599-607.

Eisikowitch, D. 1981. Some aspects of the pollination of oilseed rape (*Brassica* napus L.). J. Agric. Sci. Camb. 96:321-326.

Hogarth, C.R., Mendham, N.J. and Buzza, G.C. 1995. The effects of distance from pollen source on seed set and yield in apetalous hybrid canola seed production. Proc GCIRC 1995 Congr. A37:107-109