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Impact of Transplanting on Productivity and Profitability of Indian Mustard: A Pilot Study

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A B S T R A C T

The present investigation was carried out during *rabi* season of 2016-17 at ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur, Rajasthan to evaluate the effect of different stage of transplanting on growth, yield attributes, seed yield and economics of Indian mustard. The experiment was laid out in randomized block design with seven replications and three transplanting dates, viz.,13 October (D_1), 22 October (D_2) and 01 November (D_3).The maximum values of plant height (197 cm), leaf area index (5.87) and SPAD-chlorophyll content (54.8) were recorded at 13 October date of transplanting (D_1) compared to other transplanting dates. Yield attributes and seed yields were significantly affected by the date of transplanting. Results showed that length of silique (6.23 cm), number of seeds/silique (22.2), test weight (7.91 g) were also recorded highest at 13 October date of transplanting. Oil content (41.65 %) was also more in D_1 followed by D_2 and D_3. The higher B:C ratio was calculated in D_1(3.95) followed by D_2 and D_3. In nutshell, transplanting of mustard (variety, RH 406) at 13 October improved the productivity and profitability of Indian mustard. This also could open the new avenues for early establishment of crop where sowing of mustard is get delayed due to late harvesting of *kharif* crops.

Introduction

Rapeseed-mustard is the third most important edible oilseed crop after soybean and groundnut in India. It is one of the major sources of dietary oil in India. Indian mustard (*Brassica juncea* L.) is a winter season oilseed crop which thrives best in light to heavy loam soil in areas having 25-40 cm rainfall. Among the several reasons responsible for low productivity, non-adoption of good agronomic practices mostly the sowing window is the major one. The plant population and date of sowing much affected the yield and yield attributes. Very often farmers have to sown the crop late due to delayed monsoon rain, and late harvesting of *Kharif* crops resulting in poor crop yield. Delay in sowing might reduce yield due to its depressing effect on the plant growth, flowering duration, seed formation and productivity (Bali *et al.*, 2000). Kumari *et al.*,(2012) reported late sown mustard duration

is 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).

Indian mustard is playing a major role in oilseed production and satisfying most of the oil requirement of Indian consumers. However, late sowing of mustard cultivars was resulted in yield losses and thus affected the supply chain of oil in the market. Therefore, early crop establishment through transplanting technique could be a better alternative to minimize the yield losses in mustard. The main objective of the study was to quantify the effect of transplanting on the performance of the mustard. Accordingly, the present investigation was undertaken to assess the impact of different transplanting dates on the productivity and profitability of the Indian mustard

Materials and Methods

Experimental site and Climate characteristics

The experiment was conducted during 2016-17 at research farm, ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur located at 77°30' E longitude, 27°15' N latitude and at an altitude of 178.37 meter above mean sea level. The climate of this zone is typically semi-arid, characterized with wide range of temperature between summer and winter. The mean weekly maximum and minimum temperature during the crop growing season fluctuated between 18.3 to 40.9°C and 3.5 to 22.1°C, respectively. The mean daily evaporation from USWB class a pan evaporimeter ranged from 1.0 to 9.7 mm per day. The average relative humidity was fluctuated between 20.4 to 57.8 % (observation taken at noon). The bright sunshine hours varied from 5.9 in January to 9.3 in April. Rainfall received during crop season was 55.8 mm.

Soil characteristics

The soil samples were collected from surface soil (0-15cm) and analyzed for soil physico-chemical properties with the help of standard methods (Singh *et al.,* 2005). The experimental site was silty clay loam in texture (19.2% sand, 51.3% silt and 29.4% clay), pH (1:2 soil water suspension) 8.3, bulk density 1.52 g cm^3, field capacity (by weight) 12.5 % and permanent wilting point was observed at 2.35%. Soil organic C, available N, available P and available K were measured 0.24%, 126.3kg/ha, 17.23kg/ha, 149.3 kg/ha, respectively. The detail of the soil physico-chemical properties is presented in Table 1.

