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Yield enhancement of rapeseed-mustard through innovative transplanting technique in Assam

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Abstract

A study was carried-out during winter season of 2022-23 at Bongaigaon and Dhubri districts of Assam to evaluate the yield performance of transplanted and broadcasted sowing methods of Toria (*Brassica rapa* ssp. Toria) and Indian mustard (*Brassica juncea*). Field experiments were laid down in randomized block design with five replications and four treatments including transplanted Toria, Toria broadcasting, transplanted mustard and mustard broadcasting. Results showed that the transplanting of both Toria and mustard resulted the greater values of plant height, number of siliqua/ plant, number of primary branches/ plant and number of secondary branches/ plant over the broadcast method of sowing. The highest average seed yield was recorded in transplanted mustard (19.3 q/ha) followed by transplanted Toria (13.9 q/ha) which were recorded around 67 % and 49 % more yield as compared to broadcasted mustard and Toria, respectively. The additional net monetary return (32060 Rs./ha) and benefit cost ratio (3.2) were also recorded higher in transplanted mustard as compared to other treatments. From this study it can be concluded that the transplanting of mustard and Toria could be beneficial for getting higher yield as well as additional net monetary returns as compared to broadcasted sowing method in the Assam.

***Keywords**: Broadcasting, B:C ratio, mustard, Toria, transplanting, yield*

Introduction

Rapeseed-mustard is playing a major role in oilseed production and satisfying most of the oil requirement of Indian consumers. Rapeseed-mustard group of crops has good production potential, where the cultivation is supported with technology and knowledge inputs. Expansion of the crop to non-traditional areas is one option to increase production, especially because rapeseed-mustard is capable of growing under diverse agro-climatic zones. Rice-fallow of Assam needs to be exploited for this purpose. Rapeseed-mustard is grown in substantial area in Assam, but productivity is very low (660 kg/ha) in comparison to national average (1511 kg/ ha). As per 2019-20 data low and unstable oilseed system productivity is major problem in the state where cultivation is undertaken mostly through small and marginal agricultural holdings. Delayed sowing of mustard in Assam is one of the most important constraints in achieving higher yield. A substantial area of mustard cultivation is under paddy-mustard cropping system in the state. But sowing of mustard gets delayed due to late harvesting of *Sali* rice or inundation in some areas and crop does not have sufficient time for growth under the prevailing climatic condition that leads to yield penalty. The inadequate moisture at sowing time in rice fallow areas, lack of irrigation facilities and biotic stresses due to delayed sowing further reduces the yield of mustard. Delay in sowing reduces the yield due to its depressing effect on the plant growth, flowering duration, seed formation and productivity (Bali *et al.*, 2000). Sowing at proper time allows sufficient growth and development of a crop to obtain an optimum yield (Pandey *et al.*, 1981). Kumari *et al.* (2012) reported late sown mustard duration was less due to the high temperature during the reproductive phase with concomitant reduction in yield. In general, it was observed that the mustard crop sown after October 30th resulted in lower yields due to genetic potential limitation (Panda *et al.*, 2004). Among the agronomic factors known to augment the mustard production are spacing and plant geometry which plays a pivotal role in enhancing the production. The competitive ability of a rapeseed-mustard plant depends greatly upon the density of plants per unit area and soil fertility status (Shekhawat *et al.*, 2012). Uniform distribution of crop plants over an area result in efficient use of nutrients, moisture, and suppression of weeds leading to high yield. In wider row spacing, solar radiation falling within the rows gets wasted particularly during the early stages of crop growth whereas in closer row spacing upper part of the crop canopy may be well above

the light saturation capacity but the lower leaves remain starved of light and contribute negatively towards yield. Thus, optimum row spacing's are necessary for interception of sunlight to each of leaves. This will enhance the rate of photosynthesis and consequently the dry matter production which can ultimately increase the crop yield.

Sowing technique depends upon land resources, soil condition and level of management and thus broadcast, line sowing, ridge and furrow method and broad bed and furrow method are common sowing techniques in rapeseed-mustard. At higher soil moisture regimes, broadcasting followed by light planking gives early emergence and growth. The late sowing of rapeseed-mustard cultivars in Assam results in yield losses and thus affects the supply-chain of the oil in the market. The forceful late sowing conditions of the crop are mainly because of delayed harvesting of *Kharif* crops. Therefore, early crop establishment through transplanting technique could be a better alternative to minimize the yield losses in mustard. Transplanting the crop rather than normal drilling may be a costlier method of crop establishment. However, the labor requirement for sowing and then thinning the crop twice, to remove extra plants, may be more costly. Through transplanting, the full potentiality of individual plants can be realized and yield more than drilling of seeds. Transplanting of rapeseed-mustard has also been reported to hasten maturity thereby saving time and resources. As transplanting reduces days to maturity, it results in higher seed yield per day.

