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Growth, physiological parameters and productivity of mustard as influenced by various organic sources of nutrients

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Abstract

The present study was carried out during 2019-20 to assess the effect of organic sources of nutrients on growth, physiological parameters and productivity of Indian mustard. Seven treatments,*viz. Jivamrat* @ 500 litre/ha, *Azotobacte*, FYM @ 5 t/ha, *Jivamrat* + *Azotobacte*, *Jivamrat* + FYM @ 5 t/ha, *Jivamrat* + *Azotobacte* + FYM @ 5 t/ha and control were accommodated in a randomized block design with three replications. Result revealed that the growth parameters including plant height, number of leaves, primary and secondary branches were recorded maximum with *Jivamrat* + FYM + *Azotobacte*. Further results also revealed that the physiological parameters including leaf area index and SPAD reading were recorded maximum with *Jivamrat* + FYM + *Azotobacte*. Seed yield and stover yield were also recorded the highest with *Jivamrat* + FYM + *Azotobacte*. Therefore, it can be concluded that combine application of *Jivamrat* @ 500 litre/ha and FYM @ 5 t/ha with *Azotobacte* was found to be more productive in semi-arid regions of Rajasthan.

Keywords: *Biofertilizers,farm yard manure, jivamrat,mustard, yield*

Introduction

Mustard is a winter season crop that require relatively cool temperature, a fair supply of soil moisture during its growing season and a dry period during harvest.Mustard is predominantly cultivated in Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh and Gujarat.It is also grown under some non-traditional area of south India including Karnataka, Tamil Nadu, Andhra Pradesh. India is fourth largest vegetable oil economy in the world next to USA, China and Brazil. Globally, it is grown on 41.95 mha area and contribute 88.35 mt in oilseed basket with average yield of 2110 kg/ha (FAOSTAT, 2022). In India, it is cultivated on 7.99 mha area and contribute 11.96 mt in production with average yield of 1497 kg/ha (Anonymous, 2022). Rapeseed-mustard is also an important oilseed crop of India sharing second position in area (25%) and third in production (24%) among total oilseeds.

Organic manures play important role in crop production. In organic farming generally use of organic inputs like FYM, vermi-compost, compost, crop residues and *Jivamrat* etc. are very well known for supplying the N in major quantity and also improve physical, chemical and biological properties of the soil and also improve productivity of crops on sustainable basis(Poktile, 2017; Dotaniya *et al.*, 2025).The use of organic manure not only helps to sustain crop yield but also plays a key role by exhibiting both direct as well as indirect influence on the nutrients availability in soil by improving the physical, chemical and biological properties of soil (Singh and Biswas, 2000). Organic manures generally improve the soil physical and biological properties along with conserving the moisture holding capacity of soil and thus resulting in enhanced crop productivity along with maintaining the quality of crop produce. *Jivamrat* contains enormous amount of microbial load which multiply and act as a soil tonic. It is said to enhance microbial activity in soil and ultimately ensuring the availability and uptake of nutrients by the crops (Choudhary *et al.,* 2024a & 2024b).Farmyard manure provides all essential plant nutrients including micronutrients and it also improves soil physical, chemical and biological environment of soil for favorable crop growth and yield. It is also known to accelerate the respiratory process that increase cell permeability and hormonal growth action or by combination of all these processes. It improves the chemical and biological conditions of soil increasing cation exchange capacity and providing various, vitamins, hormones and organic acids which are very important for soil aggregation and beneficial micro-organism which involved in various bio-chemical process and release of nutrients. *Azotobacter* plays an important role in increasing the availability of nitrogen to the plants and helps in boosting the production through nitrogen fixation. Similarly, Inoculation with phosphate solubilizing bacteria (PSB) plays a pivotal role in supplementary phosphorus requirement of crop. Bio-fertilizers have the potential to solubilize / mobilize major nutrients such as nitrogen and phosphorus in addition to micro nutrients and thus act as nutrient flow regulator in nature. (Meena *et al.,* 2013).

Azotobacter chroococum non–symbiotic nitrogen fixing agro–microbe having potential to fix combined quantities of atmospheric nitrogen in rizoshpere of non–legumes. *Azotobacter* synthesizes various growth hormones, antifungal substances and siderophores that favorably affect crop growth (Sunil *et al*., 2016). Due to low-cost of these inputs, crop production could be economized. These biofertilizers also improve the fertilizer use efficiency as well as the soil health. Keeping above facts in view, the present investigation was planned and carried out with aim to assess the effect of organic sources of nutrients on productivity and profitability of mustard.