Treatment details and preparation of field

The experiment consisted of three transplanting dates viz., 13 October (D_1), 22 October (D_2) and 01 November (D_3). The mustard cultivar RH 406 was used as a test crop. The nursery of RH 406 variety was raised in transplanting trays before 8-10 days of date of transplanting. The 2-3 leaves stage plants were transplanted in to field in the evening hours. After transplanting a light irrigation was given to get established the plants. 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 field, one hoeing was done at 25 days after sowing (DAS).The crop was raised as per the recommended package and practices. The crop was harvested at 80 % silique turned down yellowish brown. Thereafter, plants from each net plot area (6m × 6 m) were harvested carefully and seed yield from each plot was recorded.

Observation recorded

The observations on growth parameters were recorded at 45 days after transplanting (DAT), 60 DAT and 90 DAT. The chlorophyll content was measured with SPAD chlorophyll meter reading (SCMR) after 45 and 90 DAT. At harvesting length of tagged plants (five silique/plant) was measured with a scale and expressed as mean length of silique (cm).The seeds of ten selected silique from respective branches were threshed, counted and average number was reported. While reporting the average number of seeds per silique, the number of seeds per silique of respective branches has been averaged. The thousand seeds were taken for recording test weight. The total biomass harvested from each plot was threshed and cleaned. The seeds so obtained were weighed and then converted in to q/ha. Harvest index was calculated by using the following formula:

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (q/ha)}}{\text{Biological yield (q/ha)}} \times 100$$

Where,
Economic yield = seed yield (q/ha)
Biological yield = seed yield + stover yield (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), and benefit-cost ratio (B:C) on per hectare area basis to ascertain the economic viability of the treatments. These economic parameters were calculated based on the prevailing market prices of different inputs and outputs.

The data obtained on various observations were tabulated and analyzed in randomized block design with seven 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 parameters

It is evident from the data that plant height increased with the advancement of the plant growth in all three transplanting dates (Table 2). The October 13th transplanting date exhibited significantly (p=0.05) higher plant height (197 cm) at all growth stages followed by October 22th transplanting in all growth stages of plant. Similar types of observations were recorded by Afroz*et al.*, (2011). A critically examination of data revealed that the early transplanting of mustard on 13th October had highest plant leaves which was at par with October 22ndat 90 DAT. Similar findings also reported by Kumar *et al.*,(2008).

The data revealed that early mustard transplanting on 13th October resulted in significantly higher numbers of primary and secondary branches at 90 DAT, though it was at par with 22 October date of transplanting (Table 3). At 60 DAT, plant girth was recorded the maximum with 13th October date of transplanting which was significantly higher over other dates of transplanting. Similar findings also reported by Kumar *et al.*,(2008).

Chlorophyll content in mustard leaves was significantly influenced by the different dates of transplanting (Table 4). Delayed transplanting of mustard crop significantly decreased the chlorophyll content. Early

transplanting (13th October) of mustard recorded significantly higher chlorophyll content (54.8), which was higher over 20th October and 1st November transplanted crop. Similar findings also reported by Singh *et al.*, 2019.

It is apparent from the data reveals that leaf area index was significantly affected by different transplanting dates at different stages (Table 4). Among different transplanting dates, the crop transplanted on October 13 produced highest leaf area index followed by 22th October and November 1stat all the growth stages. Similar results were also reported by Kumar *et al.*, 1997.

The yield attributes of the mustard viz., siliqua/plant, siliqua length, seeds/siliqua, 1000-seed weight and oil content were significantly influenced by different dates of transplanting (Table 5). It is evident from data that the number of siliquae per plant was drastically reduced with delayed planting. Planting of mustard on 13th October produced significantly higher number of siliquae per plant (514) as compared to delayed planting (22nd October and 1st November). Similarly, length of siliquae was recorded significantly higher with 13th October planted crop as compared to 22nd October and 1st November planted crop.

Further, 13th October planted crop enhanced the length of siliquae by 4 and 12 %over 22nd October and 1st November planted crop, respectively.It is evident from data that the number of seeds/siliquaewas drastically reduced with delayed planting. Planting of mustard on 13th October produced significantly higher number of seeds/siliquae (19.18) as compared to delayed planting (22nd October and 1st November). The different dates of transplanting brought about significant effect on test weight (1000-seed weight).