In this backdrop, field experiments on transplanting of Toria and mustard were conducted at Bongaigaon and Dhubri districts during 2022-23 to show the production potential of timely sown crop with proper spacing in comparison to delayed sowing with broadcasting method. The main hypothesis was to quantify the sowing time and other agronomical practices like proper spacing, thinning, line sowing and nutrient management could enhance the rapeseed-mustard growth and yield.

Materials and Methods

The 20 field experiments each were laid down in Bongaigaon and Dhubri districts. Each experiment laid down in randomized block design with five replications and four treatments, viz. transplanted toria (T_1), toria broadcasting (T_2), transplanted mustard (T_3) and mustard broadcasting (T_4). In Bongaigaon district; two villages Rabhapara and Digdari were selected under block Dangtol and ADO circle Bidpapur for this purpose and in each village, 10 experiments were conducted. The 10 experiments each in two villages Satpapura and Kazipara of Chapar Salkocha block of Dhubri district. In each district, 10 experiments each were conducted on transplanted mustard (5) and toria (5) with broadcasted mustard (5) and toria (5). Thus a total of 20 experiments on transplanted mustard (10) and toria (10) and 20 experiments on broadcasted mustard (10) and Toria (10) were conducted. Total number of plots in each experiment was twenty and plot size was 5 ×5 m^2. The variety TS-38 of Toria and DRMR 150-35 of Indian mustard were used for

Table 1: Technological interventions for transplanted and broadcasted rapeseed-mustard

Activity	Transplanted mustard and Toria	Broadcasted mustard and Toria
Variety	TS-38 of Toria and DRMR 150-35 of Indian mustard	TS-38 of Toria and DRMR 150-35 of Indian mustard
Nursery preparation	15 days before transplanting in the field	-
Field preparation	i) One to two ploughing by cultivator ii) Pit was 15-20 cm depth at 30x10 cm spacing iii) Fertilizer mixture was placed in pit before 24 hours of transplanting	One to two ploughing by cultivator
Transplanting/ broadcasting	After 15 days of sowing in nursery	Broadcasting at the time of transplanting
Irrigation	i) First irrigation with transplanting ii) Second irrigation after 30-35 days of transplanting	One irrigation after 30-35 days of transplanting
Line sowing	Adopted line transplanting with definite row pattern with optimum planting geometry	Broadcasting
Fertilizer management	Judicious use of fertilizers	As per practices
Insect pest	Need based	Need based
Other operations/ Harvesting and threshing	As per practices	As per practices

experiments in both districts. The nursery of DRMR 150-35 variety was raised before 15-20 days of date of transplanting. The 3-4 leaves stage plants were transplanted in to field in evening. The line to line spacing was 30 cm and plant to plant spacing was 10-15 cm in both transplanted Toria and mustard. Date of nursery preparation was 05-07 November 2022 and date of transplanting in both districts was 26-28 November 2022. And on the same date of transplanting the corresponding broadcasting of Toria and mustard was done. After transplanting a light irrigation was given to get the plants established. A buffer nursery was prepared for gap filling of the same cultivar. Gap filling was taken up after 8 days of transplanting. To eliminate weeds in experimental area, one hoeing was done at 25 DAS. The crop was raised as per the recommended package and practices. The crop was harvested at 75 % siliquae turned down yellowish brown. Thereafter, plants from each net plot area (4.5 m × 4.5 m) were harvested carefully and seed yield from each plot was recorded.

Experimental site and climate characteristics

The experiments were conducted during 2022-23 at Bongaigaon and Dhubri districts of Assam. Bongaigaon located at 90° 33' E longitude, 26° 28' N latitude and at an altitude of 62.6 m above mean sea level. The district is considered as flood prone having alluvial soil. Dhubri located at 89° 97' E longitude, 26° 22' N latitude and at an altitude of 34 m above mean sea level. Dhubri and Bongaigaon comes under lower Brahmaputra valley agroclimatic zone of Assam. In Bongaigaon district (Fig. 1); the rainfall received during crop season was 30 mm. The mean weekly maximum and minimum temperature during the crop growing seasons of mustard fluctuated between 23.6 to 30.7°C and 10.4 to 17°C. The average relative humidity fluctuated between 41.4 to 100 % at noon. In Dhubri district (Fig. 1); the rainfall received during crop season was 7.5 mm. The mean weekly maximum and minimum temperature during the crop growing seasons of mustard fluctuated between 22.8 to 29.9°C and 9.4 to 18.06°C. The average relative humidity fluctuated between 46.4 to 100 % at noon.

