Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 9[2] January 2020 : 91-96

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.876
Universal Impact Factor 0.9804
NAAS Rating 4.95

ORIGINAL ARTICLE **OPEN ACCESS**

Feasibility and Economics of Transplanting in Different Brassica Species

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ABSTRACT
An experiment was conducted at AICRP on Linseed and Mustard, College of Agriculture, Nagpur to study the effect of transplanting on different brassica species and crop geometry. Experiment was laid out in split plot design with three replication and Three Main plot as a Brassica species V_1- Brassica carinata var. PC-6, V_2- Brassica napus var. GSC-7, V_3- Brassica juncea var. NRCHB-101 and Sub plot as Planting geometry S_1-45x45 cm S_2-60x60 cm S_3-30x10cm. The result revealed that plant stand and number of branches plant^{-1} were not influenced by the species. Brassica carinata species recorded maximum and significantly higher plant height was at par with Brassicajuncea. Brassica carinata species recorded maximum and significantly higher siliqua plant^{-1}, yield plant^{-1} (g), seeds siliqua $^{-1}$ and brassica juncea were at par. However, yield kg ha^{-1}, GMR, NMR and B:C ratio recorded maximum and significantly higher in species brassica juncea.Brassica carinata species recorded maximum and significantly higher plant height was at par with Brassicajuncea. Brassica carinata species recorded maximum and significantly higher siliqua plant^{-1}, yield plant^{-1} (g), seeds siliqua $^{-1}$ and brassica juncea were at par. However, yield kg ha^{-1}, GMR, NMR and B:C ratio recorded maximum and significantly higher in species brassica juncea. Seeds siliqua^{-1}, siliqua plant^{-1} and seed yield g plant^{-1} were maximum and significantly more due to transplanting of B. carinata at 60x60 cm. but the seed yield kg ha^{-1}, GMR, NMR and B:C ratio significantly more due to sowing of Brassica juncea at 30x10 cm sowing.
Keywords*: Transplanting, Spacing. Species, Mustard*

Received 23.11.2019 Revised 21.12.2019 Accepted 02.01.2020

INTRODUCTION

Mustard (Brassica spp.) is one of the most important oil crop of the world. The genus Brassica belongs to the family Brassicaceae (formally Cruciferae). Indian mustard is playing a major role in oilseed production and satisfying most of the oil requirement of Indian consumers. Mustard are important *rabi* (post-rainy) season oil seed crops in India and occupies a premier position due to its high oil content. Seeds of Brassicas are used for various purposes. Rapeseeds are rich in oil and proteins. The oil content varies from 36-39% per seed. The important seed crops of Brassicas grown for oil purposes are rapeseed (*Brassica campestris* L. and *Brassica napus*), and mustard (*Brassica juncea* (L.) *Brassica carinata*and *Brassica nigra*) which are grown in the semi -arid and arid zones in various continents. oil seed crop of India and stand second after soyabean in production among the eight annual edible oil yielding crops of India. It also serves as an important raw material for industrial use such as soap, paints, varnishes, hair oil, lubricant, textile auxiliaries, pharmaceuticals. Oleiferous Brassicas are grown in about 6.18 million hectare area with 7.36 million tons production of oil seeds contributing about 26.7 of the total oil seeds production. The average productivity level of 1190 kg/ha in India is very low than that of the developed countries (2500-3000 kg/ha) as well as the world average of about 1900 kg/ha. India is at first position in area and production of rapeseed and mustard in Asia. In India, rapeseed and mustard are cultivated in the state of Utter Pradesh, Rajasthan, Haryana, Punjab, Madhya Pradesh etc. In Utter Pradesh, Allahabad zone stands first on the basis of area but on the basis of total percent area, Agra is at first position followed by Kanpur, Itawa, Kheeri and Gonda. Till recently *Brassica compestris* and *Brassica juncea* were grown in mixed stands with wheat and barley and hence it was one of the reasons for low productivity.

There is great scope increasing yield of mustard or hybrids by selecting high yielding varieties and improved management practices. Row spacing is one of the very important factor for mustard production improved varieties of mustard as hybrids are capable for higher yields when grown under optimum row spacing [13]. The seed yield and maturity of mustard plant are greatly influenced by environmental conditions regardless of proper row spacing provide variable environmental condition within the same location for growth and development of crop and yield stability. Pandey *et al.*[8].Row spacing is an important determinant of yield it depends on the onset of significant rainfall temperature and humidity of region. Decreasing yield of improper spacing has been reported by many workers. The improper row spacing decrease seed yield through synchronization of silique filling period with high temperature. The decrease of assimilates production, drought stress occurrence, shortened silique filling period and acceleration of plant maturity [12].