Significantly higher values of test weight was recorded in October 13 transplanted crop followed by 22nd October and 1st November planted crop. Similar findings were also reported by Kumari *et al.*, 2012.

Experimental data showed that the oil content of mustard was influenced by different transplanting dates (Table 5). Oil content of mustard was decreased by delayed sowing.

Transplanting of mustard on 13th October recorded higher oil content in seed (41.41%) than 22nd October and 1st Novembertransplanted crop, though difference among the treatments was non-significant.This significant decrease in oil yield was due to the combined effect lower seed yield and lesser oil content under delayed sowing, since the oil yield is product of seed yield and the oil content.

This behavior could be ascribed to improper seed development and oil synthesis in seeds under delayed sowings, owing to restricted growth of plants as stated earlier and the rise in temperature during the seed development phase.

Decrease in oil content in rapeseed with the rise in temperature was also observed by Angrej *et al.*, (2002). They reported that delay in sowing of rapeseed- mustard from optimum period adversely affected the oil content in seed.

Data presented in Table 6 clearly indicated that seed and stover yields and harvest index of the mustard were significantly affected by different dates transplanting. The maximum seed yield (40.1 q/ha) was produced under 13th October planting which was significantly higher by 9.0 and 37.3 % over 22 October and 1 November dates of transplanting, respectively.

Table.1 Physico-chemical properties of soil at the experimental site

Particulars	Values
Mechanical composition (Bouyoucos 1962)	
Sand (%)	19.2
Silt (%)	51.3
Clay (%)	29.4
Texture class	Silty clay loam
pH (1:2 soil water suspension) (Piper 1950)	8.3
Bulk density (g/cm^3) (Rana *et al.*, 2014)	1.52
Field capacity (% by weight) (Richards, 1954)	12.50
Permanent wilting point (%) (Richards, 1954)	2.35
Organic carbon (%) (Walkley and Black, 1934)	0.24
Available N (kg ha^{-1}) (Subbiah and Asija, 1956)	126.30
Available P (kg ha^{-1}) (Olsen *et al.*, 1954)	17.23
Available K (kg ha^{-1}) (Jackson, 1973)	149.26
pH (1:2 soil water suspension) (Piper, 1950)	8.3

Table.2 Plant height and plant leaves as influenced by different dates of transplanting

Date of transplanting	Plant height (cm)			Plant leaves		
	45 DAT	60 DAT	90 DAT	45 DAT	60 DAT	90 DAT
13 October (D_1)	102.34	156	197	46.63	55.87	93.36
22 October (D_2)	82	141	184	30.12	30.64	89.06
01 November (D_3)	74	124	174	22.36	29.44	73.63
SEm±	1.6	2.1	0.9	1.55	1.47	3.41
CD (p=0.05)	5.4	6.9	2.9	5.12	4.86	11.30

Table.3 Primary, secondary branches and plant girth as influenced by dates of transplanting

Date of transplanting	Primary branches		Secondary branches		Plant girth (cm)		
	90 DAT	At harvest	90 DAT	At harvest	60 DAT	90 DAT	At harvest
13 October (D_1)	11.7	13.8	25	33	8.06	9.49	9.7
22 October (D_2)	9.5	12.4	21	29	6.79	7.89	8.2
01 November (D_3)	8.9	11.2	19	26	5.60	6.37	7.4
SEm±	0.51	0.21	1.06	1.24	0.33	1.04	0.47
CD (p=0.05)	1.697	NS	3.50	NS	1.0	NS	NS

Table.4 Chlorophyll content and leaf area index as influenced by different dates of transplanting

Date of transplanting	Chlorophyll content		Leaf area index		
	45 DAT	90 DAT	45 DAT	90DAT	At harvest
13 October (D_1)	45.2	54.8	3.24	5.87	3.87
22 October (D_2)	41.4	50.3	3.01	5.29	3.16
01 November (D_3)	37.8	43.7	2.89	4.76	2.47
SEm±	0.68	0.98	0.35	0.34	0.29
CD (p=0.05)	2.24	3.25	1.08	1.2	0.91

