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Effect of crop geometry on yield, soil properties and nutrient content of transplanted Indian mustard

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Abstract
A field experimented was conducted at Research Farm, ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur during *rabi* season of 2016-17 to study the effect of plant geometry on yield, soil properties and nutrient content of transplanted Indian mustard. The results reveals that the row spacing of 60 x 30 cm spacing registered significantly higher values of yield along with soil parameters of transplanted mustard under the agro-climatic condition of Bharatpur (Raj.).

Keywords: Indian mustard, transplanted, crop geometry, nitrogen and phosphorous

Introduction
Mustard (*Brassica juncea*) locally known as "ray" or "laha" belongs to the family Cruciferae. Mustard is Latin term 'must' 'mustun' denotes expressed juice of grapes and 'ardens' means hot and burning. Rapeseed-mustard is the third important oilseed crop in the world after soybean (*Glycine max*) and palm (*Elaeis guineensis* Jacq.) oil. Among the seven edible oil seed cultivated in India, Rapeseed mustard is the second-most important oilseed crop in India, next only to soybean, with almost one-fourth share in both area and production (Jat *et al*., 2019). Dry matter accumulation is the important parameter for obtaining better growth and yield attributes and yields in the crop which can be mostly done by the adopting changing management in which planting geometry have prime importance. Indian mustard is highly sensitive to climate change and soil fertility. Among the agronomic factors which are known for augmenting the mustard production are crop spacing and planting geometry which plays a very important role in enhancing the production. Spacing is a non-monetary input but it plays a vital role by changing the magnitude of competition. The competitive ability of rapeseed-mustard plant depends upon the density of plants per unit area and soil fertility status (Shekhawat *et al*., 2012) [7]. Thus optimum row spacing is very necessary for sunlight interception at each strata of leaves. This will result in the enhancement of the rate of photosynthesis which will consequently enhance dry matter production which will finally lead to increase in the crop yield. Establishment of optimum plant population by maintaining proper row spacing is one of the important factors to secure a better translocation of photosynthesis which render better yield of crop (Alam, 2018) [1]. Transplanting of Indian mustard is gaining importance in present time due to higher yields and wider sowing window. Transplanting of Indian mustard rather than normal drilling perceived as costlier method of crop establishment, however, the labour requirement for sowing and then thinning the crop twice to remove extra plants in drilled crop may be more costlier. Transplanted crop have the exact plant population with mathematical precision, and there is also some time benefit after harvest of the *kharif* crops. Through transplanting, the full potentiality of individual plants can be realized and yield more than drilling of seeds. However, information regarding plant geometry on yield, soil properties and nutrient content of transplanted Indian mustard in Rajasthan is lacking. Keeping in view the above discussed facts of sufficient information and sparce related research, the present investigation was undertaken to find out the effect of plant geometry on yield, soil properties and nutrient content of transplanted Indian mustard (*Brassica juncea* L.).

Materials and Methods

An experiment was conducted during *rabi* season of 2016-17 at Research Farm, ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur (situated at 27°15' N latitude and 77º03' E longitude with an altitude of 178.37 m above mean sea level). The soil was loamy sand in texture having a pH of 8.3 (Alkaline), EC 1.3 (dS m^{-1}), low in organic carbon (0.24 %) and low available nitrogen (126.30 kg ha^{-1}), medium in available phosphorus (17.23 kg ha^{-1}) and low in available potassium (149.26 kg ha^{-1}). The experiment was conducted in randomized block design with replicate thrice consisted of four crop geometry treatments *viz.* 45x30 cm, 60x30 cm, 90x30 and 30x10 cm. The treatments were allocated randomly to each plot. Urea, di ammonium phosphate and murate of potash were used as a source of nitrogen, phosphorus and potassium. The crop was uniformly fertilized with 100 kg N, 60 kg P_2O_5 and 50 kg K_2O ha^{-1} giving a full dose of phosphorus and potassium as basal and nitrogen applied as basal as well as top dressing. The total rainfall experienced during the crop growth season was 55.8 mm in 2016-17. RH-406 variety of mustard was used as a test crop. Fifteen days old seedlings were transplanted on 13th October and spacing maintained as per treatment. Other crop management methods were accompanied as per the recommendation of the area.

Statistical analysis and interpretation of data: Data recorded on various parameters of mustard crop in the experiment was subjected to analysis by using Fisher's method of analysis of variance (ANOVA) and interpreted as outlined by Gomez and Gomez (1984) [3]. The levels of significance used in 'F' and 't' test was p=0.05. Critical difference values were calculated where F test was found significant.

