HIGH DENSITY PLANTING OF BRASSICA NAPUS BREEDING LINES UNDER GREENHOUSE CONDITIONS

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INTRODUCTION

Greenhouse increases of segregating lines of rapeseed (*Brassica napus* L.) represent a significant expense and time constraint in breeding programs. Greenhouse seed increases must generate sufficient seed for both progeny testing and advancement of selected lines in as short of time period as possible. Techniques to reduce either the space or time required for greenhouse increases would improve the efficiency of plant breeding efforts in rapeseed.

The purpose of this experiment was to determine if highly efficient procedures used to grow forest tree seedlings in greenhouse conditions could be adapted to winter rapeseed. An inbred parental line of the winter rapeseed cultivar, Cathy, was used to compare the relative effectiveness of increasing seed in high density plant arrangements (HDPA) and low density planting arrangements (LDPA) under greenhouse conditions (Auld et al. 1990).

MATERIALS AND METHODS

Seedlings of an inbred line of winter rapeseed (WRE-10) were grown for 21 days under a 16 h photoperiod at 16/20°C diurnal temperatures prior to vernalization. Seedlings were vernalized at 2°C under an 18 hr low-intensity photoperiod for eight weeks prior to being transplanted into the greenhouse. Each replication of the LDPA consisted of 30 seedlings planted into polyvinyl growth bags filled with 3.8 l of Sunshine^R potting mix. The seedlings were arranged in rows 45 cm apart with 15 cm between seedlings within a row. In this arrangement, the 30 seedlings occupied an area of 1.5 x 1.0 m (20 plants/m^2). LDPA was typical of many conventional greenhouse increases currently used in the breeding programs utilizing either single seed descent or pedigree methods to advance segregating lines. A bamboo stake was placed in each pot for plant support. Strings suspended from the ceiling of the greenhouse were attached to each stake to prevent swaying and breakage of taller plants. As the plants elongated, wire twisties were tied to the plant on a weekly basis, to secure it to the stake.

The HDPA utilized plant spacings and potting containers commonly used by foresters to efficiently increase tree seedlings. Styrofoam Ventblock 45^R containers were used as potting containers. These blocks measured 15 x 37 x 62 cm and contained 45 individual cells that were 2.5 cm in diameter and 14 cm deep. Each cell held 0.3 l of potting mix. Vernalized seedlings were transplanted in alternate rows across the length of the block to obtain 25 plants in each block. Seedlings were spaced 5 cm apart within rows spaced 15 cm apart. Each replication of the HDPA treatment contained four blocks with a total of 100 seedlings which occupied an area of 0.8 x 1.2 m (104 plants/m^2).

The top support portion of the metal frames used to support plants in the HDPA blocks consisted of two, 61 x 74 cm rectangles made of 2.5 cm x 1.6 mm square metal tubing (Fig. 1). The area inside each rectangle was covered with a 5 x 6.4 cm plastic coated wire mesh. Each frame was attached to a 2.5 cm square metal tube that slid along a vertical 122 cm metal mast to allow adjustment for increasing plant height. The frame provided support for each stem and helped separate individual plants.

The potting medium in both treatments was Sunshine[R] Mix #1 which contained sphagnum peat moss, dolomitic limestone, perlite and calcium sulfate. A micronutrient fertilizer containing sulfur (12%), boron (0.1%), copper (0.5%), iron (12%), and manganese (2.5%) was added to the dry media at the rate of 1.0 g per l of potting mix. The plants were fertilized every seven days with Peters[R] professional water soluble fertilizer, using a water injector. This fertilizer solution had an analysis of 15-16-17 (N-P-K) and was diluted into tap water prior to watering at a concentration of 0.25% v/v.

The temperature in the greenhouse ranged from 20 to 22°C day and 10 to 12°C at night during the course of the study. The study was maintained under a 16 h photoperiod with use of high intensity discharge multivapor halogen 1000 watt lights.

Bloom data was recorded biweekly. Plants having 15 to 20 open blossoms were considered to have bloomed. Plant height was measured just prior to pod senescence. Total plant fresh weight, seed weight and 100 seed weight were measured at harvest to provide an estimate of harvest index. The time required to maintain each treatment was also recorded on a weekly basis.

The study was conducted as a randomized, complete block design with four replications. Since only two treatments were compared, T Test analyses were used to compare the LDPA and HDPA for all indices. A total of 390 seedlings were harvested from HDPA and 120 seedlings were harvested from LDPA. Means were considered to be significantly different only when the probability of the T values exceeded P=0.05.

RESULTS AND DISCUSSIONS

The HDPA increases of Brassica napus allowed 104 plants/m^2 to be increased compared to only 20 plants/m^2 in the LDPA planting (Table 1). Use of HDPA allowed over five times as many plants to be increased in expensive and limited greenhouse facilities as the conventional method. The amount of potting medium required for each plant was also reduced by over 90%. The HDPA treatment took an average of 5.2 hours/week compared to 10.9 hours/week for the LDPA, indicating that the HDPA was also more efficient in labor costs.