Yield attributes

Table.5.Yield attributes as influenced by different dates of transplanting

Date of transplanting	Number of silique/plant	Length of siliqua (cm)	Number of Seeds/silique	Test weight (g)	Oil content (%)
13 October (D_1)	514	6.23	22.20	7.91	41.65
22 October (D_2)	437	5.99	19.80	7.02	41.02
01 November (D_3)	358	5.53	17.86	6.83	40.74
SEm±	10.229	0.061	0.303	0.052	0.26
CD (p=0.05)	33.875	0.201	1.003	0.173	NS

Seed and stover yields and harvest index

Table.6 Seed and stover yields and harvest index as influenced by different dates of transplanting

Date of transplanting	Seed yield (q/ha)	Stover yield (q/ha)	Harvest index (%)
13 October (D_1)	40.1	90.5	30.70
22 October (D_2)	36.8	82.3	30.50
01 November (D_3)	29.2	70.2	29.29
SEm±	1.11	2.31	0.74
CD (p=0.05)	3.21	7.02	NS

Table.7 Economic parameters as influenced by different dates of transplanting.

Date of transplanting	Cost of cultivation	Gross monetary returns	Net monetary returns	B:C ratio
	(Rs)			
13 October (D_1)	35500	140350	104850	3.95
22 October (D_2)	35500	128800	93300	3.63
01 November (D_3)	35500	102200	66700	2.88

Further, seed yield also recorded significantly higher with 22 October than 1 November dates of transplanting. Seed yield of crop depends on the source-sink relationship and also on the different components of source and sink. Early transplanting on 13 October produced highest seed yield might be due to larger growing period and cumulative effect of effective rainfall and favorable weather conditions which helped in better growth and development of the mustard plants and resulted into better seed yield. Delayed transplanting decreased the yield attributes and yield as these parameters were adversely influenced in the present experiment as the sowing was delayed beyond October 13. Rapeseed and mustard when sown later of October faced with cool and even frosty nights as well as reduced sunshine hours which adversely affected photosynthesis and other

growth as well as development processes in plants resulting in decreased seed and biological yields. Adverse effect of low temperature on flowering, siliquae setting and seed development in rapeseed and mustard have also been reported by, Adak *et al.,* 2011, Biswas *et al.,* 2011.

Stover yield of mustard was also decreased by delayed transplanting. Sowing of mustard on 13th October recorded higher stover yield than 22nd October and 1stNovember transplanted crop. Mustard transplanted on October 13 resulted higher harvest index followed by 22th October. Further also observed that November sowing caused the significant reduction in harvest index as compared to October sowing (Lallu*et al.,* 2010, Panda *et al.,* 2004).

Economics

Data on different economic parameters are presented in Table 7. The common cost of cultivation for mustard was Rs. 35500 per hectare. The market value of grain and straw was consideration for determination of gross monetary returns (GMR) under each treatment. The net monetary return was calculated by subtracting the cost involved into the gross monetary returns. The data reveals transplanting on 13th October had the maximum return (Rs. 104850/ha), while the lowest return (Rs. 66700/ha) was recorded under transplanting on 1st November. The net monetary returns (NMR) showed the similar trend as GMR. Benefit: cost ratio (B:C ratio) refers to the monetary gain over on each rupee of investment and expressed as profitability of a treatment. The B:C ratio was found the maximum (3.95) under transplanting on 13th October, while least B:C ratio (2.88) was recorded on 1st November transplanting. Thus, transplanting on 13th October was more profitable than transplanting on 22nd October and 01st November. These findings are corroborated the work of Kumari *et al.,* (2012) and Ram *et al.,* (2008). Mustard is a one of the important oilseed crop in India. Its production is much influenced by the planting time. During the experiment maximum plant height, plant leaves, primary and secondary branches, leaf area index, chlorophyll content, length of siliquae, number of seeds/siliquae, test weight, oil content, yield and harvest index was observedmaximumat13th October date of transplanting compared to 22ndOctober transplanting and 01 November transplanting. Net monetary return and B:C ratio was also higher in 13th October transplanting. This study highlighted the appropriate sowing time in mustard. In conclusion, 13th October date of transplanting is beneficial for getting maximum yield of mustard variety RH 406in Rajasthan, India. Further, transplanting technique in mustard could open the new avenues for early establishment of crop where sowing of mustard is get delayed due to late harvesting of *kharif* crops.

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