Results and Discussions

Crop geometry exerted significant effect on yield attributes, yield and economics of transplanted mustard. Among the crop geometry/spacing, 60x30 cm recorded significantly higher seed yield (3574 kg ha^{-1}), stover yield (10210 kg ha^{-1}) and biological yield (13784 kg ha^{-1}) during experimentation. However, 60x30 cm was statistically at par rest of the treatments except for 30x10 cm spacing (Table 1). In case of harvest index, significantly higher value was noted under spacing of 90x30 cm which was statistically at par with 60x30 cm and 45x30 cm, respectively. Increase in yield may be due to optimum plants population per unit area, plant received better nutrition and optimum space to produce more growth and yield contributing attributes like more number of branches and number of siliquae thereby produced higher yields. Similar results were also reported by Sahar *et al.* (2012) [6]; Singh *et al.* (2015) [8].

The data pertaining to various soil parameters as influenced by crop geometries are presented in Table 2. Among the crop geometries, significantly higher soil pH (7.80) and available phosphorous (36.5 kg ha^{-1}) was recorded under spacing of 45x30 cm. The significant greater pH and phosphorus observed with crop geometry of 45x30 cm. In total, pH and phosphorus per unit area increased with the density which was mainly resulted from the increase in seed yield per unit area. Similar results were also reported by Harikesh *et al.* (2017) [4]. While, significantly higher electrical conductivity (0.76 dS m^{-1}) was recorded under spacing of 60x30 cm over rest of the spacing's. The significant greater EC observed with crop geometry of 60x30 cm. In total, EC per unit area increased with the density which was mainly resulted from the increase in seed yield per unit area. Similar results were also reported by Harikesh *et al.* (2017) [4].

Significantly higher organic carbon (0.37%) and available nitrogen (261 kg ha^{-1}) was recorded under spacing of 90x30 cm. The significant greater OC and potash observed with crop geometry of 90x30 cm. In total, EC, OC and potash per unit area increased with the density which was mainly resulted from the increase in seed yield per unit area which might have added more root and leaf fall in the soil and improved the soil properties. Similar results were also reported by Harikesh *et al.* (2017) [4].

Crop geometry of 60x30 cm recorded significantly higher phosphorus (0.17%) and potassium (1.87%) over rest of the treatments (Table 3). The significant greater phosphorus and potash observed with crop geometry of 45x30 cm. Phosphorus and potash per unit area increased with the density which was mainly resulted from the increase in P and K uptake. Similar results were also reported by Bezbaruha *et al.* (2011) [2].

Table 1: Yield (kg ha^{-1}) and harvest index (%) of transplanted mustard as influenced with crop geometry

Treatments	Biological yield (kg ha^{-1})	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	HI (%)
45x30 cm	12762	3298	9464	26.01
60x30 cm	13784	3574	10210	26.06
90x30 cm	12818	3418	9400	26.54
30x10 cm	9649	2007	7641	20.92
SEm±	490	156	1660	1.35
C.D.at 5%	1568	499	519	1.35
CV (%)	8.00	10.16	11.31	4.31

Table 2: Soil properties after harvest of Indian mustard as influenced with crop geometry

Treatment	pH	EC (dS m^{-1})	OC (%)	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})
45x30 cm	7.80	0.62	0.30	36.5	258
60x30 cm	7.58	0.76	0.36	32.5	258
90x30 cm	7.68	0.62	0.37	32	261
30x10 cm	7.65	0.47	0.26	27.17	169
SEm±	0.26	0.06	0.04	5.47	15.87
C.D. at 5%	0.08	0.02	0.01	1.78	5.15
CV (%)	2.66	6.56	9.27	12.39	4.87

Table 3: Nutrient content (%) of transplanted mustard as influenced with crop geometry

Treatment	Phosphorus (%)	Potash (%)
45x30 cm	0.14	1.60
60x30 cm	0.17	1.87
90x30 cm	0.14	1.64
30x10 cm	0.10	1.29
SEm±	0.05	0.12
C.D. at 5%	0.02	0.08
CV (%)	12.28	10.72

Conclusion

On the basis of one year experiment it may be concluded that row spacing of 60 x 30 cm spacing registered significantly higher values of yield along with soil parameters of transplanted mustard under the agro-climatic condition of Bharatpur (Raj.).

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