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Influence of Pre-sowing Seed Treatment with Bio – fertilizers on Plant Growth and Yield Attribute Traits of Mustard (*Brassica nigra* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A set of thirteen treatments including control of seed treatments of mustard **(*Brassica nigra*L.)** with various biofertilizers were used to evaluate the effect of different pre sowing seed treatments of bio-fertilizers on growth,yield and yield attributing traits of mustard. The treatments were evaluated in a Randomized Block Design with three replications during the *rabi* season, 2021-22. The present investigation was carried out at the Field Experimentation Centre of Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj, U.P. during *rabi* 2021. at Naini Agriculture Institute,Naini. The data were recorded from five randomly selected plants for each treatments in all the replications for twelve characters. Analysis of variance showed significant differences among the seed treatments for all characters indicating that the seed treatment with biofertilizers has adequate variability to support the improvement the seed yield of mustard. It is concluded that all the characters under study were significantly affected by the influence of the application of biofertilizers. Among all the biofertilizers used under the study, seed treatment with the application of vermiwash at 12% for a duration of 6 hours and observed rapid increase in field emergence, plant height, seeds per siliqua and yield characteristics.

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Keywords: Mustard; biofertlizers; seed treatment etc.

1. INTRODUCTION

Mustard belongs to *Brassicaceae* Family and consists of 2n of 36. Mustard is a broadleaf, cruciferous, cool-seasoned annual oilseed crop produced primarily for the condiment market. Mustard is a one of the most important oil-seed crop in India. Out of the total mustard production of India, Indian mustard accounts for 75-80% and contributes 24.2% of the total edible oil pool of the country (DRMR, 2013). The major mustard growing states of India are Rajasthan, U.P, Gujarat, M.P, Assam, Bihar, Orissa, Haryana, Punjab and west Bengal. The present area, production and yield of nine oilseeds in India is around 26.48mha30.94mt and 1168 kg ha^{-1} respectively, and mustard sown area in India is 6.36 mha which has a production of 8.03 mt.The average productivity of mustard in India is 1262 kg ha^{-1} . (According to directorate of economics and statistics, department of agriculture and cooperation, 2012-2013). Mustard is grown for its oil rich seeds. Apart from extracting oil, seeds are also used directly in the preparation of almost all Indian curries particularly in a process called tadka. The mustard seed gives edible oil which is used as cooking medium in north India.Mustard is most often used at the table as a condiment on cold and hot meats. As a condiment, mustard averages about 5 kcal per teaspoon.Some of the many vitamins and nutrients found in mustard seeds are selenium and omega 3 fatty acid [1]. Because of its antibacterial properties and acidity, mustard does not require refrigeration for safety; it will not grow mould, mildew, or harmful bacteria.The potential of B.junceae as a natural source of the antioxidant alpha-tocopherol has been described [2]. Allyl isothiocyanate has antimicrobial and antifungal activity, and the antibacterial effect of mustard flour and oil has been evaluated for application in the processed meat industry for its inhibitory effect on Escherichia coli and salmonella [3].In mustard, salinity is one of the most important abiotic stresses limiting crop production in arid and semiarid regions, where soil salt content is naturally high and precipitation can be insufficient for leaching. Salinity affects many morphological, physiological and biochemical processes, including seed germination, Plant growth, and water and nutrient uptake. Different types of bio fertilizers as being used as seed treatments to manage resistance capability and germination. In the present study, an attempt is being made to identify the best bio fertilizer pre sowing seed treatments that hastens the seedling growth and influence better field performance (Munns and Tester, 2008). Accumulation in soil affects plant growth to different degrees. Some researchers have indicated that the reason for germination failure was the inhibition of seed water uptake due to a high salt concentration.Salinity is one of the most important abiotic constraints limiting crop productivity; 10 percent of world's arable land area is estimated to be salt-stressed (Kaouther et al., 2012).

