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Response of Vermicompost and fertility levels on growth, yield, and Quality of Indian Mustard [*Brassica juncea* (L.) *Czern and Cosson*.]

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ABSTRACT

A field experiment was conducted during *Rabi* season of 2019-20 at the Student Instructional Farm to find the effect of vermicompost and fertility levels on growth, yield and quality of Mustard [*Brassica juncea* (L.) Czern and Cosson.]". The experiment was laid out randomly in a split plot design with three replications having vermicompost *viz*., V_1 (Control), V_2 (2 tonnes ha^{-1}), V_3 (4 tonnes ha^{-1}), V_4 (6 tonnes ha^{-1}) were allotted in main plots where, F_1 (Control), F_2 50% RDF (60:30:30 kg ha^{-1} NPK), F_3 75% RDF (90:45:45 kg ha^{-1} NPK), F_4 100% RDF (120:60:60 kg ha^{-1} NPK) allotted in sub plots. Thus total sixteen treatment combinations were replicated thrice. The result showed that among the vermicompost application of 6 tonnes ha^{-1} gave significantly higher growth attributes, seed yield (2188 kg ha^{-1}), and quality parameters, *i.e.* Oil content (38.717%), Oil yield (850.655 kg ha^{-1}), Protein content (21.732 %), Protein yield (484.585 kg ha^{-1}) which was higher over control. Among the different fertility levels application of 100% RDF gave significantly higher, growth attributes, seed yield (2354.0 kg ha^{-1}), and quality parameters, *i.e.* Oil content (39.852%), Oil yield (938.520kg ha^{-1}), Protein content (24.267%), Protein yield (572.142kg ha^{-1})in compare to control treatment. However the interaction effect was non-significant.

Key words: *Quality, Mustard, Yield, Growth, Vermicompost*

Introduction

India is one of the best places in the world to grow oilseeds. It has 16% of the world's oilseed-growing land and produces 10% of the world's oilseeds. India's most important crops for making money are oilseed crops. Oilseeds are the second most important crop in India after cereals. They are important to India's economy and make up 13.33% of the total gross cropped area, 3.0% of the gross national production, and 10% of the value of all crops. The country mostly grows 9 oilseed crops: groundnut, rapeseed, mustard, soybean, sesame, sunflower, safflower, Niger, castor, and linseed. Only seven of these oilseed crops can be eaten: groundnut, rapeseed, mustard, soybean, sesame, sunflower, saf-

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flower, and Niger. Linseed and castor are the only two that can't be eaten.India is third in the world when it comes to growing rapeseed and mustard, after Canada and China (Anonymous 2020)[a]. In India, Rajasthan has the most land (26.32 lakh ha), and it also has the most crops (41.08 lakh metric tonnes) however in Uttar Pradesh, mustard is grown on 7.93 lakh ha., with a yield of 1,412 kg ha^{-1} and a production of 11.20 lakh metric tonnes (Anonymous, 2020)[b]. Artificial or inorganic fertilizer that is used over and over again or as the only source of fertilizer can make the soil sick, change the soil's environment, reduce productivity, and make it impossible to keep using. Chemical fertilizers have also made a big difference in polluting the air, water, and soil. When synthetic, toxic chemicals and fertilizers are used in an agroecosystem, they affect the fertility of the soil and the growth of crops (Kumar *et al*., 2019). (Kreye *et al.,* 2009) said that using chemical fertilizers over and over again makes the soil acidic, which makes plants sick. On the other hand, organic sources are good for the environment, make things more productive, and last longer. The current trend is to look into the possibility of adding organic fertilizers that are better for the environment and cost less than chemical ones. Bio fertilizer, vermicompost, and other eco-friendly and safe fertilizers came in handy to cut down on the use of chemical fertilizers and act as a carbon sink in crop fields. Vermicomposting is a good organic source of manure that gives plants the nutrients they need. It has a lot of Nitrogen (1.7-2.5%), Phosphorus (0.7-1.0%), Potassium (1.1-1.4%), Calcium (0.4%), Magnesium (0.15%), Sulphur (0.4%), Zinc (25 PPM), Iron (175.2 PPM), vitamins, and growth hormones, all of which help plants grow and microbial populations. In contrast, when synthetic fertilizers and vermicomposting are used together, they reduce soil toxicity by acting as a buffer, stop soil degradation, and improve soil fertility. (Dikr and Belete, 2017) said that vermicompost is a great place for both symbiotic and non-symbiotic microbes to grow, and vermicompost's effectiveness has been reported many times. Earthworms eat a lot of organic matter and pass it out as "cast." This "cast" has a lot of enzymes and plant nutrients that help bacteria and mycorrhizae grow. Combining inorganic fertilizers with organic sources is good for crops. This is because organic sources of manure have a small amount of primary, secondary, and micronutrients, but crops need a lot of nutrients. To make up for this, crops need to use both organic and inorganic fertilizers wisely.

