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Effects of bio-organics and micronutrients on yield attributes and yield of mustard under Eastern plain Zone of Rajasthan

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Abstract

A field experiment was conducted under loamy sand soil during two consecutive *rabi* seasons at Agronomy Farm, S.K.N. of College of Agriculture, Jobner, India. The experiment comprising 20 treatments combination replicated three times, was laid out in split-plot design with five treatments of bio-organic (control, FYM @ 10 t/ha, vermicompost @ 5 t/ha, FYM @ 10 t/ha + *Azotobacter*+ VAM and vermicompost @ 5 t/ha+ *Azotobacter*+ VAM) and four treatments of micronutrients (Control, $ZnSO_4$ @ 25 kg/ha, $FeSO_4$ @ 50 kg/ha and $ZnSO_4$ @ 25 kg/ha + $FeSO_4$ @ 50 kg/ha). The significantly highest dry matter accumulation, yield attributes, seed and stover yield of mustard over control were recorded with the application of vermicompost @ 5 t/ha+ *Azotobacter* + VAM. The application of $ZnSO_4$ @ 25 kg/ha + $FeSO_4$ @ 50 kg/ha registered significantly highest dry matter accumulation, yield attributes, seed, and stover yield over rest of the treatments. Based on the experimental results, it is concluded that for substantial improvement in yield attributes and yield of mustard individual and conjoint application of the treatment vermicompost @ 5 t/ha + *Azotobactor* + VAM (B_4) and $ZnSO_4$ @ 25 kg/ha + $FeSO_4$ @ 50 kg/ha(M_3) is required.

Keyword : *Azotobacter*, FYM, Mustard, VAM, Vermicompostand Yield

Introduction

Rapeseed and mustard [*Brassica juncea* (L.) Czern and Coss] is one of the important edible oilseed crops of India next to groundnut and soybean. The seed and oil are used as condiment in the preparation of pickles, flavoring of curries and vegetables. The oil is utilized for human consumption through northern India in cooking and frying purposes. It is also used in the preparation of hair oils, medicines, soap making, mixtures with mineral oils for lubrication and manufacture of greases. The oil cake is used as a cattle feed and manures.

There is a great scope for increasing the production of mustard by bringing more area under cultivation and its productivity by applying organic manures (FYM and vermicompost) with balanced fertilization and maintaining soil fertility status. The increased use of chemical fertilizers in agriculture has certainly enhanced the food production but it brought with it a host of problems related to micronutrient deficiency and environmental pollution. Integrated use of chemical fertilizers with organic manures could be quite promising in maintaining higher productivity and providing greater stability in crop production.

Among the organic manures, FYM is one of the most readily available traditional source and widely used by the farmers since time immemorial. Addition of organic material to the soil such as farm yard manure (FYM) helps in maintaining

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soil fertility and productivity. It increases soil microbiological activities, plays key role in transformation, recycling and availability of nutrients to the crop. Vermicompost has been advocated as good organic manure for use in the field crops. Earthworm-processed organic waste often referred to as vermicompost is peat like materials with high porosity, aeration, drainability and water holding capacity. They contain nutrients in the readily available form to the plants such as nitrate, exchangeable phosphorus, soluble K, Ca and Mg (Edwards and Burrows, 1988). They also contain biologically active substances such as plant growth regulators, vitamins and acts as powerful biocide against diseases and nematodes. Poor nutrient economy of light textured soils necessitates the need for supplementing fertilizer with organic manures.

For sustainable crop production, conjunctive use of organic, inorganic and bio-fertilizers is very much essential. Bio-fertilizers along with organic manures play an important role in sustainable agriculture. A number of micro-organisms including nitrogen fixing bacteria *i.e.Azotobacter* and *Azospirillum* have been used as bio-fertilizers to increase availability of nitrogen. Role of these bio-fertilizers in fixing nitrogen is well established. Besides, these micro-organisms secrete phytohormones and build-up the soil fertility. Mycorrhizae colonize the root cortex (affect root morphology and keep the roots functional for a longer period) to obtain carbon from host plant while assisting the plant with rapid uptake of phosphorus along with other mineral nutrients of low mobility from the soil (by extending hyphae) and their translocation to host root. Mycorrhizae also produce siderophores which chelate Fe and release P for plant availability and phosphatases which mobilize organic P compounds. Influence of combined inoculation of PSM and mycorrhizae is synergestic for many crops.

In recent soil and foliage tests indicates a wide spread deficiency of Zn particularly in the light textured soils, having low organic carbon and alkaline reaction. In many parts of country zinc is a plant nutrient now stands third in importance next to nitrogen and phosphorus. Therefore, micronutrients are considered as one of the constraints in the optimum production of crops. Zinc being one of the essential micronutrient, plays significant role in various enzymatic and physiological activity of the plant body. It is also essential for photosynthesis and nitrogen metabolism. It promotes synthesis of growth hormone, seed maturation, starch synthesis, chlorophyll synthesis and regulates water absorption. It is an important element for the stability of cytoplasmic ribosomes, cell division, dehydrogenase, proteinase and peptidase enzymes and also help in the synthesis of protein and carotene. The Fe is a structural component of porphyrin molecules, cytochromes, heams, hematin, ferrichrome and leghaemoglobin. These substances are involved in oxidation-reduction reactions in respiration and photosynthesis. It is also an important part of the enzyme nitrogenase, which is essential for nitrogen fixation. Iron in chloroplasts reflects the presence of cytochromes for performing various photosynthetic reduction processes and of ferrodoxin as an electron acceptor. The ferrodoxins are Fe-S proteins and are the first stable redox compound of the photosynthetic electron transport chain (Havlin *et al*., 1997).