Rhizobia have the capability to uptake ACC and break it down into a-ketobutyrate and NH3. Its breakdown product is used as a source of carbon and nitrogen. Overexpression of ACC deaminase gene in several rhizobial species enhanced the nodule number and its competitiveness (Conforte et al., 2010). Moreover, environmental stress tolerance (such as salinity) in legumes was enhanced through ACC deaminase (Brigido et al., 2013). Inoculation of ACC deaminase minus mutants of rhizobial strain produced fewer nodules and were less competitive than their wild-type counterparts (Ma et al., 2003; Uchiumi et al., 2004); ACC deaminase genes are highly prevalent and are stably vertically transmitted in Bradyrhizobium spp. and Paraburkholderiaspp. Hence an attempt is made to find out suitable pre sowing seed treatments favourable for mustard growth and development.

2. MATERIAL AND METHODS

The present experiment was carried out at the Field Experimentation Centre of Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P during *Rabi,* season 2021-22. The site of experiment is located at 25.87^0 N latitude, 81.51^0 E longitude and 98 meter above the sea level. The experimental material for present investigation comprised of thirteen treatments. Including control. The seed of mustard variety NDR 8501 were treated with three different concentrations of each biofertilizer viz., Rhizobium, Azospirillus, Azotobacter, and Vermiwash for a duration of 6 hours. The experimental was conducted in Randomized Block Design (RBD). The spacing of 30 cm within rows and 10 cm between the plants was followed. All recommended agronomical cultural practices were carried out to raise a good crop. Observation were recorded based on five

randomly selected plants in each genotype in each replication for all important characters viz., Plant height (cm), Number of primary branches per plant, Number of siliqua per plant, Number of seeds per siliqua, Biological yield per plant (g), test weight, Harvest index (%), Seed yield per plant (gm) and Seed yield per plant (g) exceptField emergence percentage and days to 50% flowering where the observations recorded on plot basis. Field emergence was observed in each plot at 4",7h, and 10th days after sowing. The data was calculated using the formula suggested by Heydecker (1972).

$$Field\ Emergence: \frac{X1}{4}+\frac{X2}{7}+\frac{X3}{10}\times 100$$

Plant Height (cm) was measured from ground level to the base of the top most fully opened leaf at 30,60 and 90DAS. Average height of five plants was recorded in centimeters. For number of Branches per plant the total numbers of branch per plant from five randomly selected plants was counted manually from each plot. Number of siliqua for each plant was counted. Number of seeds per siliqua were taken from each sample and average number of seeds in a siliqua was determined. One thousand clean dried seeds in five samples were counted randomly from the clean seed of each plot at the time of harvest and were weighed by an electrical balance. At harvest, all pods were separated manually from five tagged plants individually and dried, shelled and cleaned. The seed weight from each plant was recorded and means value of five plants was expressed as seed yield per plant in grams.

2.1 Statistical Analysis

The analysis of data was worked out to test the signification tests. It was done according to the procedure of RBD for each character as per methodology suggested by **Fisher [4].** The total variance and degree of freedom were partition into Three components viz. treatment,Replications and error. The data were subjected to analysis of variance adopting standard statistical methods. Analysis of variance was carried out according to the procedure of Randomized Block Design (RDB)for each character as per methodology advocated by Panse and Sukhatme, [5].

3. RESULT AND DISCUSSION

Analysis of variance (Table-1)revealed that the differences among fourteen treatments were significant for growth and yield, *viz.,*field emergence percentage, days to 50% flowering, plant height 30 days after sowing, plant height 60 days after sowing, plant height 90 days after sowing, number of branches per plant, Number of secondary branches per plant , Number of siliqua per plant ,number of seeds per siliqua, 1000 seed weight, seed yield per plant, seed yield per plot, Biological yield and harvest index. This indicates that there is amplescope for selection of superior biofertilizer for the improvement of yield of mustard.

