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Productivity and profitability 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 productivity and profitability of Indian mustard. Seven treatments, *viz. Jivamrat* @ 500 litre/ha, *Azotobactor*, FYM @ 5 t/ha, *Jivamrat* + *Azotobactor*, *Jivamrat* + FYM @ 5 t/ha, *Jivamrat* + *Azotobactor* + FYM @ 5 t/ha and control were accommodated in a randomized block design with three replications. Result revealed that yield attributes like number of siliquae/plant, number of seeds/siliqua, weight of seeds/plant, and test weight, were recorded maximum with *Jivamrat* + FYM + *Azotobactor*. Further, seed yield, stover yield, biological yield and harvest index were also recorded the highest with *Jivamrat* + FYM + *Azotobactor*. The treatment *Jivamrat* + FYM + *Azotobactor* had investment of Rs. 32925/ha to grow mustard crop and also fetched higher net returns of Rs. 54925/ha with maximum B:C ratio (2.67). Therefore, it can be concluded that combine application of *Jivamrat* @ 500 litre/ha and FYM @ 5 t/ha with *Azotobactor* was found to be more productive and profitable 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 are playing 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). 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.,* 2024). 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, Bharatpur located at 77°3' E longitude, 27°15' N latitude and at an altitude of 178.37 m 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- *Azotobactor* @ 500 g/ha (T_2), farm yard manure (FYM) @ 5 t/ha (T_3), *Jivamrat* @ 500 litre/ha + *Azotobactor* @ 500 g/ha (T_4), *Jivamrat* @ 500 litre/ha + FYM @ 5 t/ha (T_5), *Jivamrat* @ 500 litre/ha + *Azotobactor* @ 500 g/ha + 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 7×4 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 was loamy 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 were 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} at 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 born 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 crop at 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

The three tagged plant were harvested from each net plot area were selected randomly and tagged and their observation were recorded. Total numbers of siliquae on tagged plants were counted and average number of siliquae per plant was recorded. Length of three siliquae was measured from tagged plant with a linear scale in the form of mean length (cm). Three siliquae were split open from each tagged plant and the number of seed was counted and the mean was expressed. The stem girth (cm), seed weight and test weight were also recorded. Each bundle from the net plot was threshed separately and after winnowing the seed yield of each plot was obtained. 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. Harvest index is the economic yield expressed as percentage of biological yield and calculated as follows. It is expressed in percentage.

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (q/ha)}}{\text{Biological yield (q/ha)}} \times 100$$

Where; Economic yield = seed yield (q/ha), Biological yield = seed yield + stover yield (q/ha)

Economics

Economics of different treatments were worked out in terms of cost of cultivation, gross monetary returns (GMR), net monetary returns (NMR), and benefit-cost ratio (B:C) on per hectare area basis to ascertain the economic viability of the treatments. The cost of cultivation for each treatment is determined on the basis of different inputs used for raising the crops under different treatments on one hectare area basis. The values realized from the produce obtained under each treatment was computed on the basis of existing market price of the produce (both seed and stover) as the GMR. The NMR per hectare under each treatment were determined by subtracting the cost of cultivation of a particular treatment from the GMR of the same treatment.

Net monetary returns =Gross monetary returns - Total cost of cultivation

To estimate the benefits obtained from different treatment for each rupee of expenditure in cured, B:C ratio of each treatment was calculated as below:

$$\text{B:C ratio} = \frac{\text{Gross monetary returns (Rs./ha)}}{\text{Total cost of cultivation (Rs./ha)}}$$

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

Effect of *Jivamrat*, FYM and bio-fertilizer on yield attributes and yield of mustard

Among different treatments, number of siliquae/plant were found more in *Jivamrat* + FYM + Bio-fertilizer (*Azotobacter*) treatment (T_6) which was followed by *Jivamrat* + FYM treatment (T_5) (Table 1). Results revealed that T_6 recorded significantly highest number of siliquae/plant (342) followed by T_5 treatment. Data revealed that the application of treatment T_6 increased total number of siliquae/plant by 14.8 % over the control. Similar findings were also reported by Hadiyal *et al.* (2017) and Singh *et al.* (2018). The highest length of siliqua (5.0 cm) was recorded under the treatment T_6 followed by T_5. Application of treatment T_6 increased total number of siliquae/plant by 25.0 % over control. Similar findings were also reported by Patel and Shelke (1998). It was observed that treatment T_6 recorded significantly highest number of seeds/siliqua (16.2) followed by T_5 treatment. Data analysis indicates that the application of treatment T_6 increased total number of seeds/siliqua by 7.0 % over control. Similar findings were also reported by Hadiyal *et al.* (2017). Treatment T_6 recorded significantly maximum girth (6.90 cm) followed by T_5 treatment. Results revealed that the application of treatment T_6 increased the girth by 23.2 % over control. It was observed that treatment T_6 recorded significantly highest seed weight/plant (29.5) followed by T_5 treatment. Data analysis indicates that the application of treatment T_6 increased seed weight/plant by 31.7 % over control. Similar findings were also reported by Singh and Kanaujia (2009) and Potkile *et al.* (2017). It has been observed that significantly highest test weight 4.80 g was recorded under the treatment T_6 followed by T_5 treatment. Results revealed that the application of treatment T_6 increased the test weight by 24.0 % over control. Similar findings were also reported by Saini *et al.* (2017).

