HARVEST INDEX AND SEED YIELD OF WINTER RAPESEED GROWN AT DIFFERENT PLANT POPULATIONS

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INTRODUCTION

One goal of the University of Idaho rapeseed breeding program is to develop varieties of winter rapeseed which combine high seed yield with a high harvest index. The harvest index, harvested seed as a percentage of total plant production, is an important factor for maximizing the seed production while minimizing economic input. Good estimates of seed yield and harvest index are important for development of varieties with consistent performance under commercial production and it is necessary to choose appropriate seeding rates for making accurate estimates of field performance. Limited information is available addressing the response of currently grown varieties of winter rapeseed (Brassica napus L.) to different plant populations for environments in the northern United States.

Previous studies in Canada and Europe have shown that varieties had different responses to planting rates (Szczygielski and Owczarek 1987). Significant alterations in planting rates have given varied results for seed yields (Christensen and Drabble 1984; Budzyński et al. 1986; Kondra 1975; Jasińska et al. 1987; Geisler and Stoy 1987). As plant populations increase, shifts in some of the yield components have resulted in changes in seed yield per plant (Geisler and Stoy 1987). Seeds per plant, seed weight, pods per plant and racemes per plant have been found to decrease as plant density increases (Vincenc and Belan 1988; Guo and Yuan 1987; Mustapić et al. 1987; Budzyński et al. 1986; Szczygielski and Owczarek 1987).

Studies have also shown a relationship between environment and response to seeding rate. Higher plant densities decrease frost resistance and winter hardiness (Szczygielski and Owczarek 1987; Jasińska et al. 1987) and higher seeding rates have been related to a greater degree of lodging (Kondra 1975).

MATERIALS AND METHODS

During the 1988-89 and 1989-90 growing seasons, a study was conducted to determine the effect of differing plant populations upon agronomic traits, seed yield and yield components of winter rapeseed (Brassica napus L.). In both years, the trials were arranged in a split plot design, with varieties as whole plots and planting rates as sub-plots. The 6-row plots in these trials were 5.5 m long and 1 m wide, planted on 2 m centers with 17.8 cm row spacings. The three varieties Bienvenu, Cascade and Dwarf Essex were planted at rates of 74, 148, 221, 295, 369 and 443 seeds/m^2, equivalent to 3.5 to 21.2 kg/ha.

In the spring of both years, an estimate of spring stand for each plot was made by counting all plants in the center four rows for a length of one meter. At the completion of blooming, plant height was measured and estimates were made of the yield components; racemes per plant, pods per plant and seeds per pod. Five plants were randomly selected from the interior rows of each plot. For each plant all racemes and pods were counted and a single pod collected. Viable seeds from the five pods were counted and the variables pods per raceme and seeds per pod calculated.

In late July of both years, a Hege experimental plot combine was used to harvest the seed. The vegetative material was collected on a

tarp attached to the rear of the combine for weighing. Weight of the plot vegetative biomass was taken on a suspended scale immediately after harvest. Subsamples were collected for a determination of moisture content. The subsamples were weighed directly after harvest and again following four days of oven drying. Seed harvested from each plot was cleaned and oven dried prior to weighing. From these data, percent moisture, dry matter yield and harvest index were calculated. Seed weight was determined by weighing 100 randomly selected seeds from each plot. Analyses of variance were performed on data for the two years separately and combined. Correlation analysis was performed separately on the two years, using the means for each variety rate.

RESULTS

In both years, the plots emerged with relative uniformity and survived the winter well. Growing conditions were optimal in the 1988-89 season, as was reflected by the higher seed yields and vegetative yields (Tables 1 and 2). In the 1989-90 season, the spring rains extended well into the flowering period. Reduced seed set and development of vascular diseases such as Sclerotinia white mold and Blackleg were observed. With the onset of warm dry weather in June, plants senesced quickly and did not benefit from extra moisture early in the season. The two years differed in all agronomic traits measured and by all measures of yield, except 100 seed weight.

The variety Bienvenu had the highest seed yield and second highest vegetative yield in both years (Tables 1 and 2). Dwarf Essex bolted later and was significantly taller than the other two varieties. It produced the greatest amount of vegetative yield without a comparable seed yield, thus the lowest harvest index. The yield components 100 seed weight, seeds per pod, pods per raceme and racemes per plant did not differ between varieties in either year.

Although there was a six-fold increase from lowest to highest seeding rate, spring stands in the two years had less than a 400% differential in both years (Tables 1 and 2). Seed yields and vegetative yields remained fairly uniform across seeding rates with components of yield compensating for the differences in plant stands both years. During the first season, pods per raceme was the only yield component which varied significantly with seeding rate (Table 1). The following year, differences were found between seeding rates for all yield components, except 100 seed weight (Table 2). Seed weight was the most stable of all the yield components across years, varieties and seeding rates (Tables 1 and 2).

Correlation analysis was used to determine which variables were most closely associated with seed yield and harvest index. In the first season, the only yield component to correlate with seed yield was racemes per plant ($r=-0.74$) (Table 3). Harvest index was well correlated with seeds per pod and racemes per plant in the first year ($r=-0.62$ and -0.63, respectively). The following season, 100 seed weight and seeds per pod correlated with seed yield ($r=0.81$ and 0.49, respectively). In that season, seeds per pod was the only yield component which correlated significantly with harvest index ($r=0.72$). In both years, seed yield was positively correlated with harvest index ($r=0.67$ and $r=0.75$ for 1989 and 1990, respectively). Only in the first year was plant height significantly related to harvest index ($r=-0.84$).