Transplanting is important in increasing the mustard productivity per unit area. Several reasons responsible for low productivity is non-adoption of good agronomic practices like optimum date of sowing and planting geometry. Very often the farmers have to sow the crop late due to delayed monsoon rain, and late harvesting of *Kharif* crops resulting in poor yield. Delay in sowing reduces the yield due to its depressing effect on the plant growth, flowering duration, seed formation and productivity [1]. Sowing at proper time allows sufficient growth and development of a crop to obtain a satisfactory yield and also provide variable environmental conditions within the same location for growth and development of crop and yield stability [8]. If the mustard is sown late, duration is reduced due to the high temperature during the reproductive phase with concomitant reduction in yield [5]. Transplanting the crop rather than normal drilling may be a costlier method of crop establishment, however, the labour requirement for sowing and then thinning the crop twice, to remove extra plants, may be 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, these points are not yet studied so far scientifically. Therefore, early crop establishment through transplanting technique could be a better alternative to minimize the yield losses in mustard. The main aim of this study was to quantify the effect of direct seeding over transplanting to see the yield effect in mustard. Therefore, to address the above issues, a field experiment was conducted at on transplanting and spacing on mustard species.

MATERIAL AND METHODS

The Field experiment were conducted during the rabi season of 2018-19 at All India Research Project on Linseed and Mustard, College of Agriculture, Nagpur, Dr. PDKV, Akola. The soil of the experimental Field was clayey, pH : 7.6, Soil organic carbon: 5.35 g/kg, Available N : 222.5 kg/ha, Available P_2O_5 : 12.93kg/ha and K_2O:368.8 kg/ha.Experiment was laid out in split plot design with three replication and three main plot as a Brassica species V_1- Brassica carinata var. PC-6,V_2- Brassica napus var. GSC-7,V_3-*Brassica juncea* var. NRCHB-101 and Sub plot as planting geometry S_1- 45x45 cm,S_2-60x60 cm,S_3-30x10cm. The recommended dose of fertilizer was applied i.e. 80:40:40 NPK kg ha^{-1}. The half dose of N was applied at the time of sowing and half after one month of sowing. The observation pertaining to growth parameters, yield attributes and yield were recorded at harvest on the basis of five randomly selected plants from every plot. Economics were computed using the prizes of inputs as per prevailing local market rates and minimum support price of mustard seed. The benefit:cost ratio was calculated by using gross return divided by total cost of cultivation involved. The standard analysis of variance (ANOVA) technique prescribed for the split plot design was performed to compare the treatment means for each parameter separately.

RESULTS

Effect of Species:

Growth attributes:

Brassica carinata species recorded maximum and significantly higher plant height was at par with *Brassicajuncea.* (Table 1)

Yield attributes:

Brassica carinata species recorded maximum and significantly higher siliqua $plant^{-1}$, yield $plant^{-1}$ (g), seeds siliqua $^{-1}$ and *brassica juncea* were at par. (Table 1)

Seed yield:

However, yield kg ha^{-1} recorded maximum and significantly higher in species *brassica juncea.*Similar results recorded by Mondal *et al.,*[13] improved varieties of mustard as hybrids are capable for higher yields (Table 1)

Economics:
GMR, NMR and B:C ratio recorded maximum and significantly higher in species *brassica juncea.*(Table 2).

Table 1: Plant stand, growth attributes, yield attributes and yield of mustard as influenced by the brassica species and planting geometry

