Crop Growth Indices as influenced by FYM, Vermicompost and fertility levels of Indian Mustard (*Brassica juncea* L.)

ABSTRACT

The field experiments were carried out during *Rabi* seasons of 2021-22 at Student's Instructional Farm (SIF), Chandra Shekhar Azad University of Agriculture & Technology, Kanpur, to study the Effect of FYM, Vermicompost and Fertility levels on growth and yield of Indian Mustard (*Brassica juncea* L.). The results revealed that at 30, 60, 90 & 120 DAS the treatment (T_{14}) 100% RDF+ 50% N through Vermicompost recorded significantly higher plant height, Leaf Area Index, Crop Growth Rate and Relative Growth Rate followed by 100% RDF + 50% N through FYM (T_{10}) in both year and pooled also. The highest Grain Yield (24.63 q. ha^{-1}) with highest Harvest Index (28.40 %) was recorded over treatment (T_{14}) 100% RDF + 50% N through Vermicompost of mustard followed by Grain Yield (23.70 q. ha^{-1}) with Harvest Index (27.70 %) of 100% RDF + 50% N through FYM (T_{10}) in both year and pooled also.

Keywords: FYM (Farm Yard Manure), Vermicompost, Harvest Index

Introduction

Indian mustard (*Brassica juncea* L.) is the third most important source of edible oils in the world after soybeans and oil palms. There is a great deal of variation in Brassica sedge species in Central Asia- the Himalayas, with migration into India and China taking place **(Singh, 2023).** The Indian mustard crop is one of the world's largest producers. Around 18% of India's oilseed production comes from rapeseed and mustard. India is one of the major oilseed's grower and importer of edible oils after the United States, China, and Brazil, India has the fourth largest vegetable oil economy in the world. The oilseed accounts for 13% of the Gross Cropped Area, 3% of the Gross National Product and 10% value of all agricultural commodities **(Annual report 2021-22, DAC&FW).**

Indian mustard (*Brassica juncea* L.) is a major oilseed crop belonging to Cruciferae family. Mustard contains 37-49 % oil, 25-32% protein, 7% ash, 1.45%phosphorus, 0.6% calcium,0.6% magnesium, 0.05% manganese and best source of vitamins like thiamine (g/g)5.2, niacin (g/g) 160, riboflavin (mg/g) 3.7, pantothenic acid (mg/g) 9.2, folic acid (mg/g) 2.3, chlorine (mg/g) 6.7. The cake contains 42% crude protein and 7 % ash **(Damodaram and hedge, 2010).** Indian Mustard seed contains 37 to 49 per cent oil. The oil

cake is used as cattle feed and manure, which contains about 4.9 per cent nitrogen, 2.5 percent phosphorus and 1.5 per cent potash **(Mahesh *et. al*., 2021).**

Farm Yard Manure helps in increasing microbes' population and their activities, which play an important role in easily availability of complex nutrients to the plants. Farm yard manure (FYM) improves the soil physio- chemical properties along with direct release of macro as well as micronutrient; ultimately the crop yields increase **(Lakkineni and Abrol, 1994).**

Application of FYM at 10 tones ha^{-1} significantly increased the LAI, CGR and dry matter accumulation per plant at almost all the stages. Maximum dry matter accumulation per plant and seed yield were recorded with highest levels of FYM (20 tonnes ha^{-1}), Seed yield was strongly associated with LAI and dry matter accumulation per plant at all the stages **(Patel *et al*., 1996).**

Vermicompost application has been known to improve physical, chemical and biological properties of soil **(Nagavallemma *et al*, 2004).** The material excreted through the anus of the earthworms in the form of manure is known as vermicompost. The earthworms act as natural bio ideal breeding home for aerobic bacteria which can multiply very fast and compete on aerobic bacteria and fungi.