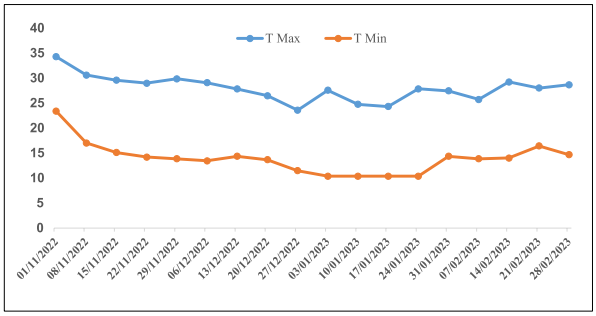

Fig. 1: Weekly maximum and minimum temperature (°C) during crop growing period at Bongaigaon district

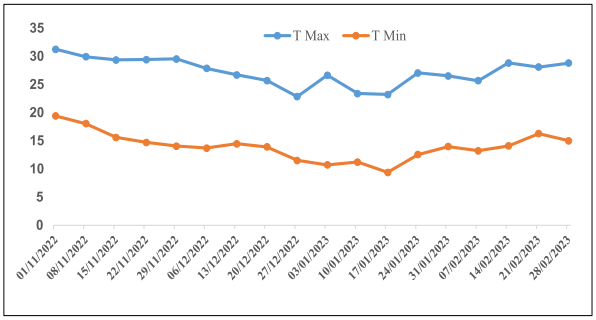

Fig. 2: Weekly maximum and minimum temperature (°C) during crop growing period at Dhubri district

Observation recorded

In each treatment, observations of yield and yield attributes, were recorded from harvested plants of net plot after excluding the border rows. The observations like plant height, number of siliquae/ plant, primary branches and secondary branches per plant were taken from net plot (4.5 m × 4.5 m). For this purpose, five plants were tagged in each plot. Per plot yield was taken from both mustard and Toria experiments and then converted to q/ha.

The economic analysis of the treatments is very important factor to assess the practical utility of treatment for farmer's point of view. Therefore, economics of different treatments were worked out in terms of cost of cultivation, gross monetary returns (GMR), net monetary returns (NMR), additional net monetary return (ANMR) and benefit-cost ratio (B:C) on per hectare area basis to ascertain the economic viability of the treatments. The cost of cultivation for each treatment is determined on the basis of different inputs used for raising the crops under different treatments on one hectare area basis. The values realized from the produce obtained under each treatment were computed on the basis of existing market price of the produce (only seed) as the gross monetary returns (GMR) per hectare under different treatments.

Gross monetary returns = value of seed × sale price

The net monetary return (NMR) per hectare under each treatment was determined by subtracting the cost of cultivation of a particular treatment from the GMR of the same treatment. Additional net monetary return (ANMR) was calculated as:

[GMR (Transplanted)-GMR(Broadcasted)]-[CoC (Transplanted)-CoC (Broadcasted)]

To estimate the benefits obtained from different treatment for each rupee of expenditure incured, B:C ratio of each treatment was calculated as below:

The data obtained on various observations were tabulated and analyzed under randomized block design with five replications by using the techniques of the analysis of variance (ANOVA) as suggested by Panse and Sukhatme (1967) and the treatment was tested by F test shown their significance where critical difference (CD) at 5% level of significance was determined for each character to compared the differences among treatment means.

Results and Discussion

Growth and yield attributes

Table 2 shows that the average plant height, number of silique, primary and secondary branches were found highest in transplanted Toria and mustard as compare to broadcast Toria and mustard. The plant height of transplanted Toria recorded higher than Toria sowing through broadcasting method. It is obvious from data, transplanted Toria has been recorded around 11.4 % more plant height than broadcasting Toria. Similarly, transplanted mustard recorded around 35.8% more plant height in comparison to normal broadcasting sowing method (Table 2). These findings are in close conformity with those reported by Pandey *et al*. (2015). The average number of primary branches in transplanted Toria was more (4.10/plant) than broadcasted Toria (3.5/ plant), while transplanted mustard recorded more average number of primary branches (4.9 /plant), which was 44% more than broadcasted mustard (4.2/plant). The more average number of secondary branches were recorded in transplanted Toria (14.0/ plant) than broadcasted Toria (10.5). The transplanted mustard recorded highest average number of secondary branches (17.3/plant) which was around 33.3% more broadcasted mustard sowing method (12.8/ plant). The more average number of silique/plant was recorded in transplanted Toria (205/plant) than broadcasted Toria (164/plant). Transplanted mustard recorded highest average number of silique/plant (256/ plant) than broadcasted mustard sowing method (221/ plant) which was about15.68 % more than broadcasted mustard sowing method. These findings are in close conformity with those reported by Yadav *et al*. (1994).

