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Research Communication

Assessment of the system of root intensification in rapeseed-mustard (*Brassica* species)

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ABSTRACT

A field study was conducted at Norman E. Borlaug Crop Research Centre of GB Pant University of Agriculture & Technology, Pantnagar to assess the system of root intensification under transplanting system in *Brassica* species during winter (*rabi*) season of 2014–15. The experiment was designed in split plot arrangement taking method of planting in main-plots and *Brassica* species in sub-plots with 3 replications. The growth and yield parameters of *Brassica* species were affected significantly by methods of planting. The highest seed yield was recorded with transplanting at 60 cm × 60 cm spacing. The highest seed and stover yields were obtained in 'RP 09' (*Brassica carinata*) transplanted at 60 cm × 60 cm spacing. These findings suggest that growing rapeseed-mustard crop through transplanting holds a great promise under *tarai* conditions of Uttarakhand.

Key words : Brassica, Planting methods, Transplanting, Yield

The optimum sowing time of rapeseed-mustard in northern India is the second fortnight of October, but it often gets delayed to December particularly after cotton, maize, soybean and rice. So the productivity gets reduced due to reduction in vegetative and reproductive phases of the crop. Further, the yield potential of rapeseed-mustard has gone stagnant under conventional planting system, which cannot be further increased, unless we try to explore some agronomic manipulations for further enhancement in its production to cater the ever growing demand for edible oils in the country. Root intensification through transplanting could offer such an option, which is already being practiced raising seedlings in a nursery bed or trays or polythene bags in some irrigated rapeseed-mustard growing regions in the country, but needs to be optimized further. However, the information on raising the crop by transplanting method is meagre. Genotypes may differ in their production potential, depending on growth habit, canopy structure and different phenophases, and need to be studied.

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A field experiment was conducted during the winter (*rabi*) season of 2014–15 at N. E. Borlaug Crop Research Centre of GB Pant University of Agriculture & Technology, Pantnagar (29^{o} N', 79^{o}29 E' and at an altitude of 243.83 m above mean sea-level) to study the effect of planting methods and genotypes on the growth, yield attributes and yield of rapeseed-mustard. The soil of the experimental site was silty clay loam with *p*H 7.2, organic carbon 0.81%; and 261, 21.3 and 231 kg/ha of N, P_2O_5 and K_2O, respectively. The experiment consisted of 12 treatments, having four levels of planting geometry (90 cm × 60 cm transplanting, 60 cm × 60 cm transplanting, 75 cm × 75 cm transplanting, and the conventional planting) in main-plots and 3 genotypes {*Brassica juncea* cv. 'Kranti', *B. carinata* cv. 'RP 09' and *B. rapa* ssp. yellow *sarson* cv. 'Pant Shweta'} in sub-plots laid out in split-plot design with 3 replication.

Seedlings were raised in polythene bags for 15 days. Frequent irrigation was given after emergence of crop on the basis of visual symptoms. The experimental crop was fertilized uniformly with 120:40:20 kg/ha of N, P and K, respectively. Half of the nitrogen along with full amount of phosphorous and potassium was applied at the time of sowing as basal. The remaining nitrogen was top dressed in 2 equal splits, at 25 and 50 days after planting of the crop. The seedlings were transplanted manually as per the intended geometry after basal application of fertilizers 15 days after raising the nursery. The conventional sowing was carried out in 30 cm apart rows. Normal practices of crop husbandry were followed for successful raising of the crop. Data related to growth parameters, yield attributes and yield recorded during the experimental year were subjected to appropriate statistical analysis and interpretation as suggested by Gomez and Gomez (2010).