Agronomic practices, such as fertilizer management, irrigation, and pest control, can also influence grain quality by affecting the availability of nutrients and other resources for crop growth and development. Adequate and balanced fertilization is essential for ensuring optimal grain quality, as nutrient deficiencies or imbalances can lead to reduced growth, altered nutrient composition, or increased susceptibility to pests and diseases. **(Sachan *et.al.*, 2023)**

The Indian mustard productivity is managed only through the selection of appropriate varieties and management of fertility in addition to irrigation **(Bhat *et al*., 2006)**. Among nutrients nitrogen, phosphorus, potassium and Sulphur (N, P, K and S) are essential to increase productivity of cultivars. Sulphur promotes oil synthesis, besides being an important constituent of seed protein, amino acid, enzymes, glucosinolate and chlorophyll **(Singh, 2018).** In terms of agronomic efficiency, each kilogram of S increases the yield of mustard by 7.7 kg (**Katyal *et al.*, 1997**). Rapeseed (*Brassica compestris* and *Brassica rapa* L.) has been observed to require 3-10 times more S than barley (**Bole and Pitman 1984**).

Materials and Methods:

Experimental Site

The experiment was conducted at 'Student's Instructional Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. The experimental field had an even topography and good drainage facility. Geographically, experimental site falls under the sub-tropical and semi- arid tract of North India of Indo- Gangetic plains and lies on the right bank of holy river Ganga. It is located on 260 28'36" N latitude, 800 18' 26" E longitude and at an altitude of 126 meters above mean sea level.

Edaphic condition

Soil samples were collected from different locations of the field before sowing and analysed some physio-chemical characteristics in the Laboratory, C.S. Azad University of Agriculture and Technology, Kanpur. The soil of the experimental field was clayey in texture and slightly alkaline in pH (8.12). The electrical conductivity (EC) of the soil was 0.39 (d S m^{-1}) estimated by Digital EC Meter. Organic carbon in the soil was 0.42% which was estimated by rapid titration method given by **Walkley and Black, 1934**. The available Nitrogen in soil was 189.12 kg ha^{-1}, which was estimated by the Alkaline permanganate method given by **Subbiah and Asija, 1956**. The available Phosphorus was 14.60 kg ha^{-1} estimated by Olsen's method given by **Jackson, 1967**. The available K was 167.31 kg ha^{-1} which was estimated by the Flame photometer method given by **Jackson, 1967.** The available S was 18.50 kg ha^{-1} which was estimated by the calcium extraction method given by **William and Steinberg, 1959.**

Treatment details

The experiment was laid out in Randomized Block Design with three replications. There were fourteen treatment combinations (T1) Control (No fertilizer and no organic source), (T2) 100% RDF (120:60:60:30 NPKS kg ha^{-1}), (T3) 75% RDF, (T4) 125% RDF, (T5) FYM alone (100% N through FYM), (T6) Vermicompost alone (100% N through Vermicompost), (T7) 75% RDF + 25% N through FYM, (T8) 100% RDF + 25% N through FYM, (T9) 75% RDF + 50% N through FYM, (T10) 100% RDF + 50% N through FYM, (T11) 75% RDF + 25% N through Vermicompost, (T12) 100% RDF + 25% N through Vermicompost, (T13) 75% RDF + 50% N through Vermicompost and, (T14) 100% RDF + 50% N through Vermicompost.

Seed Sowing and Spacing

The field was ploughed with a tractor drawn cultivator and after with the rotavator to obtain a fine tilth. The seed was sown at the spacing of 45 cm between rows and 15 cm between plant. The Mustard Variety **Azad Mahak** was sown and the applied seed rate was 5 kg ha^{-1}. Thinning and gap filling was after 15 days after sowing wherever it was required for maintaining optimum plant population.

Land preparation

Land preparation was started after harvesting of kharif crop with an object of optimum moisture condition. For proper germination of seed, a pre-sowing irrigation (palewa) was applied in the experimentation field. One ploughing was done by disc plough followed by two ploughing by tractor drawn cultivator and each ploughing followed by planking so that the soil was well pulverized and levelled. Layout was done carefully after land preparation.