Table 2: Average yield and its attributing characters in transplanted and broadcasted crop in Assam

Treatments	Plant height (cm)	Primary branches /plant	Secondary branches /plant	Silique /plant	Yield (q/ha)
Transplanted Toria	91	4.3	14.0	205	13.9
Broadcasted Toria	81	3.5	10.5	164	9.3
Transplanted mustard	206	6.1	17.3	256	19.3
Broadcasted mustard	151	4.2	12.8	221	11.5
SEm±	4.1	0.4	0.97	10.6	1.14
CD (P=0.05)	12.7	1.2	3.03	32.9	3.53

Table 3: District-wise average yield and its attributing characters in transplanted and broadcasted crop at Bongaigaon and Dhubri districts of Assam

Treatments	Plant height (cm)		Siliquae / plant		Primary branches / plant		Secondary branches / plant		Yield (q/ha)	
	Bongai-gaon	Dhubri	Bongai-gaon	Dhubri	Bongai-gaon	Dhubri	Bongai-gaon	Dhubri	Bongai-gaon	Dhubri
Transplanted Toria	92	89	202	208	4.1	4.4	13.2	14.8	14.2	13.6
Broadcasted Toria	82	80	160	167	3.4	3.6	10.0	10.9	9.4	9.2
Transplanted mustard	215	196	239	272	4.9	7.2	15.6	19.0	19.8	18.8
Broadcasted mustard	171	131	217	224	4.3	4.1	13.6	12.0	11.6	11.4
SEm±	3.0	5.1	13.3	7.7	0.3	0.4	1.0	0.9	1.2	1.0
CD (P=0.05)	9.4	16.0	41.6	24.1	0.9	1.4	3.1	2.9	3.7	3.2

Seed yield

Table 2 shows that the transplanted mustard recorded average seed yield of 19.3 q/ha with significant yield improvement of 67.8% over the broadcasted mustard (11.5 q/ha), while transplanted Toria recorded average seed yield of 13.9 q/ha with yield improvement of 49.5% over the broadcasted Toria (9.3 q/ha). It clearly indicates that optimum crop geometry, balanced NPK fertilizers and intercultural operations are the building blocks for achieving the utmost yield targets of rapeseed-mustard. Sowing time influences phenological development of crop plants through temperature and heat unit. These findings are in close conformity with those reported by Singh *et al.* (2019) and Kumari *et al.* (2019). Sowing at optimum time gives higher yields due to suitable environment that prevails at all the growth stages. The result evidently shows that transplanted mustard and Toria gives higher yield due to proper plant spacing, timely sowing, sufficient time for growth and efficient management/utilization of inputs/resources. All recommended practices or operations like intercultural operations, fertilizer management, irrigation management, plant protection measures, etc. can be adopted in a best way in transplanted crop that helps in proper plant growth and height, more number of primary and secondary branches

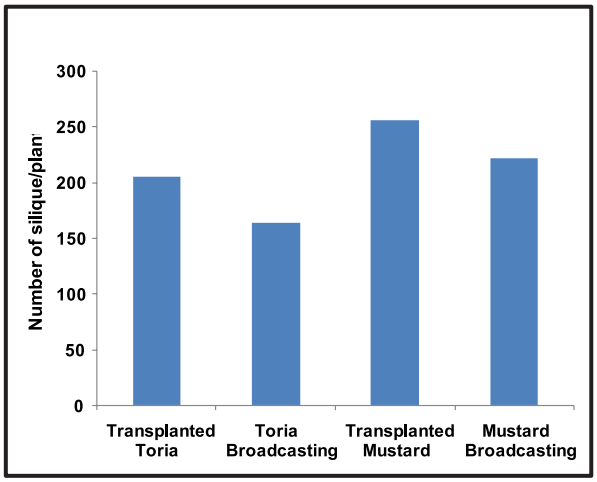

Fig. 3: Effect of transplanted rapeseed mustard and broadcasted rapeseed mustard on average number of silique in Assam