Materials and Methods

The experiment was conducted at the Student's Instructional Farm (SIF), Department of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, India. Total rainfall received during the crop period was 113.2 mm, with the maximum rainfall of 65.6 mm recorded during the week of January 15-21, 2020. The weekly maximum and minimum temperature ranged from 12.3 ^{0}C to 31.6 ^{0}C and 3.9 ^{0}C to 16.9 ^{0}C respectively. Weekly maximum relative humidity ranged from 77 to 96 %, and weekly minimum relative humidity varied from 37.7 to 81 %. The experiment consisted of 16 treatment combinations laid out in a split plot design with 3 replications. In the main plot, the crop was fertilized with different doses of vermicompost, while in the sub plot, it was fertilized with Urea, DAP, and MOP with different doses of RDF 120: 60:60 kg ha^{-1}. The variety used was Azad Mahak[KMK (E)15-2].

The plant population of each plot was recorded at different stages and converted to plants per hectare. The height of four tagged plants per plot was measured and averaged. Four plants were also harvested from each plot, dried, and weighed to determine the dry matter weight per plant. The total number of branches per plant was counted and averaged. Crop yield was measured in kilograms per plot, and then converted to kilograms per hectare. Oil yield was calculated by multiplying seed yield with oil content. Protein content was estimated using Kjeldahl's method on the oil-free cake and multiplying the result by 6.25. Protein yield was then calculated by multiplying mustard seed yield and protein content.

The collected experimental data was statistically analyzed using ANOVA as per the standard procedure outlined by Gomez and Gomez (1984). The treatments were tested for significance using the variance ratio 'F' test, and the standard error of mean was calculated for all cases. The difference between treatment means was tested using the Least Significant Difference (LSD) at a 5% level of probability, as per the formula used when significant differences were found among means using the 'F' test.

$$LSD = \frac{\sqrt{2 \times error\ mean\ sum\ of\ square}}{N} \times t\ (error\ d.f.\ 5\%)$$

C.D. at 5% = SE (d) × $t_{at5\%}$ error of freedom

Results and Discussion

Effect on plant population

The initial, after thinning and final plant population m^{-2} of mustard does not influenced significantly by vermicompost and fertility levels as presented in Table 1. also interaction effect was non-significant. This finding is closely related to (Mondal *et al*., 2015).

Effect on plant height at harvest

The study presented in Table 1 shows that vermicompost and fertility levels significantly influenced plant height at both stages of crop growth. The application of 6 tonnes vermicompost ha^{-1} and 100% RDF resulted in the maximum plant height at harvest and 120 DAS, respectively. The interaction effect of vermicompost and fertility levels on plant height was found non-significant. The increase in plant height may be attributed to the beneficial enzymes and increased micro-floral diversity in the soil due to vermicompost application and the availability of appropriate NPK nutrients in the case of fertility levels. These findings are consistent with previous studies (Mondal *et al*., 2015).

Effect on dry weight per plant (g) at harvest

The study recorded dry weight at different stages of crop growth, and the data showed that vermicompost and fertility levels had a significant effect on the dry weight at harvest Table 1. The highest dry weight at harvest was obtained with the application of 6 tonnesvermicompost $ha^{-1}$and 100% recommended dose of fertilizer, respectively. The results suggest that vermicompost and fertilizer influenced the soil nutrient availability and uptake of nutrients by the plants, resulting in increased dry matter accumulation. The findings are consistent with previous studies by Kumawat *et al.* (2014) and (Mondal *et al*., 2015).The interaction effect of vermicompost and fertility levels on dry weight was not significant.