Table 1. Mean sum of squares for different characters in Mustard

Sl. No.	Characters	Mean sum of squares	
		Treatments (df=12)	Error (df=24)
1	Field emergence	19.86	1.13
2	Days to 50% flowering	2.13	0.80
3	Plant height at 30DAS	101.14	2.86
4	Plant height at 60DAS	0.40	0.018
5	Plant height at 90DAS	0.64	0.02
6	Number of primary branches per plant	8.39	1.74
7	Number of secondary branches per plant	94.65	3.59
8	Number of siliquae per plant	3.54	0.04
9	Seeds per siliqua	0.27	0.002
10	1000 seed weight	85.32	2.18
11	Seed yield per plant	0.37	0.005
12	Seed yield per plot	22.89	0.17
13	Biological yield	0.10	0.008
14	Harvest index	19.86	1.13

Table 2. Mean Influence of Bio Fertilizers treatments on for different characters in Mustard

Sl.No.	Treatment	Field emergence	Days to 50% flowering	Plant height 30days	Plant height at 60 days	Plant height at 90 days
T_0	Control	85.33	48.33	26.57	52.63	90.63
T_1	Rhizobium at 8%	86.33	46.00	30.30	59.77	95.90
T_2	Rhizobium at 10%	87.67	48.00	32.67	64.33	103.93
T_3	Rhizobium at 12%	91.67	46.33	37.30	68.90	108.03
T_4	Azospirullus at 8%	86.33	46.67	29.17	59.43	94.87
T_5	Azospirullus at 10%	87.33	46.33	32.87	63.10	100.77
T_6	Azospirullus at 12%	90.67	47.00	35.80	64.53	105.30
T7	Vermiwash at 8%	91.67	46.67	31.50	62.43	95.40
T_8	Vermiwash at 10%	89.00	46.00	35.57	65.37	102.87
T_9	Vermiwash at 12%	93.67	47.00	38.43	70.37	110.97
T_{10}	Azotobacteria at 8%	86.67	47.67	29.83	59.50	99.93
T_{11}	Azotobacteria at 10%	87.00	48.33	33.03	63.97	102.10
T_{12}	Azotobacteria at 12%	87.67	46.33	35.53	65.57	105.60
	Grand Mean	88.53	46.97	32.96	63.06	101.25
	Range	85.33-93.67	46-48.33	38.43-26.57	70.37-52.63	110.97-90.63
	SE(d)	0.61	0.51	0.74	0.73	0.97
	C.D@(5%)	1.79	1.51	2.18	2.14	2.85

The mean values, standard error of the difference (SEd$\pm$), the critical difference (C.D.) at 5% and range of 13 treatments for various characters are presented in Table 2-4 which revealed a wide range of variation for all treatments studied and are discussed as below.

A range of 85.33-93.67% was recorded for field emergence. The mean value for this parameter was 88.53%. The maximum field emergence (93.67%) was observed with T9 (Vermiwash at 12%) while minimum field emergence (85.33) was observed with control. The maximum days to 50% flowering (48.33 days) observed with T_O (control). Minimum days to 50% flowering (46 days) flowering recorded for T8 (Vermiwash at 10%) and T_1 (Rhizobium at 8%). A range of 38.43-26.57cm was recorded for plant height at 30DAS. The mean value for this parameter was 32.96. The maximum plant height at 30DAS (38.43) was observed with T9 (Vermiwash at 12%) minimum plant height at 30DAS (26.57) was observed with control. A range of 70.37-52.63 was recorded for plant height at 60DAS. The mean value for this parameter was 63.06. The maximum plant height at 60DAS (70.37) was observed with T9 (Vermiwash at 12%) and minimum plant height (52.63) was observed with control. A range of 110.97-90.63was recorded for plant height at 90DAS. The mean value for this parameter was 101.25. The maximum plant height at 90DAS (110.97cm) was observed with T9 (Vermiwash at 12%) and minimum plant height at 90DAS (90.63) was observed with control (Table 2). A range of 6.33-5.10 was recorded for number of primary branches per plant. The mean value for this parameter was 5.69. The maximum number of primary branches per plant (6.33) was observed with T9 (Vermiwash at 12%) and minimum number of primary branches per plant (5.10) was observed with control. A range of 9.77-8.07 was recorded for number of secondary branches per plant. The mean value for this parameter was 8.98. The maximum number of secondary branches per plant (9.77) was observed with T9 (Vermiwash at 12%) and minimum number of secondary branches per plant (8.07) was observed with control. The observation on number of siliquae per plant of mustard was statistically analyzed. A range of 71-51.33 was recorded for number of siliquae per plant. The mean value for this parameter was 62.28. The maximum number of siliquae per plant (71) was observed with T9 (Vermiwash at 12%)and minimum number of siliquae per plant (51.33) was observed with