Treat.	Plant Height cm	No. of branches	Siliqua Plant^{-1}	Yield plant^{-1} g	Test weight g	Seeds/ siliqua	Yield kg ha^{-1}
Main- plot -Brassica species							
C- (*B. Carinatavar*.PC-6)	152.7	7.6	548.42	24.0	5.1	16.28	1176.4
N-(*B. Napusvar.*GSC-7)	139.4	7.3	247.7	11.2	5.7	14.04	502.1
J-(*B. Junceav*ar.NRCHB-101)	150.6	6.9	519.7	23.5	6.7	15.66	1643.6
SE(m)±	1.6	0.12	22.11	0.7	-	0.3	29.3
CD at 5%	6.2	0.46	86.81	2.64	-	1.3	114.9
Sub-plot – planting geometry							
S_1-Trans.45X45 cm	153.1	7.1	493.4	21.4	5.7	15.6	993.0
S_2-Trans.60X60 cm	141.2	8.3	558.1	25.0	6.0	15.8	884.9
S_3-Sow. 30X10 cm	148.5	6.6	263.7	12.4	6.7	14.5	1444.3
SE(m)±	3.80	0.24	16.25	0.44	-	0.4	34.0
CD at 5%	NS	0.74	50.09	1.35	-	NS	105.0
Interaction							
SE(m)±	6.7	0.4	28.15	0.76	-	0.6	59.05
CD at 5%	NS	NS	86.77	2.35	-	1.95	181.9
CV			11.13	6.3		7.1	9.2

Effect of Spacing:
Growth attributes:
Plant height were maximum and significantly more due to transplanting at 45x45 cm spacing.(Table 1)
Yield attributes:
Seeds siliqua^{-1} and yield^{-1} (g) were maximum and significantly more due to transplanting at 60x60 cm spacing. The improper row spacing decrease seed yield through synchronization of silique filling period with high temperature. The decrease of assimilates production, drought stress occurrence, shortened silique filling period and acceleration of plant maturity [12].
Seed yield:
The seed yield kg ha^{-1} maximum and significantly higher due to conventional sowing at 30x10 cm spacing over 60x60 cm and 45x45 cm transplanting spacing. Similar results recorded by Mondal *et al.* [13]when grown under optimum row spacing. Similarly, mustard is sown late, duration is reduced due to the high temperature during the reproductive phase with concomitant reduction in yield by [5] Kumari *et al.,* (Table 1).
Economics:
GMR, NMR were maximum and significantly higher due to conventional sowing at 30x10 cm spacing over 60x60 cm and 45x45 cm transplanting spacing. The same treatments also recorded more B:C ratio (Table 2).
Interaction effect:
Seeds siliqua^{-1}, siliqua plant^{-1} and seed yield g plant^{-1} were maximum and significantly more due to transplanting of *B. carinata* at 60x60 cm. but the seed yield kg ha^{-1}, GMR, NMR and B:C ratio significantly more due to sowing of *Brassica juncea* at 30x10 cm sowing. (Table 1a, b c d and 2a).

Table 1 a: Seeds siliqa^{-1} of mustard as influenced by the brassica species and planting geometry interaction

Interaction	S_1-Trans.45X45 cm	S_2-Trans.60X60 cm	S_3-Sow. 30X10 cm
C- (B. carinata var.PC-6)	16.43	15.83	16.56
N-(B. napus var.GSC-7)	13.53	15.73	12.86
J-(B. juncea var.NRCHB-101)	16.86	15.90	14.20
SE(m)±			0.63
CD at 5%			1.95

Table 1 b: Siliqua plant^{-1} of mustard as influenced as influenced by the Brassica species and planting geometry interaction

Interaction	**S_1-Trans.45X45 cm**	**S_2-Trans.60X60 cm**	**S_3-Sow. 30X10 cm**
C- (B. carinata var.PC-6)	643.73	656.60	344.93
N-(B. napus var.GSC-7)	273.27	299.27	168.66
J-(B. juncea var.NRCHB-101)	563.27	718.33	277.60
SE(m)±			29.68
CD at 5%			86.77

Table 1c: Seed yield g/plant mustard as influenced by the Brassica species and planting geometry interaction

Interaction	S_1-Trans.45X45 cm	S_2-Trans.60X60 cm	S_3-Sow. 30X10 cm
C- (B. carinata var.PC-6)	29.07	32.14	10.87
N-(B. napus var.GSC-7)	13.42	14.02	6.35
J-(B. juncea var.NRCHB-101)	21.61	28.67	20.23
SE(m)±			0.76
CD at 5%			2.35

Table 1d: Seed yield kg ha^{-1} mustard as influenced by the Brassica species and planting geometry interaction

Interaction	S_1-Trans.45X45 cm	S_2-Trans.60X60 cm	S_3-Sow. 30X10 cm
C- (B. carinata var.PC-6)	952.58	1178.27	1398.45
N-(B. napus var.GSC-7)	445.16	355.51	705.74
J-(B. juncea var.NRCHB-101)	1581.36	1120.82	2238.89
SE(m)±			59.05
CD at 5%			181.98