Materials and Methods

A field experiment was carried out during the winter (*rabi*) seasons at S.K.N. College of Agriculture, Jobner (26^0 05′ North, longitude of 75^0 28′ East and at an altitude of 427 metres above mean sea level), Rajasthan. The soil was sandy loam having bulk density 1.52 Mg/m^3, pH 8.3. The soil was poor organic carbon (0.23%), low available nitrogen (130.5 kg/ha) and phosphorus (15.1 kg/ha) and medium in potassium (148.9 kg/ha). The experiment was laid out in split-plot design with three replications. The treatments comprising five bio-organics i.e. B_0(control), B_1 (FYM @ 10 t/ha), B_2 (Vermicompost @ 5 t/ha), B_3 (FYM @ 10 t/ha + *Azotobactor* + VAM) and B_4 (Vermicompost @ 5 t/ha + *Azotobactor* + VAM) and four micro nutrients i.e. M_0 (control), M_1 (zinc sulphate @ 25 kg/ha), M_2 (ferrous sulphate @ 50 kg/ha) and M_3 (zinc sulphate @ 25 kg/ha + ferrous sulphate @ 50 kg/ha). Mustard variety "Bio-902" was sown on 1st November and 18thOctober during 2013 and 2014, respectively. Seed @ 4 kg/ha was taken with 30 cm row spacing.

Vermicompost was applied as per treatment just before sowing. The weighed quantity of well decomposed farm yard manure (FYM) was applied as per treatments at 20 days before sowing and incorporated well in surface soil layer manually. 10-15 g of jaggery was boiled in 100 ml of water and then cooled and 50 g of culture was mixed in jaggery solution. The required quantity of seed was thoroughly mixed with the paste of culture to inoculate them with *Azotobacter* and then the seeds were allowed to dry in shade before sowing. The soil based VAM inoculation (*Glomus fasciculatum*) containing hyphae, spores, sporocarp and infected root fragments were applied to the open furrows @ 15 kg/ha (13-15 viable spore/ g inoculums) using field soil to bulk the carrier in a uniform layer at a depth of about 5 cm. Zinc and iron was applied basally through $ZnSO_4.7H_2O$ and $FeSO_4.7H_2O$ as per treatment at sowing time according to the plan of layout and incorporated in soil. The S supplied through $ZnSO_4$ and $FeSO_4$ equated by elemental sulphur to meet out the 40 kg S/ha uniformly and elemental sulphur was applied 20 days before sowing. Half dose of nitrogen and full dose P and K was applied basally before sowing and remaining half dose of N was top dressed in two splits i.e. with I^{s}t and IInd irrigation. Three irrigations were given to the crop at 35, 65 and 90 DAS by Check basin method. The crop was harvested from a net plot size of 3.0 m x 1.8 m (5.4 m^2) separately, tied in bundles and after tagging these were left on the threshing floor for sun drying. After complete drying, bundles were weighed to record biological yields. Thereafter, threshing was done by beating the plants with sticks. The seed and stover were separated by manual winnowing and yield was recorded in q/ha.

All the observation during individual years as well as in pooled analysis was statistically analyzed for their test of significance using the *F*-test. The significant of difference between treatment means were compared with t critical difference at 5 % level of probability.

Results and Discussion

Yield attributes

Effect of bio-organics

The application of treatment B_4 (Vermicompost @ 5 t/ha + *Azotobacter* + VAM) registered significant superiority in increasing dry matter accumulation, siliquae per plaant and seeds per siliqua over rest of the treatments of bio-organics (Table 1). However, above treatment was remained at par with treatment B_2 and B_3 in respect to test weight (Table 2). The beneficial response of FYM/ vermicompost to yield attributes and yield might be due to availability of sufficient amounts of plant nutrients throughout the growth

Table 1. Effect of bio-organics and micronutrients (Zn & Fe) on dry matter, number of siliquae per plant and number of seeds per siliquaof mustard

Treatments	Dry matter accumulation (g/metre row length)	Siliquae per plant	Seeds per siliqua
Bio-organics			
B_0: Control	171	143	9.61
B_1: FYM @ 10 t/ha	201	179	10.91
B_2: VC @ 5 t/ha	223	196	11.44
B_3: FYM @ 10 t/ha + Azoto. + VAM	244	210	11.91
B_4: VC @ 5 t/ha + Azoto. + VAM	266	224	12.08
SEm ±	4.71	1.58	0.03
CD (P = 0.05)	13.90	4.65	0.08
Micronutrients (Zn & Fe)			
M_0:Control	203	154	9.71
M_1:$ZnSO_4$ @ 25 kg/ha	220	196	11.45
M_2:$FeSO_4$ @ 50 kg/ha	224	194	11.38
M_3: $ZnSO_4$ @ 25 kg/ha + $FeSO_4$ @ 50 kg/ha	237	218	12.22
SEm±	3.53	1.10	0.02
CD (P = 0.05)	9.87	3.07	0.06