control. A range of 11.80-8.27 was seeds per siliqua. The mean value for this parameter was 9.79. The maximum number of seeds per siliqua (11.80) was observed with T9 (Vermiwash at 12%) and minimum number of seeds per siliqua (8.27) was observed with control. A rage of 4.89-4.28g test weight recorded with 4.54 mean value. The maximum test weight (4.89) observed with T_9 (vermiwash at 12% ;). Minimum test weight (4.28) recorded for T_O (control) (Table-3).The observations on seed yield per plant of mustard were statistically analyzed. A range of 1.51-2.44 was recorded for seed yield per plant. The mean value for this parameter was 1.98. The maximum seed yield per plant (2.44) was observed with T9 (Vermiwash at 12%) and minimum seed yield per plant (1.51) was observed with control. An observation of seed yield per plot of mustard was statically analyzed. A rage of 11.80- 8.27 seed yield per plot recorded with 43.12 mean value. The maximum seed yield per plot (11.80g) observed with T9 (Vermiwash at 12%). Minimum seed yield per plot (8.27g) recorded for T_O (control). The experiment provided information about mustard seeds when treated with Vermiwash at 12% increased the seed yield per plot. Observations of biological yield of mustard were statically analyzed. A rage of 8.31-7.11g of biological yield recorded 7.7g as mean value. The maximum biological yield (8.31) observed with T_9 (vermiwash at 12%). Minimum biological yield (7.11) recorded for T_O (control). Observations of harvest index of mustard were also statically analyzed. A rage of 29.40-21.27 % harvest index recorded with 25.49% mean value. The maximum harvest index (29.40) observed with T_9 (vermiwash at 12%). Minimum harvest index (21.27) recorded for T_O (control) (Table-4).

Table 3. Mean Influence of Bio Fertilizers treatments on for different characters in Mustard

S.No.	Treatment	Primary branches per plant	Number of secondary branches per plant	Days To Maturity	Number of siliquae per plant	Seeds per siliqua	1000 seed weight(g)
T_0	Control	5.10	8.07	121.33	51.33	8.27	4.28
T_1	Rhizobium at 8%	5.53	8.70	117.33	59.33	9.03	4.30
T_2	Rhizobium at 10%	5.80	9.07	118.00	65.00	10.40	4.43
T_3	Rhizobium at 12%	6.27	9.63	119.00	69.33	11.23	4.83
T_4	Azospirullus at 8%	5.26	8.50	117.33	57.00	8.57	4.46
T_5	Azospirullus at 10%	5.63	8.87	118.67	60.67	9.73	4.66
T_6	Azospirullus at 12%	5.87	9.30	118.33	66.33	10.17	4.64
T7	Vermiwash at 8%	5.53	8.90	118.33	59.33	9.13	4.42
T_8	Vermiwash at 10%	5.93	9.27	117.67	65.67	10.90	4.63
T_9	Vermiwash at 12%	6.33	9.77	119.00	71.00	11.80	4.89
T_{10}	Azotobacteria at 8%	5.29	8.67	118.67	56.00	8.73	4.46
T_{11}	Azotobacteria at 10%	5.67	8.80	123.33	63.33	9.30	4.54
T_{12}	Azotobacteria at 12%	5.86	9.23	119.00	65.33	10.13	4.50
	Grand Mean	5.69	8.98	109.82	62.28	9.79	4.54
	Range	6.33-5.10	9.77-8.07	117.33-121.33	71-51.33	11.80-8.27	4.89-4.28
	SE(d)	0.07	0.09	0.76	1.09	0.12	0.05
	C.D@(5%)	0.22	0.28	2.22	3.19	0.37	0.15