Application of FYM and Vermicompost

In the experimental field, well decomposed FYM and Vermicompost was applied by broadcasting method in individual plot and mixed with soil by hand plough according to required quantity of the particular treatment at the time of sowing after preparation of layout.

Application of nutrients or fertilizers

In main plot, the crop was fertilized with Urea, DAP, MOP and Zinc Sulphate with different doses of RDF viz. 75%, 100%, 125%, (recommended dose 120:60:60:30 kg ha^{-1} NPKS). These doses are applied according to treatment wise.

Results and Discussion

Effect of treatments on Plant height

The data pertaining to Plant height (cm) of Mustard crop was recorded at 30 DAS, 60 DAS and 120 DAS presented in Table-1. Plant height is a crucial parameter in assessing crop growth, and this study revealed that treatments with vermicompost consistently promoted taller plants. The application of treatment 100% RDF and 50% N through vermicompost (T14) consistently outperformed other treatments in promoting taller plants at various stages of growth during both the year and pooled also. This outcome underscores the positive influence of vermicompost in enhancing plant height, likely due to its rich organic matter content and nutrient availability. **Rundala *et al*. (2013)** observed that integrated nutrient management with FYM led to maximum plant height.

At 30 DAS table-1 showed that highest plant height (31.30 cm) was influenced significantly under the different treatment. table indicated that highest plant height (29.800 cm) was recorded with application of 100% RDF + 50 % N through Vermicompost (T14) which was significantly superior over the Control (T1) while at par with remaining of the treatment in both the year and pooled also. It is also clear from the table that application of increasing dose of fertility levels along with FYM and Vermicompost increase the plant height of mustard crop. The increase of plant height by a margin of (11.20 cm) or (37.58 %), (0.63 cm) or (2.16 %), (0.53 cm) or (1.98 %), (0.23 cm) or (0.78 %), (1.53 cm) or (5.41 %), (1.30 cm) or (4.57 %), (1.133 cm) or (3.96 %), (0.27 cm) or (0.91 %), (0.80 cm) or (2.76 %), (0.03 cm) or (0.10 %), (0.90 cm) 0r (3.11%), (0.20 cm) 0r (0.68 %), (0.63 cm) or (2.16 %) as compared to Control (T1), 100% RDF (120:60:60:30 NPKS kg ha-1) (T2), 75% RDF(T3), 125% RDF(T4), FYM alone (100% N through FYM) (T5), Vermicompost alone (100% N through Vermicompost) (T6), 75% RDF + 25 % N through FYM (T7), 100% RDF + 25 % N through FYM (T8), 75% RDF + 50 % N through FYM (T9), 100% RDF + 50 % N through FYM (T10), 75% RDF + 25 % N through Vermicompost (T11), 100% RDF + 25 % N through Vermicompost (T12), 75% RDF + 50 % N through Vermicompost(T13). It is also indicated that increasing dose of fertility levels with FYM and Vermicompost increase the plant height (cm) of mustard crop. The lowest plant height (18.10 cm) was recorded with control (T1).

The data pertaining to Plant height (cm) of Mustard crop was recorded at 120 DAS presented in table-1 and the results indicated that highest plant height (208.50 cm) was recorded with application of 100% RDF + 50 % N through Vermicompost (T14) which was significantly superior under the Control (T1) while at par with remaining of the treatment in both the year and pooled also. It is also clear from the table that application of increasing dose of fertility levels along with FYM and Vermicompost increase the plant height of mustard crop. The lowest plant height (117.50 cm) was recorded with control (T1).