Table 2. Economics of the various treatments as influenced by brassica species and planting geometry

Treat.	**Yield kg/ha**	**Cost of cultivation**	**GMR Rs ha^{-1}**	**NMR Rs ha^{-1}**	**B:C ratio**
Main- plot -Brassica species					
C- (B. carinata var.PC-6)	1176.4	15819	49410	33590	3.14
N-(B. napus var.GSC-7)	502.1	15819	21089	5270	1.34
J-(B. juncea var.NRCHB-101)	1643.6	15819	69035	53215	4.39
SE(m)±	29.3	-	1229	1229	-
CD at 5%	114.9	-	4826	4826	-
Sub-plot – sowing method					
S_1-Trans.45X45 cm	993.0	16553	41707	25154	2.52
S_2-Trans.60X60 cm	884.9	15753	37164	21411	2.36
S_3-Sow. 30X10 cm	1444.3	15153	60663	45510	4.00
SE(m)±	34.0	-	-	1432	-
CD at 5%	105.0	-	-	4412	-
Interaction					
SE(m)±	59.05	-	-	2480	-
CD at 5%	181.9	--	-	7643	-

Table 2a: NMR Rs ha^{-1} mustard as influenced by the Brassica species and planting geometry interaction

Interaction	S_1-Trans.45X45 cm	S_2-Trans.60X60 cm	S_3-Sow. 30X10 cm
C- (B. carinata var.PC-6)	23455.507	33734.139	43582.003
N-(B. napus var.GSC-7)	2143.541	-821.416	14487.986
J-(B. juncea var.NRCHB-101)	49864.054	31321.319	78460.635
SE(m)±			2480
CD at 5%			7643

DISCUSSION

Effect of Species:

Effect of species showed that highest plant height, Number of branches, Siliqua Plant^{-1} was highest in *Brassicacarinata* species but the seed test weight and seeds per pod was heightest in *Brassica juncea*as compared to other two species which might be due to the size of pod and seed was greater as compared to the size of seed and pod in *Brassica carinata and Brassicanapus*. (Table 1). Therefore, the yield was also highest in *Brassica iuncea* species.GMR, NMR and B:C ratio recorded maximum and significantly higher in species *brassica juncea.*(Table 2).

Effect of Spacing:

In between the different spacing though the yield attributing character such as number of branches, Siliqua Plant^{-1} and Yield plant^{-1} were significantly higher in 45 x 45 cm and 60 x 60 cm but the test weight and yield kg/ha was highest in conventional practices i.e. sowing at 30 x 10 cm row spacing. Similarly, economics of the various treatments as influenced by planting geometryshowed highest GMR, NMR and B:C ratioin conventional sowing at 30 x10 cm as compard to 45 x 45 cm and 60 x 60 cm spacing. The highest yield and B:C ratio is due to the high plant population in 30x10 cm as compared to 45x45 cm and 60x60 cm.

Interaction Effect:

The seed yield gm per plant was recorded highest in *Bassica carinata* and *Brassica juncea*at 45 x 45 cm and 60 x 60 cm as cpmared to Brassica napus and and conventional sowing method i.e 30 x 10 cm. Similar results were recoreded in interaction effect of yield kg/ha. Howerver, the significantly highest seed yield kg/ha was reported in *Brassica juncea* at 30 x 10 cm. Interaction effect of net monitory return also showed the similar results.

COCLUSIONS

Brassica carinata species recorded maximum and significantly higher plant height, number of branches, siliqua plant^{-1}, yield plant^{-1} (g), seeds siliqua^{-1} and *brassica juncea* were at par. Yield kg ha^{-1}, GMR, NMR (Rs ha^{-1}) and B:C ratio was recorded higher in *brassica juncea* species.

The seed yield kg ha^{-1}, GMR and NMR were maximum and significantly higher due to conventional sowing at 30x10 cm spacing over 60x60 cm transplanting and transplanting at 45x45 cm spacing. The same treatments also recorded more B:C ratio.

The seed yield kg ha^{-1}, GMR and NMR were maximum and significantly more due to sowing of *brassica juncea* at 30x10 cm sowing.

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CITATION OF THIS ARTICLE

V Pohare, S Rananaware, J. R. Katore, S. R. Kamdi and B Nair. Feasibility and Economics of Transplanting in Different Brassica Species .Bull. Env. Pharmacol. Life Sci., Vol 9[2] January 2020 : 91-96