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Sensitivity of zero erucic acid genotypes of oleiferous brassicas to plant population and planting geometry

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ABSTRACT

A field experiment was conducted during winter seasons of 1997–98 and 1998–99 at New Delhi, to study the sensitivity of 2 zero erucic acid genotypes of brassicas ['TERI (OE) R 15' and 'TERI (OE) M 21'] and 1 normal genotype '(Bio 902' as check) to planting geometries and plant population (20 cm × 10 cm, 20 cm × 15 cm, 30 cm × 10 cm, 30 cm × 15 cm, 45 cm × 10 cm and 45 cm × 15 cm). The genotype 'TERI (OE) R 15' of *Brassica napus* ssp. *oleifera* var. *annua* produced maximum branches/plant (8.7), siliquae/plant (285), siliqua length (4.6 cm), seeds/ siliqua (18), harvest index (24.5%) and oil content (42.0%). However, 'Bio 902' of *Brassica juncea* (L.) Czernj. & Cosson recorded statistically more 1,000-seed weight, seed weight/plant and biological, seed and oil yields than 'TERI (OE) R 15' and 'TERI (OE) M 21' of *Brassica juncea.* On an average, seed and oil yield of 'Bio 902' was 20.2% and 8.60% higher than 'TERI (OE) R 15' and 31.7% and 53.5% higher than 'TERI (OE) M 21' respectively. Planting geometry of 30 cm × 10 cm which corresponds to 33 plants/m^2 recorded significantly the highest seed (16.7 q/ha) and oil (6.2 q/ha) yields and harvest index (24.8%) over same plant density obtained with 20 cm × 15 cm and rest of planting geometries except 30 cm × 15 cm. Genotypes interacted significantly with planting geometries. Optimum plant population for 'TERI (OE) R 15' was 33 plants/m^2, 22 to 33 plants for 'TERI (OE) M 21' and 15 to 33 plants/m^2 for 'Bio 902'.

Key words : Zero erucic acid brassicas, Planting geometry, Plant population

The oleiferous brassicas are now the third most important source of edible vegetable oils in the world, whereas in India these are competing with groundnut for the first position. But unfortunately, the varieties of rapeseed-mustard, which are under cultivation in India, have high content of erucic acid (40–60%) branding it a oil of poor quality in the international market.

In order to catch international market and to provide good-quality oil in the domestic market zero erucic acid strains or varieties have been developed for Indian conditions. These strains or varieties differ genetically as well as morphologically from traditional varieties, so they are likely to respond differently to the crop ecosystems. Among different agronomic manipulations, the optimum number of plants/unit area is one of the important non-monetary parameter in increasing the productivity (Bali *et al.* 2000). In addition to optimum plant density, proper geometry of planting is another important non-monetary input in increasing the productivity per unit area. The optimum level of these 2 non-monetary inputs depends on variety, its growth habit and agro-climatic conditions (Singh and Verma, 1993). Keeping these aspects in view, 2 zero erucic acid genotypes and a traditional genotype of brassicas were evaluated for their sensitivity to plant population and planting geometry.

MATERIALS AND METHODS

A field experiment was conducted during winter (*rabi*) seasons of 1997–99 at Division of Agronomy, Indian Agricultural Research Institute, New Delhi, in spilt-plot design with 4 replications. The main plot treatments consisted 3 genotypes of brassicas viz. 'TERI (OE) M 21' of *Brassica juncea*, 'TERI (OE) R 15' of *Brassica napus* and 'Bio 902' (Pusa Jaikisan) of *Brassica juncea*, whereas sub-plot treatments were 6 planting geometries, viz. 20 cm × 10 cm, 20 cm × 15 cm, 30 cm × 10 cm, 30 cm × 15 cm, 45 cm × 10 cm and 45 cm × 15 cm. The plant density under each planting geometry was 50, 33, 33, 22, 22, and 15 plants/m^2 respectively. The soil was sandy loam, low in available nitrogen (254 kg/ha), medium in available P (17 kg/ha) and potassium (256 kg/ha), with pH 7.8. Among the genotypes 'TERI (OE) M 21' and 'TERI (OE) R 15' are zero erucic acid genotypes and 'Bio 902' ('Pusa Jaikisan') with normal erucic acid content used as check for yield comparison. The crop was raised following recommended package of practices. It was sown on 21 October 1997 and 29 October 1998 and harvested on 7 March 1998 and 20 March 1999 respectively. A uniform basal dose of nitrogen, phosphorus and potassium @ 40 kg each/ha was applied at the time of sowing. In addition to this, crop received top-dressing of 40 kg N/ha at 35 days after sowing at the time of the first irrigation. Sulphur requirement of the crop was ensured through the application of single superphosphate as source of recommended dose of phosphorus. The plant-to-plant distance was maintained 30 days after sowing. The crop received 2 irrigations during each season in addition to pre-sowing irrigation.