Table-1: Plant Height(cm)

Treatments	**Plant height (cm) at 30 DAS**			**Plant height (cm) at 60 DAS**			**Plant height (cm) at 120 DAS**		
	2021-2022	**2022-2023**	**Pooled**	**2021-2022**	**2022-2023**	**Pooled**	**2021-2022**	**2022-2023**	**Pooled**
T1	18	19.23	18.6	69.13	71.167	70.16	117.03	118	117.5
T2	28.2	30.1	29.16	105.4	108.73	107.0	197.7	199.43	198.5

T3	26.5	27	26.76	97.13	100.3	98.7	189.13	191.2	190.2
T4	28.8	30.3	29.56	107	110.43	108.7	200.9	203.1	202
T5	27.1	29.4	28.26	99.13	102.26	100.7	190.16	192.2	191.1
T6	27.4	29.6	28.5	100.26	103.33	101.8	190.7	192.5	191.6
T7	27.6	29.7	28.66	101.26	104.3	102.7	191.06	193.53	192.3
T8	28.76	30.3	29.53	107.03	110.5	108.7	201.06	203.3	202.2
T9	28.03	30	29	103.13	106.46	104.8	192.46	194.66	193.5
T10	29.1	30.4	29.76	108.03	111.56	109.8	205.2	207.56	206.4
T11	27.9	29.9	28.9	102.23	105.3	103.7	191.46	193.93	192.7
T12	28.9	30.3	29.6	107.9	111.06	109.4	203.36	205.23	204.3
T13	28.2	30.1	29.16	104.2	107.5	105.8	195.7	197.6	196.6
T14	29.23	30.43	29.8	108.13	111.86	110	207.2	209.26	208.2
SE(m)±	1.082	1.082	1.057	3.81	3.99	3.86	7.27	7.35	7.21
CD at 5%	3.161	3.16	3.08	11.13	11.66	11.31	21.25	21.50	21.1

Effect of treatments on Leaf Area Index, Crop Growth Rate and Relative Growth Rate

The data pertaining to Leaf area index of Mustard crop was recorded at 30, 60 and 90 DAS is presented in table-2. At 30 DAS table showed that highest Leaf area index of Mustard crop (0.733) was recorded with application of 100% RDF + 50 % N through Vermicompost (T14) which was significantly superior over the Control (T1), 75% RDF (T3), FYM alone (100% N through FYM (T5), Vermicompost alone (100% N through Vermicompost (T6), 75% RDF + 25 % N through FYM (T7), 75% RDF + 50 % N through FYM (T9), 75% RDF + 25 % N through Vermicompost (T11), 75% RDF + 50 % N through Vermicompost (T13) while at par with 100% RDF (120:60:60:30 NPKS kg ha^{-1}) (T2), 125% RDF (T4), 100% RDF + 25 % N through FYM (T8), 100% RDF + 50 % N through FYM (T10), 100% RDF + 25 % N through Vermicompost (T12) of the treatment in both the year and pooled also. It is also clear from the table that application of increasing dose of fertility levels along with FYM and Vermicompost increase the plant height of mustard crop. The lowest Leaf area index of Mustard crop (0.30) was recorded with control (T1).

At 90 DAS table-2 showed that highest Leaf area index of Mustard crop (0.63) was recorded with application of 100% RDF + 50 % N through Vermicompost (T14) which was significantly superior under the Control (T1), 75% RDF (T3), FYM alone (100% N through

FYM (T5), Vermicompost alone (100% N through Vermicompost (T6), 75% RDF + 25 % N through FYM (T7), 75% RDF + 50 % N through FYM (T9), 75% RDF + 25 % N through Vermicompost (T11) while at par with 100% RDF (120:60:60:30 NPKS kg ha-1) (T2), 125% RDF (T4), 100% RDF + 25 % N through FYM (T8), 100% RDF + 50 % N through FYM (T10), 100% RDF + 25 % N through Vermicompost (T12), 75% RDF + 50 % N through Vermicompost (T13) of the treatment in both the year and pooled also. The lowest Leaf area index of Mustard crop (0.30) was recorded with control (T1).

It is also clear from the table that application of increasing dose of fertility levels along with FYM and Vermicompost increase the plant height of mustard crop.