Materials and Methods

The field experiment was conducted during *Rabi* season of 2019-20 at research farm of ICAR-Directorate of Rapeseed-Mustard Research, Bharatpurlocated at 77°3' E longitude, 27°15' N latitude and at an altitude of 178.37 meter AMSL. The region falls under Agro Climatic Zone III a (semi-arid Eastern plain) with sub-tropical and semi-arid climate.Weather parameters play a great role in affecting growth and development process of crop; hence it is important to present climatic variables. The mean weekly maximum and minimum temperature during the crop growing season of mustard fluctuated between 20.8 to 40.9°C and 7.0 to 25.1°C. The mean daily evaporation from 'USWB class A' pan evaporimeter ranged from 1.0 to 9.7 mm per day. The average relative humidity fluctuated between 20.4 to 57.8 percent at noon. The bright sunshine hours varied from 5.9 in January to 10.3 in April. There was very low rainfall received during the month of October 5.3 mm and 37.4 mm in January.

There were seven treatments viz. *Jivamrat* @ 500 litre/ha (T_1), Bio-fertilizer- *Azotobacte* (T_2), farm yard manure (FYM) @ 5 t/ha (T_3), *Jivamrat*+ Bio-fertilizer (T_4), *Jivamrat*+ FYM @ 5 t/ha (T_5), *Jivamrat* + Bio-fertilizer+FYM @ 5 t/ha (T_6) and control (T_7). Variety 'Giriraj' was used for sowing purpose. The randomized block design was laid out with three replications. Plot size was 7 m ×4 m. The line to line spacing was used 45 cm and plant to plant was 10-15 cm and distance between two replications was 2 meters.The soil of experimental site wasloamy sand in texture and slightly alkaline in reaction (pH 8.2). The soil was medium in organic carbon (0.35%), low in available nitrogen (124.7 kg/ha), medium in available phosphorus (16.9 kg/ha)and medium in available potassium (152.5 kg/ha). While the available sulphur content of the soil (8.3 ppm) indicated its deficiency. The FYM refers to decomposed mixture of dung and urine of farm animals along with the litter (bedding material) and left-over material from roughages or fodder fed to the cattle. FYM collected daily from cattle shed consists mainly of dung and part of the urine soaked in the refuse. Newly collected and stored FYM is fresh as against well decomposed FYM which has been stored for a sufficient period of time to allow its decomposition to completion. On an average well-rotted FYM contain 0.48 % N, 0.2 % P_2O_5, and 0.45 % K_2O. FYM 5 t/ha was applied 15 days before sowing as per the treatments. The ingredients of *Jivamrat* viz., cowdung: 10 kg, jaggery: 2 kg, legume flour: 2 kg, cow urine: 10 liter, soil: 1 kg was put into a drum containing 200 litres water. After covering the drum with lid was kept in shade and stirred thrice a day. After a week, the *jivamrat* was ready and was used for soil application. *Jivamrat* was applied @ 500 litre ha^{-1} the time of irrigation.The seeds were inoculated by *Azotobactor spp.* as per the treatment. The seeds were dried in shade and sown with depth 3 to 4 cm. Before sowing, the seeds of mustard were treated with bavistin @ 2 g/kg seed to prevent seed borne diseases.The seed rate was 4 kg/ha. The crop was sown on 3 November 2019.Thinning was done in two phases; in first phase the dense emerging seedlings were thinned out at 15 days after sowing (DAS). At second phase thinning and gap filling was completed at 25 DAS in order to maintain plant to plant distance 10-15 cm.To eliminate weeds in all the plots of experimental area, one hoeing was done at 25 DAS.One pre sowing irrigation was given and two irrigations were applied to the cropat pre-flowering and pod formation stages.The crop was harvested when the seeds were fully ripened. At the time of harvesting, first of all border rows were harvested around the individual plots leaving the net plot. The crop from the net plots were harvested, bundled separately and tagged.The bundles of the harvested crop were weight after drying in the sun. The threshing was done manually by beating the bundles of produce with stick for yield measurements.