RESULTS AND DISCUSSION

Genotype performance

Five plants of each genotype were uprooted 60 days after sowing and it was observed that both the strains of zero erucic acid have comparatively shallow root-system than 'Bio 902'. In 'TERI (OE) R 15' lodging of plant was observed under the influence of excess moisture and wind. During the winter season of 1997–98, the climatic conditions were favourable for the white rust. Among the cultivars, 'Bio 902' found more susceptible to white rust, followed by 'TERI (OE) M 21' and least in 'TERI (OE) R15' The 'TERI (OE) R 15' was found to be 8 to 10 days early in maturity.

Genotypes showed significant differences in growth and yield attributes. 'Bio 902' and 'TERI (OE) M 21' being at par produced significantly taller plant than 'TERI (OE) R 15' (Table 1). In contrast to plant height, branches/plant, siliquae/plant, siliqua length and seeds/ siliqua were significantly more in 'TERI (OE) R 15' than 'Bio 902' and 'TERI (OE) M 21'. Between 'Bio 902' and 'TERI (OE) M 21' the latter was superior to 'Bio 902' with respect to aforesaid growth and yield attributes. 'Bio 902' produced the boldest seed among the varieties, resulting in significantly the highest 1,000-seed weight and consequently seed yield/plant. In other 2 genotypes, 'TERI (OE) M 21' recorded statistically low value for 1,000-seed weight and seed yield/plant compared with 'TERI (OE) R 15'. Rana and Saran (1999) reported similar variation in the yield attributes of 3 species of brassicas.

'Bio 902' gave the highest biological yield, followed by 'TERI (OE) M 21'. But this trend was absent with respect to seed yield. 'Bio 902' recorded significantly highest seed yield owing to its highest 1,000 weight. Between 'TERI (OE) R 15' and 'TERI (OE) M 21', seed yield of 'TERI (OE) R 15' was statistically more than 'TERI (OE) M 21, which was the result of its superiority in terms of its yield attributes. The seed yield of 'Bio 902' was 20.2 and 31.7% more than the seed yield of 'TERI

Table 1. Growth and yield attributes of zero erucic acid brassicas at harvest under different plant population and planting geometry (pooled over 2 years)

Treatment	Plant height (cm)	Branches/ plant	Siliquae/ plant	Siliqua length (mm)	Seeds/ siliqua	1,000-seed weight (g)	Seed weight/ plant (g)
Genotype							
'TERI (OE) M 21'	177	6.8	269	35.9	16.2	1.81	.6.7
'TERI (OE) R 15'	129	8.7	285	46.1	18.0	2.18	8.0
'Bio-902'	172	6.2	238	34.7	13.7	3.16	9.5
CD (P=0.05)	6	0.2	11	1.8	0.9	0.25	0.2
Planting geometry (cm) or plant population (plants/m²)							
20 cm × 10 cm (50)	165	6.7	248	37.3	15.0	2.27	6.7
20 cm × 15 cm (33)	166	6.9	250	38.2	15.4	2.30	7.0
30 cm × 10 cm (33)	163	7.6	272	38.5	16.0	2.42	8.3
30 cm × 15 cm (22)	157	7.5	269	39.7	16.1	2.42	8.6
45 cm × 10 cm (22)	153	7.5	271	39.6	16.8	2.45	9.1
45 cm × 15 cm (15)	153	7.4	274	40.2	16.5	2.45	9.0
CD (P=0.05)	4	0.4	16	0.9	0.7	0.9	0.6

(OE) R 15' and 'TERI (OE) M 21' respectively. On the basis of harvest index 'TERI (OE) R 15' showed the highest partitioning efficiency (24.5%) and it was lowest in 'TERI (OE) M 21' (18.5%). Oil content (%) was significant by more in 'Teri (OE) R 15' (42.0%), followed by 'Bio 902' (37.9) and significantly lowest in 'TERI (OE) m 21' (32.2). Estimated oil yield followed trend similar to seed yield but the magnitude of variation was not the same due to significantly higher oil content in 'TERI (OE) R 15' than 'Bio 902'. 'Bio 902' recorded 20.2% more seed yield than 'TERI (OE) R 15' but this gap squeezed to 8.6% with respect to oil yield. In contrast to this, between 'TERI (OE) R 15' and 'TERI (OE) M 21', the gap in oil yield (41%) was more compared to seed yield (9.4%).

