Original Research Article

INFLUENCE OF PRE-SOWING SEED TREATMENT WITH BIO – FERTILIZERS ON PLANT GROWTH AND YIELD ATTRIBUTE TRAITS OF MUSTARD (*Brassica nigra* L.)

Comment [D1]: ATTRIBUTING

ABSTARCT

A set of thirteen treatments including control of seed treatments of mustard **(*Brassica nigra* L.)** with various biofertilizers were evaluated in a Randomized Block Design with three replications during the *rabi* season, 2021-22 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.

Key Words: Mustard, Biofertlizers , Seed Treatment etc.

Comment [D2]: for
Comment [D3]: delete
Comment [D4]: delete
Comment [D5]: in
Comment [D6]: was
Comment [D7]: delete
Comment [D8]: influenced by
Comment [D9]: delete
Comment [D10]: delete
Comment [D11]: delete
Comment [D12]: delete
Comment [D13]: f
Comment [D14]: delete
Comment [D15]: W
Comment [D16]: ,
Comment [D17]: with
Comment [D18]: Delete
Comment [D19]: Sentence case
Comment [D20]: Italics
Comment [D21]: delete
Comment [D22]: Italics
Comment [D23]: Salt content in soil
Comment [D24]: is
Comment [D25]: p
Comment [D26]: are
Comment [D27]: has been
Comment [D28]: delete
Comment [D29]: NH_3

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 26.48 mha30.94mt and 1168kg/ha 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. (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 (Park *et. al.*, 2018). 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 (Yusuf and Sarin, 2007). 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 (Olivier et.al., 1999).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.

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. Over expression 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 Paraburkholderia spp.

Comment [D30]: What the authors want to convey? Not clear

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 experiental 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) except Field emergence percentage and days to 50% flowering where the observations recorded on plot basis.

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 (1936).** 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, (1967).

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 DAS, plant height 60 DAS, plant height 90DAS, 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 a ample scope for selection of superior biofertilizer for the improvement of yield of mustard.

Table 1: Mean Influence of Bio Fertilizers treatments on for different characters in Mustard

S.No.	Treatment	Field emergence	Days to 50% flowering	Plant height 30DAS	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

Comment [D31]: r

Comment [D32]: delete

Comment [D33]: delete

Comment [D34]: maintained

Comment [D35]: followed

Comment [D36]: s

Comment [D37]: T

Comment [D38]: Rewrite

Comment [D39]: ed

Comment [D40]: t

Comment [D41]: r

Comment [D42]: done

Comment [D43]: s

Comment [D44]: at

Comment [D45]: at

Comment [D46]: club all these as plant height at 30,69 and 90 DAS

Comment [D47]: why capital letters in between the sentence?

Comment [D48]: delete

Comment [D49]: mention units?? In text also

Comment [D50]: are these concentrations, then do write Rhizobium @8%

The mean values, standard error of the difference (SEd±), 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 value. 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 30 DAS. The mean value for this parameter was 32.96. The maximum plant height at 30 DAS (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).

Comment [D51]: delete and any unit?

Comment [D52]: The authors should revisit and go through the MS critically. There are countless minor errors. Further discussion part is poor. Require more support so look for literature citing probable reasons?

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
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	Seed yield per plot	Biological yield	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 (Fig.1). **Geetha and Balamurugan (2021)** reported with Azospirillum enhanced the germination by 13.3% over control. **Kalita *et al*.,(2019)** 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.*,(2017)** reported that Seed 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 (2016)** 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.

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.