Results (Table 2) revealed that treatment T_6 (*Jivamrat* + FYM + *Azotobacter*) recorded significantly highest seed yield (25.10 q/ha) followed by T_5 treatment (*Jivamrat* + FYM). Results 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. Results revealed that 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). Results revealed that treatment T_6 recorded significantly highest biological yield (83.80 q/ha) followed by T_5 treatment. Results revealed that the application of treatment T_6 increased the biological yield by 63.89 % over control. Premi *et al.* (2005) also reported that the application of vermicompost at 5.0 t/ha + 75 % recommended dose of FYM recorded maximum plant height, number of primary and secondary

Table 1: Effect of organic sources of nutrients on yield attributes of mustard

Treatments	Number of siliquae/plant	Siliqua length (cm)	Number of seeds/siliqua	Girth (cm)	Seed weight/ plant (g)	Test weight (g)
Jivamrat (T1)	308	4.3	15.3	6.0	24.3	4.20
Azotobactor (T2)	306	4.2	15.2	5.8	23.2	4.00
FYM @ 5 t/ha (T3)	322	4.7	15.7	6.3	26.4	4.40
Jivamrat + *Azotobactor* (T4)	314	4.5	15.5	6.2	26.1	4.30
Jivamrat + FYM (T5)	331	4.8	15.9	6.6	27.9	4.60
Jivamrat + FYM + *Azotobactor* (T6)	342	5.0	16.2	6.9	29.5	4.80
Control (T7)	299	4.0	15.1	5.6	22.4	3.87
SEm±	1.1	0.04	0.02	0.04	0.30	0.05
CD (P = 0.05)	3.3	0.13	0.08	0.12	0.93	0.15

Table 2: Effect of organic sources of nutrients on productivity and economics of mustard

Treatments	Seed yield (q/ha)	Stover yield (q/ha)	Biological yield (q/ha)	Harvest index (%)	Cost of cultivation (Rs./ha)	Gross monetary returns (Rs./ha)	Net monetary returns (Rs./ha)	B:C ratio
Jivamrat (T1)	17.43	43.60	61.03	22.22	31425	61017	29592	1.94
Azotobactor (T2)	16.17	41.33	57.50	21.95	29925	56583	26658	1.89
FYM @ 5 t/ha (T3)	21.40	52.23	73.63	22.51	30425	74900	44475	2.46
Jivamrat + *Azotobactor* (T4)	19.23	47.33	66.57	22.42	31925	67317	35392	2.11
Jivamrat + FYM (T5)	23.00	55.23	78.23	22.72	32425	80500	48075	2.48
Jivamrat + FYM + *Azotobactor* (T6)	25.10	58.70	83.80	23.06	32925	87850	54925	2.67
Control (T7)	13.87	37.27	51.13	21.33	29425	48533	19108	1.65
SEm±	0.23	0.71	0.81	0.18	-	-	-	-
CD (P = 0.05)	0.73	2.20	2.52	0.55	-	-	-	-

branches/plant, number of siliquae/plant and number of seeds/siliquae. The harvest index of mustard was higher in T_6 and found superior over other treatments. Further, application of treatment T_6 increased the harvest index by 8.1 % over control. Similar findings were also reported by Saini *et al.* (2017).

Effect of *Jivamrat*, FYM and bio-fertilizer on economics

The determination of economic indices like cost of cultivation, gross monetary returns (GMR), net monetary returns (NMR) and B:C ratio are the most important parameters to evaluate the effect of the treatments for practical purpose particularly from farmers as well as planner point of view. The farmers mainly interested to earn more profit per unit area, per unit time and investment. The common cost of cultivation of mustard was Rs. 29425/ha (Table 2). However, it was varied with different treatments. The maximum investment of Rs 32925/ha was recorded with treatment T_6, while minimum investment of Rs. 29425/ha was incurred under the treatment T_7. The higher GMR was calculated in the treatment T_5 (Rs. 87850/ha) followed by T_5 (Rs. 80500/ha) and T_3 (Rs. 74900/ha), while the least GMR was calculated in the treatment of T_7 (Rs. 48533/ha). The maximum NMR (Rs. 54925/ha) was calculated in the treatment of T_6 followed by T_5 (Rs. 48075/ha) and T_3 (Rs. 44475/ha), while the least NMR was calculated in the treatment T_7 (Rs. 19108/ha). The treatment T_6 attained the maximum value of GMR and NMR which was closely followed by T_5 due to higher seed yield. The related research work done by Potkile et al. (2017). The B:C ratio was found highest in the treatment of T_6 (2.67) followed by T_5 (2.48) and T_3 (2.46) due to proportionate increase in profit with each rupee of investment. The related research work done by Potkile *et al.* (2017) and Saini *et al.* (2017).

Conclusion

The yield attributes like number of siliquae/plant, number of seed/siliqua, weight of seeds/plant and test weight were recorded maximum with the application of *Jivamrat* + FYM + bio-fertilizer (*Azotobactor*). Further, the seed yield, stover yield, biological yield and harvest index were also calculated highest with the application of *Jivamrat* + FYM + *Azotobactor*. The *Jivamrat* + FYM + *Azotobactor* also fetched the highest net monetary returns (Rs. 54925/ha) with the maximum B:C ratio (2.67). Thus, it can be concluded that combined application of *Jivamrat* @ 500 liter/ha and FYM @ 5 t/ha with bio-fertilizer (*Azotobactor*) was found to be more productive and profitable in semi-arid regions of Rajasthan.

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