The growth parameters, viz. root density, stem diameter and dry-matter were significantly influenced by different treatments (Table 1). The transplanting of *Brassicas* was associated with vigorous growth of the crop. Root density and stem diameter were measured more in the crop transplanted at 75 cm × 75 cm spacing, which remained on a par with that of the other transplanting geometries. The transplanted crop attained significantly more root density and stem diameter over the conventionally sown crop which might be due to more vigorous root system and more spacing under the transplanted crop letting it derive more water and nutrients for its growth and development. Al- Doori (2013) has also reported larger stem diameter with the lowest plant density. *Brassica carinata*, cultivar 'RP 09' produced significantly higher root density and broader stem diameter over the other 2 *Brassica* species. More root density in case of the transplanted crop could be owed to more exploitation of soil for nutrients and water by the transplanted crop. Also, the root diameter and root branching were more in case of the transplanted crop. The direct sown crop produced significantly lowest root density, which may be due to a low dry weight of roots due to less growth of the conventionally sown crop. The difference among the genotypes could be attributed to their growth behavior, biomass production and the crop duration. The transplanted crop accumulated significantly more dry-matter over the conventionally sown crop. The maximum dry-matter/plant was at 75 cm × 75 cm transplanting, which remained on a par with that of the other transplanting geometries. Among the different *Brassica* species, 'RP 09' accumulated significantly more dry-matter followed by 'Kranti' and 'Pant Shweta' possibly due to higher uptake of N and a longer duration taken by this genotype, which is truly indicative of the total photosynthate production (Prakash *et al*., 2000).

The yield attributes like branches/plant, siliquae/plant, seeds/siliqua and 1,000-seed weight were influenced significantly by the planting methods and the genotypes (Table 1 and Fig. 1 and 2). The transplanted crop produced more number of primary, secondary and tertiary branches over the conventionally sown crop, which was due to branching taking place from the basal part of the main shoot in transplanted crop. Among the genotypes, 'RP 09' (*Brassica carinata*) produced more number of primary, secondary and tertiary branches as compared to the other 2 genotypes. *B. juncea* variety 'Kranti', also recorded more number of primary, secondary and tertiary branches over that of *B. rapa* variety 'Pant Shweta'. The number of siliquae/plant was significantly more in the transplanted

Table 1. Root and plant attributes, yield and economics of oilseed *Brassica* as affected by planting methods and genotypes

Treatment	Root density (kg/m^3)	Stem diameter (mm)	Dry-matter/plant (g)	Siliquae/plant				Seeds/siliqua	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)	Benefit: cost ratio
				Main shoot	Primary branches	Secondary branches	Tertiary branches					
Planting methods												
Transplanting at 90 cm × 60 cm spacing	1.99	25.3	220.4	27.6	352.7	679.8	433.5	23.6	1.61	6.57	20.1	0.58
Transplanting at 60 cm × 60 cm spacing	2.01	24.6	212.2	27.1	351.5	686.7	427.8	23.8	2.42	8.70	22.8	1.22
Transplanting at 75 cm × 75 cm spacing	2.05	25.6	220.8	27.8	351.0	692.0	430.1	23.6	1.60	6.44	20.6	0.58
Conventional planting	0.65	13.7	38.7	24.2	104.2	162.7	0.0	13.8	1.18	4.27	22.8	0.76
SEm±	0.04	0.7	3.2	1.1	5.2	17.6	21.3	0.4	0.04	0.124	0.51	0.04
CD (P=0.05)	0.15	2.4	11.1	NS	18.1	61.0	73.8	1.6	0.13	0.429	1.7	0.12
Genotypes												
B. juncea 'Kranti'	1.83	20.2	146.7	38.3	315.3	728.5	262.2	12.9	1.65	6.32	20.7	0.75
B. carinata 'RP 09'	2.53	32.1	268.3	15.2	319.9	873.8	704.3	13.1	2.25	9.58	18.9	1.32
B. rapa 'Pant Shweta'	0.66	14.7	104.1	26.6	234.3	63.5	2.2	37.6	1.21	3.58	25.2	0.27
SEm±	0.02	0.7	3.8	1.5	7.7	15.2	17.3	0.4	0.032	0.081	0.40	0.03
CD (P=0.05)	0.07	2.2	11.5	3.2	23.0	45.6	51.9	1.3	0.096	0.245	1.20	0.10

crop over the conventionally sown crop owing to more number of secondary and tertiary branches in the transplanted crop. This is in line with the findings of Satpathy (2007). The number of siliquae/plant is a function and resultant of the number of branches/plant. The genotypes significantly influenced the number of siliquae/plant. *Brassica carinata*, cultivar 'RP 09', produced significantly more number of siliquae/plant over the other 2 genotypes. 'Kranti' bore significantly more number of siliquae on the main shoot as compared to the other genotypes. *Brassica carinata* cultivar 'RP 09' had significantly more number of siliquae on the primary, secondary and tertiary branches over the other 2 genotypes. However, 'Kranti' did not differ significantly in case of the siliquae on the primary branches. The varietal character in yield attributes has also been reported by various researchers including Prakash *et al.* (2000) and Singh *et al.* (2001). The conventional planting caused a significant reduction in the average number of seeds/siliqua. Among the different genotypes, *B. rapa* 'Pant Shweta' produced significantly more number of seeds per siliqua which maybe a varietal character. This varietal character is also reported by Kumar (2003).