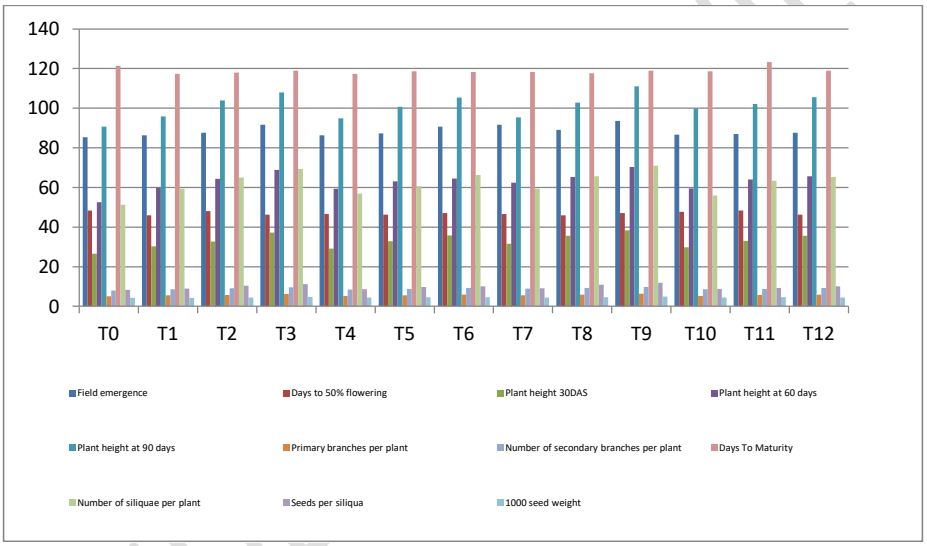

Fig.1 Comparison of seed treatment with Vermiwas at 12% with Control in Mustard for various characters.

Comment [D53]: ?? Do read MS critically before giving such assignments to the reviewer, please.

References

Fisher, R.A. (1936). The correlation between relative on the supposition of genotypes grown in Kumaun Himalaya, *Indian Journal Genetics.*66 (1): 37-38.

Hadiyal JG, RN Kalsaria, PD Vekariya, and PK Ichchhudauda (2017). Effect of spacing, fertility levels and bio-fertilizers on growth and yield of summer greengram (Vigna radiata L. Wilczek). Journal of Pharmacognosy and Phytochemistry, 6(5): 934-937.

Nilim Kalita, Sanjib Bhuyan,Subal Maibangsa and Ranjit Kumar Saud(2019). Effect of Biofertilizer Seed Treatment on Growth, Yield and Economics of Toria (Brassica Campestris L.) under Rainfed Condition in Hill Zone of Assam. Current Agriculture Research Journal. Vol. 7, No.(3), pg. 332-336.

Panse V. G., and Sukhatme P. V. (1967). Statistical Methods for Agricultural Workers. *Indian Council of Agricultural Research:* 103-108.

Park, Kun-Young; Kwon, Dae Young; Lee, Ki Won; Park, Sunmin (2018). Korean Functional Foods:Composition, processing and Health Benefits. CRC Press.

S**ingh, M.S. and Dutta, S. (2016).** Mustard and rapeseed response to Azotobacter - a review". Agric. Rev., 27 (3): 232 – 234.

Olivier C, Vaughn SF, Mizubuti ES, Loria R. (1999).Variation in allyl isothiocyanate production within *Brassica* species and correlation with fungicidal activity. *J Chem Ecol*. 1999;25(12):2687-2701.

Yusuf MA, Sarin NB (2007). Antioxidant value addition in human diets: genetic transformation of *Brassica juncea* with gamma-TMT gene for increased alpha-tocopherol content. *Transgenic Res*. 2007;16(1):109-113.17103027

Singh, M.S. and Dutta, S. (2016). "MUSTARD AND RAPESEED RESPONSE TO AZOTOBACTERA REVIEW". Agric. Rev., 27 (3): 232 – 234.

Vessey, J.K. 2003. Plant Growth Promoting Rhizobacteria as Biofertilizers. Plant Soil, 255: 571– 86.

Wani,S.A.,Subhash,C.&Tahir,A.2013. Potential Use of Azotobactera Chroococcum in Crop Production. Current'Agriculture'Research'Journal, 1(1)

.

Noel, D.D., Nafan,D., Souleymane, S., JeanALuc, M.A., Jesus, F.I. & Lamine, B.M. 2016. Combination of Rizhobacteria and Foliar Bio Fertilizer Accelerating Maize and Soybean Crop

Plants Growth Process in Arid Soil. Academia' Journal' of' Agricultural' Research, 4(7):446A456.

Masso, C., Ochieng, J.R.A. &Vanlauwe, B. 2015. Worldwide Contrast in Application of Bio A Fertilizers for Sustainable Agriculture: Lessons for SubASaharan Africa. Journal'of'Biology,' Agriculture'and'Healthcare, 5 (12).