Table 4. Mean Influence of Bio Fertilizers treatments on for yield characters in Mustard

Treatment	Treatment	Seed yield per plant(g)	Seed yield per plot	Biological yield(g)	Harvest index%
T_0	Control	1.51	8.27	7.11	21.27
T_1	Rhizobium at 8%	1.79	9.03	7.59	23.61
T_2	Rhizobium at 10%	2.09	10.40	7.86	26.63
T_3	Rhizobium at 12%	2.34	11.23	8.16	28.63
T_4	Azospirullus at 8%	1.62	8.57	7.42	21.87
T_5	Azospirullus at 10%	1.94	9.73	7.74	25.04
T_6	Azospirullus at 12%	2.25	10.17	8.05	27.99
T7	Vermiwash at 8%	1.81	9.13	7.51	24.14
T_8	Vermiwash at 10%	2.26	10.90	8.12	27.87
T_9	Vermiwash at 12%	2.44	11.80	8.31	29.40
T_{10}	Azotobacteria at 8%	1.63	8.73	7.43	21.98
T_{11}	Azotobacteria at 10%	1.97	9.30	7.77	25.35
T_{12}	Azotobacteria at 12%	2.21	10.13	8.01	27.62
	Grand Mean	1.98	43.12	7.77	25.49
	Range	2.44-1.51	11.80-8.27	8.31-7.11	29.40-21.27
	SE(d)	0.02	0.12	0.04	0.24
	C.D @ (5%)	0.07	0.37	0.12	0.70

Among the different bio fertilizer treatments Vermiwash at 12% gave highest field emergence, plant height and control contributed lowest plant height at 30DAS, 60DAS and 90DAS.This treatment gave highest number of primary branches per plant and secondary branches per plant and control contributed lowest number of secondary branches per plant, number of siliquae per plant, highest number of seeds per siliqua and test weight while control contributed lowest for these parameters. Treatment with bio fertilizer Vermiwash at 12% also gave highest seed yield per plant ,seed yield per plot biological yield and harvest index and at the same time vermiwash at 12% contributed highest harvest index.Thus, Among all the biofertilizers used under the study, seed treatment with the application of vermiwash at 12% for a duration of 6 hours significantly affected all the character under study. Geetha and Balamurugan (2021) reported with Azospirillum enhanced the germination by 13.3% over control. Kalita et al. [6] reported that seed treatment with biofertilizers in combination with different levels of chemical fertilizers was found to be superior over recommended dose of NPK. Application of Azotobacter and PSB in combination with 75 and 50% NPK and FYM @2 t ha-1 were found as viable and feasible option for getting higher yield and economic return from cultivation of toria in hill zone of Assam. Hadiyal et al. [7] reported thatSeed inoculation with azotobacter spp. + PSB spp. (each @ 10 ml/kg seed) promoted growth parameters viz., number of primary & secondary branches per plant; yield attributes viz., number of silique per plant and number of seed per silique and ultimately higher seed and stover yield with higher net returns of 86629 Rs/ha and B: C ratio 3.40 over control (no inoculation). Singh et al. [2014] reported that seed inoculation with either of the bacteria significantly increased the number of branches, pods/plant, seeds/pod and yield of seed and stover yield. Singh and Dutta [8] reported that mustard and rapeseeds gave good response to Azotobacter growth and development, seed yield and oil yield. Incidence of some diseases of mustard and rapeseeds could be reduced by inoculating with Azotobacter [9-12].

4. CONCLUSION

It is concluded that all the characters under study were significantly affected by the influence of the application of biofertilizers. Among all the biofertilizers used under the study, seed treatment with the application of vermiwash at 12% for a duration of 6 hours.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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