FYM = Farm yard manure, VC = Vermicompost, Azoto = Azotobacter, VAM = Vesicular arbuscular mycorrhiza period of the crop plants especially at critical growth periods of crops resulting in better uptake of plant nutrients, plant vigour and superior yield attributes (Rao and Sitaramaya, 2000). Treatments clearly indicated the beneficial effects of Azotobacter and VAM in presence of vermicompost and FYM. Increased dry matter in those treatments might be due to positive role of the biofertilizers in presence of organic manures supply of the required nutrients through organic source and biofertilizer facilitated balanced nutrient to the yield attributes of crop (Raj and Mallick, 2017).

Effect of micronutrients

The combined application of $ZnSO_4$ @ 25 kg/ha + $FeSO_4$ @ 50 kg/ha(M_3) produced significantly higher dry matter accumulation, siliquae per plant, seeds per siliqua and test weight over control (M_0). However, the treatment M_1 and M_2 were remained statistically at par (Table 1 & 2). The higher fertility level of the soil might have improved the growth and development of the plants by improving the uptake of essential nutrients (Ola *et al.,* 2013 and Singh and Pal, 2011).

Yields

Effect of bio-organics

The application of vermicompost @ 5 t/ha + *Azotobacter* + VAM (B_4) recorded significantly highest seed and stover yields (Table 2) over control (B_0). Significant increase in growth of plant under conjoint application of vermicompost and FYM may be attributed to the better availability of nutrients in balanced form throughout life period of the crop, effective utilization of nutrients, besides increasing microbial activity by supplying substrates to the soil available microorganisms which are responsible for mineralization of soil native status of the nutrients (Tripathi *et al.*, 2011). The ability of *Azotobactor* to produce growth substances and antifungal substances in addition to fixed N made available to plants was probably the reason of higher yields of seed and stover of the crop (Singh *et al.,* 2014). The enhanced availability of phosphate to the crop plants during the growth period may also be due to solubilisation, mineralization of soil native phosphate and potassium which might have also in turned in to higher yield potentials. The increase in seed yield due to application of vermicompost and FYM may also be due to the fact that application of vermicompost and FYM favourably improved the nutritional environment along with soil physical condition of the soil (Jat *et al.,* 2013) there by resulting in better growth and development leading to higher yield attributes and yield of seed and stover of the crop (Yadav *et al.*, 2013, Sipai *et al.*, 2017 and Kumar *et al.* 2018).

Table 2. Effect of bio-organics and micronutrients (Zn & Fe) on test weight, seed yield and stover yield of mustard

Treatments	Test weight (g)	Seed yield (q/ha)	Stover yield (q/ha)
Bio-organics			
B_0: Control	3.63	723	2273
B_1: FYM @ 10 t/ha	4.01	1205	3338
B_2: VC @ 5 t/ha	4.21	1498	3750
B_3: FYM @ 10 t/ha + Azoto.+VAM	4.40	1703	4114
B_4: VC @ 5 t/ha + Azoto.+VAM	4.42	1861	4403
SEm $\pm$	0.08	30	51
CD (P = 0.05)	0.24	87	150
Micronutrients (Zn & Fe)			
M_0: Control	3.76	930	2720
M_1: $ZnSO_4$ @ 25 kg/ha	4.16	1497	3752
M_2: $FeSO_4$ @ 50 kg/ha	4.19	1450	3710
M_3: $ZnSO_4$ @ 25 kg/ha + $FeSO_4$ @ 50 kg/ha	4.44	1716	4121
SEm$\pm$	0.07	21	36
CD (P = 0.05)	0.18	59	100

FYM = Farm yard manure, VC = Vermicompost, Azoto = Azotobacter, VAM = Vesicular arbuscular mycorrhiza

Effect of micronutrients

Application of Zn and Fe micronutrients individually or in combination significantly influenced the seed and stover yields of mustard (Table 2). Application of both micronutrients in combination ($ZnSO_4$ @ 25 kg/ha + $FeSO_4$ @ 50 kg/ha) obtained significantly higher seed and stover yields over control (Table 2). The higher fertility level of the soil might have improved the growth and development of the plants by improving the uptake of essential nutrients and translocation of sink to source and better accumulation of dry matter right from the early stage of crop growth to harvest by virtue of increased photosynthetic efficiency under this treatment (Kumar and Ahlawat, 2008, Jadhav *et al.* 2009, Baber and Dongale, 2013).

Conclusion

Based on the experimental results, it is concluded that for substantial improvement in yield attributes and yield of mustard individual and conjoint application of the treatment vermicompost @ 5 t ha^{-1} + *Azotobacter* + VAM (B_4) and $ZnSO_4$ @ 25 kg ha^{-1} + $FeSO_4$ @ 50 kg ha^{-1} (M_3) is required.

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