Transplanting at 75 cm × 75 cm produced higher 1,000-seed weight, while the conventional sowing ended up with the lowest weight of 1,000-seeds. More accumulation of dry-matter resulted in better accumulation of photosynthates in the transplanted crop, which resulted in more number of siliquae/plant because of the availability of more photoassimilates. Singh *et al.* (2006) has also documented more number of siliquae/plant and 1,000-seed weight in transplanted crop than that in the direct-seeded crop of mustard. Among the various genotypes, *B. carinata* 'RP 09' produced higher 1,000-seed weight over the other 2 *Brassica* species. This is in line with the findings of Kumar (2003). Among the various planting geometries, transplanting with 60 cm × 60 cm spacing yielded

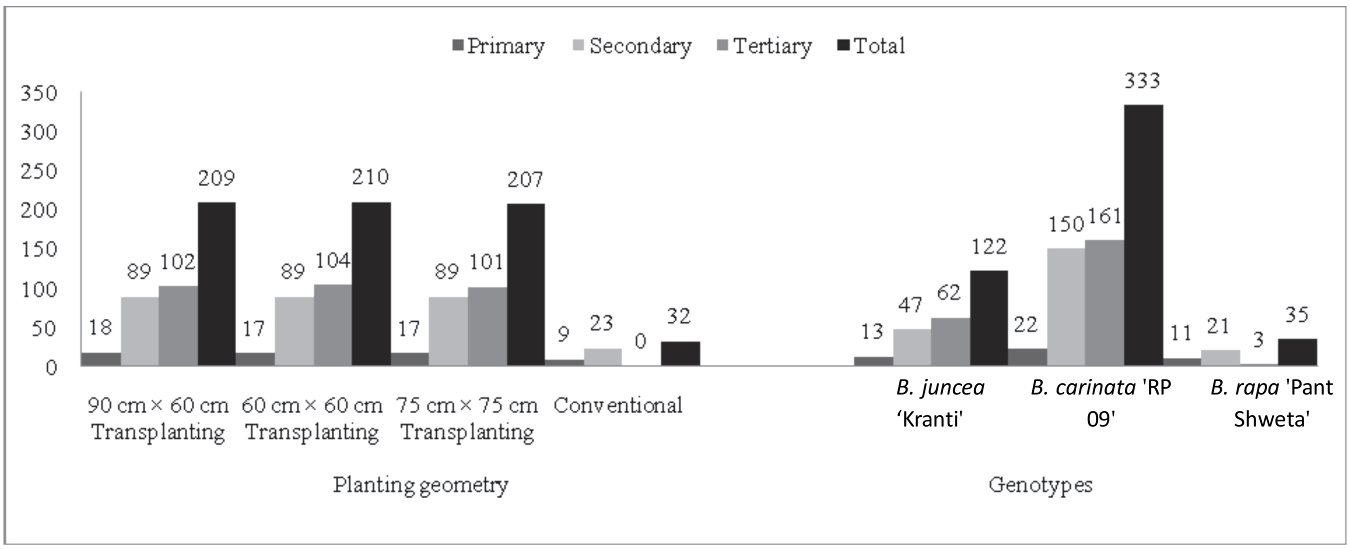

Fig. 1. Effect of planting methods and genotypes on branches/plant

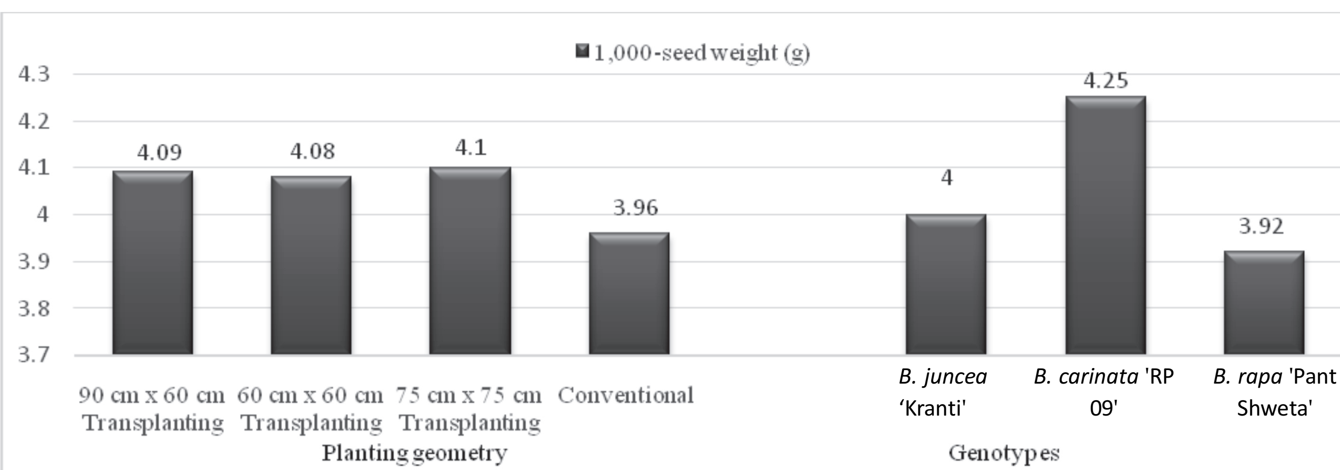

Fig. 2. Effect of planting methods and genotypes on 1,000-seed weight (g)

Table 2. Interaction effect of planting geometry and genotypes on seed yield (t/ha) of *Brassica* species

Genotypes (G) /*Planting geometry (PG)*	*B. juncea* 'Kranti'	*B. carinata* 'RP 09'	*B. rapa* 'Pant Shweta'
Transplanting (90 cm × 60 cm)	1.50	2.28	1.05
Transplanting (60 cm × 60 cm)	2.31	3.13	1.82
Transplanting (75 cm × 75 cm)	1.52	2.24	1.02
Conventional	1.27	1.33	094
CD (P=0.05)			
To compare 2 levels of G at same level of PG			0.193
To compare 2 levels of PG at same or different levels of G			0.201

the maximum being significantly superior over the other planting methods. The lowest seed yield was harvested in conventional planting which remained significantly poor as compared to transplanting. The difference in the plant population between 60 cm × 60 cm and 75 cm × 75 cm made the difference in the seed yield significant. ATMA (2013) and Singh *et al.