No. of branches

Effect on number of primary secondary and tertiary branches branches plant^{-1}

Table 2 summarizes the effects of different levels of vermicompost and fertility on the average number of primary branches per plant. Vermicompost levels had a significant effect on primary, secondary, and tertiary branches. The highest number of primary, secondary, and tertiary branches was observed with the application of 6 tonnes vermicompost ha^{-1} (V4), which was statistically at par with application of vermicompost @ 4 tonnes ha^{-1} (V3) and 2 tonnes ha^{-1} (V2), and significantly higher than the control treatment. The application of vermicompost likely enhanced the nitrogen fixing ability of nitrogen fixers leading to higher uptake of nutrients by plants. Fer-

Table 1. Effect of Vermicompost and fertility levels on growth attribute of Indian mustard

Treatment	Plant population (running meter)			Plant height (cm)	Dry weight (gm)
	Germination	Afterthinning	Harvest	At harvest	At harvest
Vermicompost					
V1- Control	24.985	17.428	16.460	128.340	31.133
V2- 2 t. ha^{-1}	25.980	17.955	16.273	129.575	34.195
V3- 4 t. ha^{-1}	25.805	17.950	17.020	131.503	35.283
V4- 6 t. ha^{-1}	25.190	17.570	16.275	134.513	36.648
SEm±	0.495	0.239	0.250	1.356	0.641
CD (P=0.05)	NS	NS	NS	3.959	1.873
Fertility levels					
F1-Control	24.425	17.202	16.463	116.920	19.900
F2- 50% RDF	25.917	18.140	16.643	133.497	32.702
F3- 75% RDF	24.748	17.762	16.457	136.005	40.925
F4- 100% RDF	25.870	17.798	16.465	137.508	43.640
SEm±	0.625	0.316	0.382	1.438	0.600
CD (*P*=0.05)	NS	NS	NS	4.964	2.069
VXF	NS	NS	NS	NS	NS

tility levels also had a significant effect on the number of branches, with the highest number found with the application of 100% RDF (F4) which was significantly higher than 75% RDF, 50% RDF and control treatments. The interaction effect of vermicompost and fertility levels on the number of branches was non-significant. The increased number of branches might be attributed to the higher activities of meristematic tissue of plants at higher fertility levels, which plays a role in cell differentiation, more meristematic division and more translocation of food materials in plants, leading to higher branch production at different growth stages. These findings are supported by previous studies (Singh *et al.,* 2018 and Shorna *et al.,* 2020). The interaction effect of Vermicompost and fertility levels on number of primary secondary and tertiary branches plant^{-1}was not significant.

Table 2. Effect of Vermicompost and fertility levels on No. of branches

Treatment	Number of branches		
	Primary	Secondary	Tertiary
V1- Control	5.722	13.700	3.703
V2- 2 t. ha^{-1}	6.067	14.183	3.883
V3- 4 t. ha^{-1}	6.297	14.598	4.088
V4- 6 t. ha^{-1}	6.450	14.925	4.195
SEm±	0.179	0.296	0.064
CD (P=0.05)	0.522	0.865	0.187
Fertility levels			
F1-Control	4.367	11.280	2.688
F2- 50% RDF	5.470	13.940	3.778
F3- 75% RDF	7.012	15.505	4.520
F4- 100% RDF	7.688	16.680	4.882
SEm±	0.159	0.276	0.060
CD (P=0.05)	0.548	0.951	0.207
VXF	NS	NS	NS

Effect on seed yield (q ha^{-1})

The study analyzed the impact of different levels of vermicompost and fertility on the seed yield of mustard Table 3. The results showed that higher seed yield was obtained with the application of 6 tonnesvermicompost^{-1}(V4) and 100% RDF (F4) for vermicompost and fertility treatments, respectively. The increase in seed yield was attributed to improved dry matter accumulation, yield attributes, and nutrient content in the plants. The interaction effect of vermicompost and fertility levels on seed yield was found non-significant. The increase in biological yield per hectare was also observed in these treatments. The results were consistent with previous studies by Singh *et al.* (2014).