CONCLUSIONS

Consistent estimates of seed yield in Brassica napus can be obtained from trials planted at a variety of seeding rates. Plant stands increase as seeding rates increase but not proportionally, probably due.

to plant competition. Seed yields at widely different plant populations remain uniform due to compensation by various components of yield. The means of compensation differs according to environmental conditions, as was observed during two widely differing years in this study.

Variability in agronomic responses of varieties to environments indicates that some indices are not always reliable selection factors for harvest index. In both years, seeds per pod was significantly correlated with harvest index, but that relationship was negative the first year and positive the next. Although there were varietal differences for plant height in this study, it was not consistently associated with harvest index and will not always provide the best means of selecting for that trait.

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Table 1. Seed yield and agronomic performance of three varieties of winter rapeseed (Brassica napus L.) planted at six seeding rates for the 1988-89 growing season.

	n	Spring Stand	Plant Height	Seed Yield	Vegetat. Yield	Harvest Index	Seed Weight	Seeds Per Pod	Pods Per Raceme	Racemes Per Plant
		plants/m^2	--m--	-kg/ha-	-kg/ha-	--%--	--g--	----------	no.	----------
Variety										
Bienvenu	24	108	1.5	8257	19,697	29.7	0.48	17	28.2	8
Cascade	24	103	1.5	7142	18,378	28.1	0.48	17	23.6	9
D. Essex	24	89	1.9	6975	22,919	23.6	0.48	19	30.5	11
LSD		15	0.1	365	1,130	1.4	ns	ns	ns	ns
Seed Rate (seeds/m^2)										
74	12	43	1.7	7188	19,148	27.3	0.47	17	33.6	10
148	12	73	1.7	7649	21,006	27.1	0.47	18	28.0	9
221	12	100	1.6	7691	20,625	27.3	0.49	18	28.1	9
295	12	118	1.6	7389	19,455	27.8	0.48	17	24.0	9
369	12	123	1.6	7447	20,593	27.2	0.48	17	26.3	9
443	12	142	1.6	7383	21,160	25.9	0.48	18	24.7	9
LSD		14	0.1	ns	ns	ns	ns	ns	4.2	ns
Mean	72	100	1.6	7458	20,331	27.1	0.48	18	27.4	9

Table 2. Seed yield and agronomic performance of three varieties of winter rapeseed (Brassica napus L.) planted at six seeding rates for the 1989-90 growing season.

	n	Spring Stand	Plant Height	Seed Yield	Vegetat. Yield	Harvest Index	Seed Weight	Seeds Per Pod	Pods Per Raceme	Racemes Per Plant
		plants/m²	--m--	-kg/ha-	-kg/ha-	--%--	--g--	---------- no. ----------		
Variety										
Bienvenu	24	116	1.7	5082	16,234	23.9	0.49	10	15.9	8
Cascade	24	99	1.7	3766	13,947	21.3	0.47	9	15.5	8
D. Essex	24	130	1.8	3987	18,897	17.4	0.47	7	15.3	7
LSD		ns	0.1	501	2,415	2.2	ns	ns	ns	ns
Seed Rate (seeds/m²)										
74	12	43	1.8	4452	15,419	22.5	0.48	11	18.4	12
148	12	88	1.7	4525	16,888	21.1	0.49	9	17.8	8
221	12	109	1.7	4382	16,565	20.8	0.48	9	15.7	7
295	12	127	1.7	4443	16,407	21.6	0.49	8	14.6	7
369	12	157	1.7	3940	16,339	19.9	0.47	8	13.3	7
443	12	167	1.7	3929	16,536	19.2	0.46	8	13.3	6
LSD		27	ns	ns	ns	2.2	ns	2	2.4	2
Mean	72	115	1.7	4279	16,359	20.9	0.48	9	15.5	7

Table 3. Correlation analysis between seeding rate, spring stand, seed yield, vegetative yield, harvest index and yield components for three rapeseed varieties at six seeding rates during two growing seasons. Results of the 1988-89 growing season are shown on the upper diagonal and results of the 1989-90 growing season are shown on the lower diagonal.

Indices	Seed Rate	Spring Stand	Seed Yield	Vegetat. Yield	Harvest Index	Seed Weight	Seeds Per Pod	Pods Per Raceme	Racemes Per Plant	Plant Ht.
	r values									
Seed Rate		0.92**	0.01ns	0.16ns	-0.10ns	0.24ns	0.22ns	-0.54*	-0.21ns	-0.20ns
Spring Stand	0.90**		0.18ns	0.02ns	0.12ns	0.39ns	0.05ns	-0.64**	-0.46ns	-0.40ns
Seed Yield	-0.29ns	-0.31ns		-0.16ns	0.67**	-0.00ns	-0.12ns	-0.01ns	-0.74**	-0.55*
Vegetat. Yield	0.09ns	0.32ns	0.14ns		-0.83**	-0.37ns	0.71**	0.21ns	0.26ns	0.69**
Harvest Index	-0.31ns	-0.47*	0.75**	-0.54*		0.25ns	-0.62**	-0.20ns	-0.63**	-0.84**
100 Seed Weight	-0.47*	-0.44ns	0.81**	0.20ns	0.54		0.00ns	-0.33ns	-0.18ns	-0.36ns
Seeds Per Pod	-0.51*	-0.69**	0.49*	-0.46ns	0.72**	0.27ns		0.31ns	0.34ns	0.59**
Pods Per Raceme	-0.79**	-0.81**	0.12ns	-0.35ns	0.37ns	0.11ns	0.65**		0.80**	0.57*
Racemes Per Plant	-0.76**	-0.79**	0.10ns	-0.37ns	0.38ns	0.08ns	0.66**	0.77**		0.76**
Plant Ht	-0.20ns	0.04ns	-0.15ns	0.77**	-0.46ns	0.08ns	-0.42ns	0.04ns	0.04ns	