Table- 2: Leaf Area Index

Treatments	**Leaf area index at 30 DAS**			**Leaf area index at 60 DAS**			**Leaf area index at 90 DAS**		
	2021-2022	**2022-2023**	**Pooled**	**2021-2022**	**2022-2023**	**Pooled**	**2021-2022**	**2022-2023**	**Pooled**
T1	0.3	0.31	0.3	0.73	0.73	0.73	0.23	0.43	0.3
T2	0.6	0.7	0.66	1.46	1.567	1.53	0.5	0.6	0.56
T3	0.5	0.56	0.53	1.3	1.4	1.36	0.4	0.5	0.46
T4	0.63	0.73	0.66	1.5	1.6	1.56	0.53	0.63	0.56
T5	0.53	0.56	0.56	1.36	1.43	1.4	0.43	0.5	0.5
T6	0.56	0.56	0.56	1.4	1.46	1.43	0.46	0.5	0.5
T7	0.56	0.6	0.6	1.4	1.5	1.46	0.5	0.53	0.5
T8	0.66	0.73	0.7	1.5	1.6	1.56	0.56	0.63	0.6
T9	0.56	0.63	0.6	1.4	1.56	1.5	0.5	0.56	0.53
T10	0.66	0.76	0.73	1.56	1.6	1.6	0.56	0.66	0.63
T11	0.6	0.6	0.6	1.43	1.5	1.46	0.5	0.56	0.53
T12	0.66	0.76	0.73	1.53	1.63	1.6	0.56	0.63	0.6
T13	0.6	0.66	0.63	1.46	1.56	1.53	0.53	0.56	0.56
T14	0.66	0.76	0.73	1.6	1.7	1.66	0.6	0.66	0.63
SE(m)±	0.03	0.02	0.02	0.06	0.06	0.05	0.02	0.02	0.02
CD at 5%	0.09	0.08	0.07	0.18	0.18	0.14	0.07	0.08	0.07

Leaf area index is indicative of the crop's photosynthetic potential. The study showed that treatments involving vermicompost consistently resulted in higher LAI values compared to the control. Specifically, 100% RDF with 50% N through vermicompost (T14) exhibited the highest LAI values at multiple stages of growth followed by 100% RDF and 50% N through FYM (T10) in both the year and pooled also. Whereas the lowest Leaf area index was recorded over Control (No fertilizer and no organic source) T1. This suggests that vermicompost supplementation enhanced the crop's ability to capture sunlight, which can lead to improved photosynthesis and ultimately higher yields**. Singh *et al*., (2011)** reported that combining FYM with recommended doses of fertilizers significantly increased plant height, total dry matter accumulation, leaf area index, and seed yield compared to fertilizer application alone.

Table-3. Crop growth rate (g m^{-2} day^{-1})

Treatments	**Crop growth rate (g m^{-2} day^{-1}) at 0-30 DAS**			**Crop growth rate (g m-2 day - 1) at 30-60 DAS**			**Crop growth rate (g m-2 day - 1) at 60-90 DAS**		
	2021-2022	**2022-2023**	**Pooled**	**2021-2022**	**2022-2023**	**Pooled**	**2021-2022**	**2022-2023**	**Pooled**
T1	0.4	0.5	0.46	3.4	3.9	3.66	8	9.33	8.66
T2	1.2	1.46	1.33	9.9	11.3	10.6	23.86	27.2	25.53
T3	1.0	1.23	1.133	9.16	10.1	9.63	22.43	24.9	23.66
T4	1.13	1.43	1.3	10.43	12.2	11.3	24.5	28.16	26.3
T5	1.1	1.3	1.2	9.26	10.3	9.8	22.76	25.33	24.06
T6	1.1	1.33	1.23	9.36	10.6	10	22.96	25.73	24.36
T7	1.13	1.33	1.23	9.4	10.8	10.1	23.16	26.2	24.66
T8	1.2	1.5	1.36	10.43	12.2	11.3	24.56	28.73	26.66
T9	1.13	1.4	1.3	9.8	11.03	10.4	23.66	26.76	25.23
T10	1.233	1.5	1.4	11.3	13.5	12.4	26.4	31.46	28.9
T11	1.133	1.4	1.267	9.66	10.867	10.3	23.46	26.26	24.9
T12	1.233	1.5	1.4	10.96	12.93	11.96	26.2	30.96	28.6
T13	1.13	1.4	1.3	9.9	11.3	10.6	23.86	27.23	25.56
T14	1.23	1.533	1.4	11.5	13.767	12.63	26.6	31.76	29.16
SE(m)±	0.02	0.05	0.04	0.37	0.433	0.403	0.88	1.03	0.955
CD at 5%	0.08	0.16	0.13	1.09	1.266	1.177	2.599	3.01	2.79