Quality Character

Effect on oil content (%) in seed

The study presented data on the effect of different levels of vermicompost and fertility on oil content (%) in mustard seeds, as shown in Table 3. Results showed that the application of 6 tonnes ha^{-1}vermicompost (V4) and 100% RDF (F4) significantly increased oil content (%), which was higher than other treatments and control. The increase in oil content (%) may be attributed to the presence of sulfur in vermicompost and better nutrient uptake

Table 3. Effect of Vermicompost and fertility levels on Quality parameters of Indian mustard

Treatment	Seed yield (kg ha^{-1})	Oil content (%)	Oil yield (kg ha^{-1})	Protein content (%)	Protein yield (kg ha^{-1})
Vermicompost					
V1- Control	1635.3	36.853	609.667	19.258	328.757
V2- 2 t. ha^{-1}	1840.0	37.467	695.577	20.140	383.095
V3- 4 t. ha^{-1}	2023.0	38.145	777.880	20.972	435.988
V4- 6 t. ha^{-1}	2188.0	38.717	850.655	21.732	484.585
SEm±	441	0.045	112.66	0.122	50.52
CD (*P*=0.05)	1288	0.131	328.91	0.357	147.49
Fertility levels					
F1-Control	1271.7	36.375	466.847	16.704	216.875
F2- 50% RDF	1884.5	36.658	693.169	19.290	365.440
F3- 75% RDF	2176.0	38.297	835.243	21.840	477.967
F4- 100% RDF	2354.0	39.852	938.520	24.267	572.142
SEm±	424	0.038	110.89	0.083	48.42
CD (*P*=0.05)	1465	0.130	382.73	0.287	167.11
VXF	NS	NS	NS	NS	NS

by the plant. Similar findings were reported by Singh *et al.* (2018). However, the interaction effect of different levels of vermicompost and fertility on oil content (%) was non-significant.

Effect on oil yield (kg ha^{-1})

Table 3 shows the influence of vermicompost and fertility levels on mustard oil yield. The application of 6 tonnes vermicompost ha^{-1} (V4) resulted in significantly higher oil yield than other vermicompost treatments, likely due to higher seed yield. Similarly, the application of 100% RDF (F4) led to significantly higher oil yield than other fertility treatments. The interaction effect between vermicompost and fertility on oil yield was non-significant. These findings are consistent with previous studies by Singh *et al.* (2018) and Meena *et al.* (2013).

Effect on protein content (%) in seed

Table 3 shows the influence of different levels of vermicompost and fertility on protein content (%) in mustard seed. The application of 6 tonnes vermicompost ha^{-1} (V4) led to significantly higher protein content in seeds than V3, V2 and control treatments, likely due to higher phosphorus uptake. Similarly, the application of 100% RDF (F4) resulted in significantly higher protein content in seeds than other fertility treatments. The interaction effect between vermicompost and fertility on protein content was non-significant. These findings are consistent with previous studies by and Kumar and Singh (2019).

Effect on protein yield (kg ha^{-1})

The protein yield (kg ha^{-1}) of mustard was significantly influenced by different levels of vermicompost and fertility, as presented in Table 3. The highest protein yield was obtained with the application of 6 tonnes vermicompost ha^{-1} (V4) and 100% RDF (F4), respectively. The interaction effect of different levels of vermicompost and fertility on protein yield was found non-significant. The increased protein yield may be due to the higher seed yield resulting from the application of these treatments. Similar results were reported in previous studies by Kansotia *et al.* (2015) and Mohiuddin *et al.* (2011).

Conclusion

The study suggests that the application of 6 t ha^{-1}vermicompost had a significant impact on the growth, yield, and quality of mustard, while the use of 100% RDF proved to be the most effective in terms of growth, yield, and quality among inorganic fertilizers. However, since the experimental results are based on only one year of data, it is advisable to repeat the experiment with the same design to obtain consistent and reliable outcomes.

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