The date of bloom did not differ between the HDPA and LDPA (Table 1). In earlier studies, plants grown in high density plantings appeared to initiate both bolting and bloom earlier than in conventional pots. The reduced root area has also allowed more rapid drying and maturation of seed in many lines. In this study, the plants grown in the HDPA matured only 2 days earlier than those grown in LDPA. Plant height of seedlings grown in the HDPA (88 cm) was significantly shorter than seedlings grown in the LDPA treatment (158 cm). The large pots (3.8 l) used in conventional planting have allowed plants to grow in excess of 2 meters which made separation and support of individual plants difficult.

Average plant weight at the time of harvest of seedlings grown in the HDPA (6.2 g/plant) was only 10% of the average plant weight of seedlings grown in the LDPA (60.9 g/plant). The plants grown in the larger pots dried at a much slower rate and often had secondary tillers which further delayed maturity. Seedlings grown under HDPA produced 0.63 g of seed per plant compared to 1.63 g per plant in the LDPA. Even though seed yield per plant was reduced by 61% in the HDPA, sufficient seed was obtained to advance the line using single seed descent and for screening segregating lines for glucosinolate content using the Testape procedure (McGregor and Downey 1975).

Harvest index of seedlings grown in the HDPA treatments was 11.6% compared to 2.8% for seedlings grown in the LDPA treatments (Table 1). This indicates that factors other than root volume and plant spacing probably limit seed yield of greenhouse increases of winter rapeseed lines.

CONCLUSION

The HDPA allowed more efficient utilization of greenhouse space, potting medium, and labor. The harvest index was maximized with the HDPA treatment, since secondary growth was reduced. The HDPA also allowed more rapid and uniform seed maturation. The quantity of seed produced by HDPA was sufficient for early generation increases and progeny testing. The quality of seed grown under the HDPA was nearly equivalent to the conventional LDPA method. Use of the HDPA could optimize the number of lines which could be increased in limited greenhouse space while minimizing the cost of these increases.

REFERENCES

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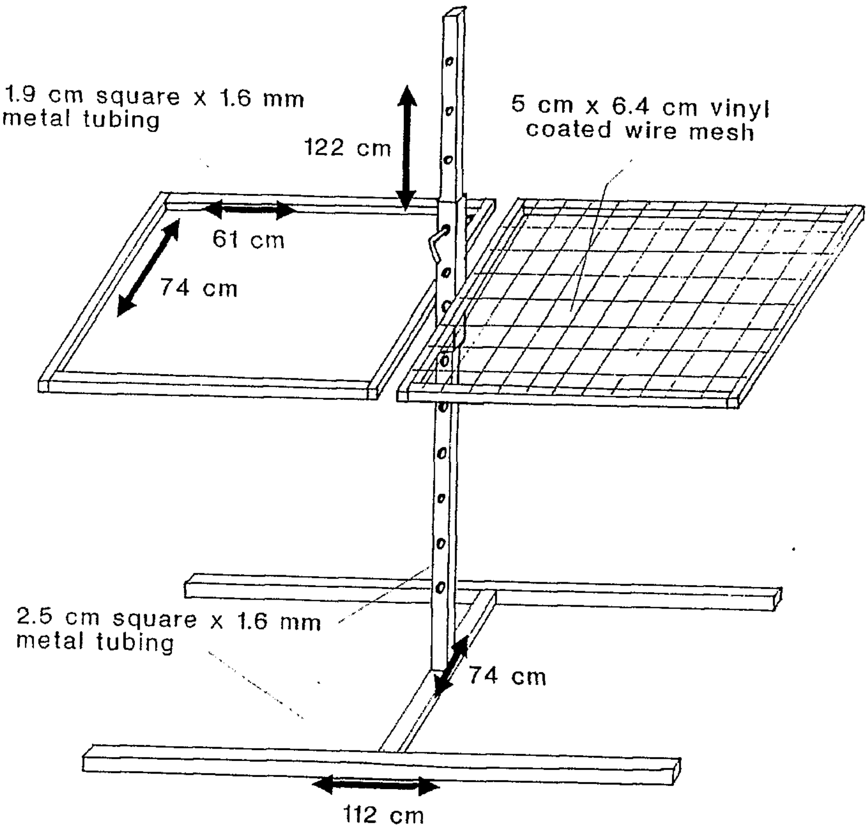

Figure 1. Dimensions of metal frames used to support seedlings grown under high density plant populations under greenhouse conditions.

Table 1. Plants per area, potting mix per plant, bloom date, days to maturity, plant height, plant weight and harvest index of an inbred line of winter rapeseed (WRE-10) grown at two plant densities under greenhouse conditions.

Planting Arrangement	Plants per Area	Potting Mix per Plant	Bloom Date	Plant Height	Days to Maturity	Plant Weight	Seed Weight	Harvest Index
	plts/m^2		Julian Date	--cm--	--days--	g/plt^{-1}	g/plt^{-1}	--%--
High Density	104	0.3	298	88	90	6.2	0.63	11.6
Low Density	20	3.8	297	158	92	60.9	1.62	2.8
T-test values	--	--	1.7 NS	-41.9**	-4.5**	-27.5**	-9.4**	26.9**

NS, **-non-significant and significant at the 0.01 level of probability, respectively.