Observation recorded

In each treatment from net plot for recording observation at regular interval, two sampling area i.e. one from first irrigation and other two irrigations were marked. The observations like plant height, leaf area index, chlorophyll content and number of primary and secondary branches per plant were taken from both areas apart from net plot. For recording growth parameter of 3 plants from both net plot area was selected randomly and tagged and their observation were recorded at 45, 60, 90 DAS and at harvest. Yield and yield attributing character were recorded after harvest. Plant height of three randomly tagged plants was measured from base of plant up to the growing tips of main stem of randomly tagged plants and average height was recorded in cm. The number of functional green leaves per plant were counted on the three representative plants and expressed as average number of leaves per plant. Three randomly tagged plants were used for the number of primary and secondary branches were counted at maturity stage from the same three tagged plants (used for plant height) and average was worked out. The chlorophyll content was measured with SPAD chlorophyll meter reading (SCMR) at 45 days interval after 60 and 90 DAS. SCMR data were recorded on top, middle and bottom leaf each representative plant, between 9.00 to 11.00 am of the day. Reading form three tagged plants per plot were taken. The leaf area of three plants was measured by leaf area meter and leaf area index was calculated by the following formula and by using formula given by Watson (1947).

$$\text{LAI} = \frac{\text{Leaf area per plant}}{\text{Land area occupied per plant}}$$

The seed yield of per plot was converted to determine the yield per hectare in q/ha.The difference between the total biological yield and seed yield gives the value of stover yield, represented in q/ha. The weight of the thoroughly sun-dried harvested produce of each net plot was recorded separately before threshing as biological yield. This was converted in to q/ha.

Statistical analysis

The experimental data obtained during the course of study were subjected to statistical analysis by applying the technique of analysis of variance (ANOVA) prescribed for the RBD design to set the significance of the overall differences among treatments as suggested by Panse and Sukhatme (1967) and the treatment was tested by F test shown their significance where critical difference (CD) at 5% level of significance was determined for each character to compared the differences among treatment means.

Results and Discussion

Growth and physiological parameters

Growth of a plant can be manifested in many ways. Simple way to measure the growth is by recording height. The height is controlled genetically and it can be modified by environment and application of nutrient source. Plant height gradually increased with the advancement in the growth stage up to 90 DAS under all treatment. The senescence of plant might be also the reason for a little reduction in plant height at maturity stage. The treatment T_6 (*Jivamrat* + FYM + Bio-fertilizer) recorded significantly highest plant height 61.43, 150.10, 219.80 and 216.16 cm at 45, 60, 90 DAS and harvest stage followed by T_5 jivamrat + FYM treatment. Application of Bio-fertilizer in combination with FYM and jivamrat increased the plant height by 6.17, 14.84, 12.28 and 11.56 percent over control at 45, 60, 90 DASand harvest stages. These findings are in close conformity with those reported by Singh and Kanaujia, (2009), Pathak and Godika (2010). Number of leaves indicates the assimilatory apparatus of plant. Determination of number of leaves provides the photosynthetic surface area. Higher number of leaves absorb more light interception. Lower the number of leaves apparently brings production as net assimilation is relatively low. The data on number of leaves (plant^{-1}) had increased with the advanced in the growth stage up to 90 DAS. The emergence of new leaves almost stopped after 90 DAS because the conversion of vegetative phase of crop into reproductive phase by the time. Highest number of leaves 16.63, 35.46, and 48.60 was recorded under the treatment T_6 (*Jivamrat* + FYM + Bio-fertilizer) at 45, 60, 90 DASfollowed by T_5 jivamrat + FYM treatment. It was observed that application of Bio-fertilizer in combination

Table 1: Effect of organic sources of nutrients on growth parameters of mustard

Treatments	Plant height (cm)				Number of leaves			Branches/Plant	
	45 DAS	60 DAS	90 DAS	At harvest	45 DAS	60 DAS	90 DAS	Primary	Secondary
Jivamrat (T_1)	59.5	134.3	200.2	198.8	14.6	30.3	42.7	6.1	17.9
Azotobacte (T_2)	59.4	132.6	197.4	196.5	13.5	29.2	41.7	5.7	17.5
FYM @ 5 t/ha (T_3)	60.3	139.2	204.6	202.3	15.4	32.8	44.7	6.8	18.7
Jivamrat + *Azotobacte* (T_4)	59.7	135.9	202.1	199.9	14.8	31.3	43.5	6.4	18.4
Jivamrat+ FYM (T_5)	60.1	142.4	207.8	205.4	15.9	34.0	45.9	7.1	19.3
Jivamrat + FYM + *Azotobacte* (T_6)	61.4	150.1	219.8	216.1	16.6	35.4	48.6	7.3	20.2
Control (T_7)	57.8	130.7	195.7	193.7	13.1	27.3	40.6	5.4	17.1
SEm(±)	0.34	0.76	1.10	1.00	0.16	0.38	0.29	0.09	0.11
LSD (P = 0.05)	1.08	2.37	3.44	3.12	0.51	1.19	0.93	0.28	0.34

Table 2: Effect of organic sources of nutrients on physiological parameters and seed yield of mustard