The data pertaining to Crop Growth Rate and Relative Growth Rate of Mustard crop was recorded at 30, 60 and 90 DAS is presented in table-3 and table-4, respectively. CGR and RGR are critical indicators of crop growth and vigour. The results revealed that 100% RDF with 50% N through vermicompost (T14) consistently had the highest CGR values at various growth stages. This indicates that the combination of 100% RDF and 50% N through vermicompost (T14) significantly stimulated crop growth rate. The results revealed that 100% RDF with 50% N through vermicompost (T14) consistently had the highest RGR values at various growth stages. This indicates that the combination of 100% RDF and 50% N through vermicompost (T14) significantly stimulated Relative Growth Rate. The positive influence of vermicompost on nutrient availability and soil health likely contributed to these results. **Patel *et al.*, (1996)** found that FYM application increased leaf area index (LAI), crop growth rate (CGR), and dry matter accumulation per plant during different growth phases.

Table-4. Relative Growth Rate (g g^{-1} day^{-1})

Treatments	**Relative growth rate (g g^{-1} day^{-1}) at 0-30DAS 0-30 DAS**			**Relative growth rate (g g^{-1} day^{-1}) at 30-60 DAS**			**Relative growth rate (g g^{-1} day^{-1}) at 60-90 DAS**		
	2021-2022	**2022-2023**	**Pooled**	**2021-2022**	**2022-2023**	**Pooled**	**2021-2022**	**2022-2023**	**Pooled**
T1	0.01	0.044	0.027	0.04	0.046	0.043	0.044	0.051	0.047
T2	0.06	0.063	0.061	0.061	0.065	0.063	0.063	0.067	0.065
T3	0.035	0.07	0.052	0.068	0.072	0.07	0.07	0.074	0.072
T4	0.087	0.082	0.084	0.08	0.067	0.073	0.082	0.086	0.084
T5	0.04	0.063	0.051	0.058	0.053	0.055	0.063	0.069	0.066
T6	0.05	0.065	0.057	0.063	0.084	0.073	0.065	0.069	0.067
T7	0.052	0.051	0.051	0.049	0.073	0.061	0.051	0.055	0.053
T8	0.088	0.082	0.085	0.08	0.085	0.082	0.065	0.069	0.067
T9	0.057	0.071	0.064	0.069	0.086	0.077	0.051	0.055	0.053
T10	0.09	0.063	0.076	0.064	0.046	0.055	0.082	0.086	0.084
T11	0.055	0.058	0.056	0.061	0.065	0.063	0.071	0.075	0.073
T12	0.089	0.067	0.078	0.068	0.072	0.07	0.083	0.087	0.085
T13	0.058	0.071	0.064	0.08	0.084	0.082	0.082	0.086	0.084

T14	0.092	0.084	0.088	0.051	0.054	0.052	0.053	0.055	0.054
SE(m)±	0.014	0.016	0.015	0.015	0.014	0.014	0.014	0.014	0.014
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

Conclusions:

The study showed that treatments involving vermicompost consistently resulted in higher LAI values compared to the control. It is also suggested that vermicompost supplementation enhanced the crop's ability to capture sunlight, which can lead to improved photosynthesis and ultimately higher yields. CGR are critical indicators of crop growth and vigour. The results revealed that 100% RDF and 50% N through vermicompost gave best CGR value. It is also suggested that vermicompost supplementation enhanced the crop's ability to capture sunlight, which can lead to improved CGR. The whole study revealed that the combination of 100% RDF with 50% N through vermicompost emerged as the most promising nutrient management approach for good mustard growth.

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