* (2006) also reported higher seed yield under transplanting system in mustard. *Brassica carinata* out yielded the other 2 species being significantly superior in terms of seed yield. Indian mustard variety 'Kranti' also remained significantly superior over yellow *sarson* variety 'Pant Shweta' which registered the lowest seed yield among the three. The higher seed yield in case of 'RP 09' (*Brassica carinata*) might be due to more number of branches, siliquae, and the 1,000-seed weight. The varietal differences in seed yield have also been reported by Raquibullah *et al*. (2006) and Razzaque *et al*. (2007).

The interaction between the *Brassica* species and the planting methods was found to be significant on seed yield (Table 2). Transplanting of the Ethiopian mustard 'RP 09' under 60 cm × 60 cm geometry stood out to be significantly superior among all the combinations of *Brassica* species and planting geometries producing the maximum seed yield.

The stover yield, too, was significantly higher in 60 cm × 60 cm transplanting geometry over the other planting geometries. Transplanting at 90 cm × 60 cm and 75 cm × 75 cm remained on a par and significantly superior over the conventional planting. The higher stover yield in 60 cm × 60 cm spacing could be taken as a function of more plant population, number of branches per plant, and more vegetative growth. Among the different genotypes, 'RP 09' produced significantly higher stover yield over the other 2 genotypes. Conventional planting resulted in maximum harvest index (22.8%), which was statistically on a par with that of 60 cm × 60 cm transplanting geometry. Among the various Brassica species, *B. rapa* variety 'Pant Shewta' had significantly higher harvest index over Kranti (*B. juncea*) and 'RP 09' (*B. carinata*).

Among the various treatments, *Brassica carinata* 'RP 09' transplanted at 60 cm × 60 cm spacing registered the maximum benefit: cost ratio. Other combinations could not register benefit: cost ratio greater than unity.

Thus, it could be concluded that transplanting of *Brassica carinata* at 60 cm × 60 cm spacing can prove a step ahead in realizing the yield potential of the crop through root intensification in *tarai* region of Uttarakhand.

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