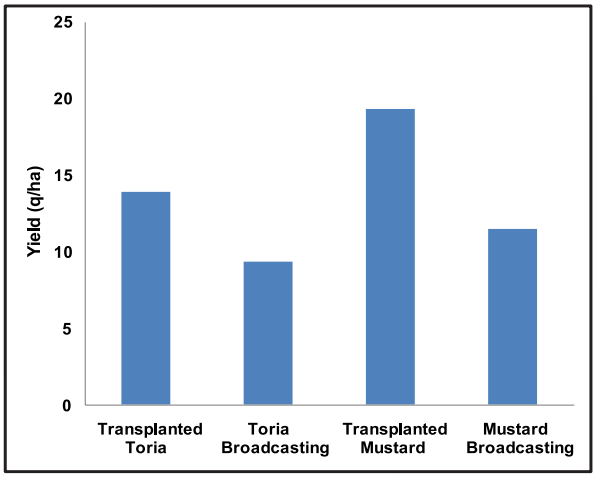

Fig. 4: Effect of transplanted rapeseed mustard and broadcasted rapeseed mustard on average seed yield in Assam

increased silique/plant, sufficient time for maturity, etc. which contribute in higher yield than delayed sowing through broadcasted method. The late sowing of mustard and dense plant population results in yield losses. These findings are in close conformity with those reported by Sahar *et al.* (2012) and Biswas *et al.* (2011).

Table 3 depicts the district-wise analysis which also shows that the average plant height (cm)), number of silique, primary and secondary branches per plant were found significantly higher in transplanted Toria and mustard as compare to broadcast Toria and mustard in both districts viz. Bongaigaon and Dhubri districts of Assam.

Economic analysis of transplanted and broadcasted Toria and mustard crops

For economic analysis of the treatments, cost of

Table 4: Economic analysis of transplanted and broadcasted Toria and mustard crops

Treatments	CoC (Rs./ha)	GMR (Rs./ha)	NMR (Rs./ha.)	ANMR (Rs./ha)	B:C ratio
Transplanted Toria	28100	75755	47655	16320	2.69
Broadcast Toria	19350	50685	31335	-	2.61
Transplanted mustard	32850	105185	72335	32060	3.20
Broadcasted mustard	22400	62675	40275	-	2.79

Abbreviation: CoC: Cost of cultivation, GMR: Gross monetary returns, NMR: Net monetary returns, ANMR: Additional net monetary returns, B:C: Benefit: Cost
Mustard sale@ ₹ 54.50/kg

cultivation (CoC), gross monetary return (GMR), net monetary return (NMR), additional net monetary return (ANMR) and benefit cost ratio were also calculated for transplanted and broadcasted Toria and mustard as shown in table 4. It shows that the cost of cultivation was higher in transplanted Toria (Rs. 28100/ha) and transplanted mustard (Rs. 32850/ha) in comparison to broadcasted Toria (Rs. 19350.0/ha) and broadcasted mustard (Rs. 22400/ha). Though cost of cultivation was higher in transplanted crop but the gross monetary return was higher (Rs. 75755/ha for Toria and Rs. 105185/ha for mustard) also due the increased yield in transplanted crop than broadcasted crop (Table 4). The maximum ANMR of Rs. 32060 /ha was reported in transplanted mustard in lieu of the additional cost of Rs. 10450.0./ha, while ANMR of Rs. 16320/ha was recorded in transplanted Toria in lieu of additional cost of Rs. 8750./ha. The higher B:C ratio for the transplanted Toria (2.69) and transplanted mustard (3.20) was realized in comparison to broadcasted Toria (2.61) and mustard (2.79).

Conclusion

The forceful late sowing conditions of the crop are mainly because of delayed harvesting of *Kharif* crops. The experiment shows that timely sown transplanted crop of Toria and mustard recorded more plant height and more number of silique/plant, primary branches and secondary branches in comparison to delayed sowing with broadcasting method. The result of this experiment conducted in Dhubri and Bongaigaon districts of Assam concluded that there was yield increase in mustard and Toria due to timely sowing through transplanting technique that helped getting full maturity period, maintaining proper plant population and spacing, better fertilizer management etc. Therefore, early crop establishment through transplanting technique could be a better alternative to minimize the yield losses in mustard and Toria. Transplanting of mustard has also been reported to hasten maturity thereby saving time and resources. As transplanting reduces days to maturity, it results in higher seed yield per day.

This study showed that the timely sowing of mustard and Toria through transplanting technique could be helpful in maximizing the productivity and profitability as compared to delayed sowing with traditional broadcasting method in Assam. However, experiment of transplanting of Toria and mustard was conducted in two districts (Dhubri and Bongaigaon) only during 2022-23, therefore there is a need to conduct these experiments in other districts of Assam during coming years for further strengthen the impact of transplanting technique in mustard and Toria under different agro climatic situations of Assam. After satisfying with results of experiments conducted in different districts, the recommendations should be included in package of practices for popularization among the farmers in the state.

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