Treatments	Leaf area index			Chlorophyll content SPAD			Seed yield	Stover yield
	45 DAS	60 DAS	90 DAS	45 DAS	60 DAS	90 DAS	(q/ha)	(q/ha)
Jivamrat (T_1)	2.80	4.36	3.43	39.6	42.5	44.4	17.43	43.60
Azotobacte (T_2)	2.43	4.20	3.26	38.7	41.4	43.3	16.17	41.33
FYM @ 5 t/ha (T_3)	3.23	5.20	3.70	41.6	44.5	45.9	21.40	52.23
Jivamrat + *Azotobacte* (T_4)	3.03	4.63	3.60	40.1	43.5	45.7	19.23	47.33
Jivamrat+ FYM (T_5)	3.60	5.43	3.80	42.7	45.8	46.8	23.00	55.23
Jivamrat + FYM + *Azotobacte* (T_6)	3.80	5.60	4.06	44.2	47.9	49.3	25.10	58.70
Control (T_7)	2.20	4.10	3.10	38.4	40.6	42.4	13.87	37.27
SEm(±)	0.08	0.12	0.06	0.21	0.17	0.33	0.23	0.71
LSD (P = 0.05)	0.26	0.40	0.19	0.67	0.53	1.04	0.73	2.20

with FYM and jivamrat increased the number of leaves by 26.36, 29.89 and 19.52 percent over control at 45, 60 and 90 DAS. Similar results were also found by Hamid *et al*. (2003).

Chlorophyll content of leaves recorded by SPAD meter. Among different treatments, treatment T_6 (*Jivamrat* + FYM + Bio-fertilizer) recorded significantly highest chlorophyll content 44.26, 47.93 and 49.36 percent recorded at 45, 60, 90 DASfollowed by T_5 *Jivamrat* + FYM treatment due to increase the size of leaves and more photosynthesis at this stage. Similar findings were also reported by Kumawat *et al*.(2014). Treatment T_6 (*Jivamrat* + FYM + Bio-fertilizer) recorded significantly highest number of primary branches *i.e.* 7.30 followed by T_5 (*Jivamrat* + FYM). Treatment T_6 (jivamrat + FYM + Bio-fertilizer) recorded significantly highest number of secondary branches *i.e.* 20.23 followed by T_5 *Jivamrat* + FYM treatment. Results revealed that the application of treatment T_6 increase the number of secondary branches by 18.30 percent over control. Similar findings were also reported by Reddy *et al*. (2011) and Sahay *et al.* (2016). The leaf area index (LAI) was recorded at 45, 60, 90 DAS. Leaf area index was found to be higher at 60 DAS and marginally decrease after 60 DAS in all treatments. It is indicated that treatment T_6 (*Jivamrat* + FYM + Bio-fertilizer) recorded significantly highest leaf area index (LAI) 3.80, 5.60 and 4.06 recorded at 45, 60 and 90 DAS followed by T_5 *Jivamrat* + FYM treatment. Results indicated that treatment T_6 significantly increased LAI by 72.73, 36.58 and 30.96 percent over control at 45, 60 and 90 DAS respectively. Similar findings were also reported by Rao and Shaktawat, (2001) and Tripathi *et al.* (2011).

Seed and stover yield

Results (Table 2) showed that treatment T_6 (*Jivamrat* + FYM + Bio-fertilizer) recorded significantly highest seed yield (25.10 q/ha) followed by T_5 treatment (*Jivamrat* + FYM). Results also revealed that, the application of treatment T_6 increased the seed yield by 81.0% over the control. The significantly higher seed yield of mustard in T_6 was due to significantly higher values of yield attributes. Similar findings were also reported by Saini *et al.* (2017), Singh *et al.* (2018) and Mhetre *et al.* (2019). Results revealed that treatment T_6 recorded significantly highest stover yield (58.70 q/ha) followed by T_5 treatment. Further, the application of treatment T_6 increased the stover yield by 57.49% over control. Similar findings were also reported by Pradhan *et al.* (2017), Beenish *et al.* (2018) and Mhetre *et al.* (2019).

Conclusion

The growth and physiological parametersincludingplant height, number of leaves, primary and secondary branches, leaf area index and SPAD reading were recorded maximum with the application of *Jivamrat* + FYM + Bio-fertilizer (*Azotobacte*). Further, theseed yield and stover yieldwere also calculated highest with the application of *Jivamrat* + FYM + *Azotobacte*. Thus, it can be concluded that combined application of *Jivamrat* @ 500 liter/ha and FYM @ 5 t/ha with bio-fertilizer (*Azotobacte*) was found to be more beneficial to enhance the productivity of mustard in semi-arid regions of Rajasthan.

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