Plant population and planting geometry

Planting geometry and plant population resulted in significant changes in the growth, yield attributes and yield (Tables 1, and 2). Closer planting geometries resulted in taller plants than wider planting geometries and this reduction in plant height was significant when plant population was decreased from 33 plants/m^2 to 22 plants/m^2. This might be attributed to reduction in the magnitude of competition for light as we move from closer to wider spacing. Contrary to plant height, growth and yield attributes such as branches/ plant, siliquae/ plant, siliqua length, seeds/siliqua, 1,000-seed weight and seed yield/plant showed significant improvement as the plant population decreased from 50 plants/m^2 to

Table 2. Biological yield, seed yield, harvest index, oil content and oil yield of zero erucic acid brassicas under different plant population and planting geometry (pooled over 2 years)

Treatment	Biomass yield (q/ha)	Seed yield (q/ha)	Harvest index (%)	Oil content (%)	Oil yield (q/ha)
Genotype					
'TERI (OE) M 21'	68.5	12.7	18.5	32.2	4.1
'TERI (OE) R 15'	57.0	13.9	24.5	42.0	5.8
'Bio 902'	72.5	16.7	23.0	37.9	6.3
CD (P=0.05)	2.8	1.0	1.3	2.1	1.3
Planting geometry (cm) or plant population (plants/m^2)					
20 cm × 10 cm (50)	70.1	12.6	17.9	36.6	4.6
20 cm × 15 cm (33)	68.5	14.8	21.6	36.4	5.4
30 cm × 10 cm (33)	67.1	16.7	24.8	36.8	6.2
30 cm × 15 cm (22)	65.3	15.6	23.8	38.1	5.9
45 cm × 10 cm (22)	64.0	14.1	22.0	37.9	5.3
45 cm × 15 cm (15)	62.7	12.8	20.4	37.9	4.8
CD (P=0.05)	2.3	1.2	1.6	NS	0.8

15 plants/m^2. Changes in the intensity of competition and mutual shading over the plant densities might be the cause for such behaviour of growth and yield attributes. Planting geometries of 20 cm × 15 cm and 30 cm × 10 cm, with same plant density, produced perceptible changes in growth and yield attributes such as branches/plant, siliquae/plant, 1,000-seed weight and seed weight/plant. Between these 2 planting geometries, 30 cm × 10 cm was superior to 20 cm × 15 cm. This may be attributed to intensive inter-row competition in 20 cm × 15 cm compared to 30 cm × 10 cm spacing. Further reduction in plant density from 33 plant/m^2 to 15 plants/m^2 failed to produce marked variation in growth and yield attributes. A positive correlation was noted between plant density and biological yield, but there was proportionately less reduction in biological yield than corresponding decrease in plant density due to high degree of plasticity in relation to space. In contrast to biological yield, both closer and wider planting geometries caused depressive effect on seed yield and harvest index. Moderate spacing of 30 cm × 10 cm corresponding to 33 plants/m^2 resulted in significantly higher seed yield (16.7 q/ha) and harvest index (24.8%) over other planting geometries except 30 cm × 15 cm. Low values of yield attributes at 30 cm × 10 cm should have resulted in low seed yield compared to high value at 45 cm × 10 cm and 45 cm × 15 cm, but this did not happen due to over-compensation by higher number of plants per unit area. At the same plant density of 33 plants/m^2, there was significant increase in the seed yield (12.8%) and harvest index (14.8%) when the planting geometry was changed from 20 cm × 15 cm to 30 cm × 10 cm. Over-competition and low partitioning coefficient in closer spacing and under-utilization of available resources in wider spacing might be the cause for such trend. Oil content did not differ significantly among the planting geometries. Due to this behaviour of oil content, oil yield responded to planting geometries and plant population similar to seed yield. The planting geometry of 30 cm × 10 cm recorded significantly highest oil yield than rest of planting geometries except 20 cm × 15 cm and 30 cm × 15 cm.

Table 3. Interaction effect of zero erucic acids brassicas and planting geometry on seed yield (q/ha) (pooled over 2 years)

Planting geometry (cm) or plant population (plants/m^2)	'TERI (OE) R 15'	'TERI (OE) M 21'	'Pusa Jaikisan'
20 cm × 10 cm (50)	14.4	10.5	13.0
20 cm × 15 cm (33)	16.3	13.0	15.1
30 cm × 10 cm (33)	16.3	15.4	18.4
30 cm × 15 cm (22)	13.6	15.0	18.3
45 cm × 10 cm (22)	11.7	12.3	18.4
45 cm × 15 cm (15)	11.0	10.2	17.1
CD (P=0.05)		1.9	

Interaction effect

The interaction between genotypes and planting geometries was significant for seed yield (Table 3) 'TERI (OE) R 15' statistically similar seed yield at 20 cm × 15 cm and 30 cm × 10 cm but it was significantly higher than other planting geometries. On the contrary 'TERI (OE) M 21' gave seed yield of at 30 cm × 10 cm and 30 cm × 15 cm spacings which was higher than other planting geometries. 'Bio 902' gave statistically similar seed yield over the plant densities varying from 15 plants/m^2 to 33 plants/m^2. The optimum plant population for 'TERI (OE) R 15' was 33 plants/m^2, 22–33 plants for 'TERI (OE) M 21' and 15 to 33 plants/m^2 for 'Bio 902'.

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