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Productivity of mustard [*Brassica juncea* L.] as effected by different organic manures and fertilizers

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Abstract
A field experiment entitled "Effect of Organic Manure and Fertilizers on Productivity and Nutritional quality of Mustard (*Brassica juncea* L.)" was carried out during *rabi*, 2022-23 at Experimental Farm, Department of Agronomy, School of Agricultural Sciences, Dr. K. N. Modi University, Newai Rajasthan. The soil was sandy loam in texture, slightly alkaline in reaction, low in available nitrogen, medium in organic carbon, medium in available phosphorus and high in available potassium. The experiment was carried out with 9 treatments *viz.*, Control (100% RDF -80:40:40 kg NPK ha^{-1}) (T_1), 25% RDN through Farm Yard Manure + 75% RDF (T_2), 25% RDN through Vermicompost + 75% RDF (T_3), 25% RDN through Sheep manure + 75% RDF (T_4), 25% RDN through Neem cake + 75% RDF (T_5), 50% RDN through FYM + 50% RDF (T_6), 50% RDN through Vermicompost + 50% RDF (T_7), 50% RDN through Sheep manure + 50% RDF (T_8), 50% RDN through Neem cake + 50% RDF(T9), laid out in randomized block design, replicated thrice. application of 25% RDN through vermicompost + 75% RDF (T_3) had shown significantly higher plant height, leaf area index compared to rest of treatments and was statistically at par with 25% RDN through FYM + 75% RDF (T_2). Application of 25% RDN through vermicompost + 75% RDF (T_3) had shown significantly higher number of branches $plant^{-1}$, dry matter production, number of siliqua $plant^{-1}$, length of siliqua, number of seed $siliqua^{-1}$ and test weight which was superior to rest of treatments and was at par with 25% RDN through FYM + 75% RDF (T_2).The highest seed yield, stover yield, oil content and protein content were observed with application of 25% RDN through vermicompost + 75% RDF (T_3) compared to all remaining treatments and control (100% RDF) and it was at par with 25% RDN through FYM + 75% RDF (T_2). Higher nutrient uptake (N, P and K) was observed with 25% RDN through vermicompost + 75% RDF (T_3) compared to other treatments and it was statistically at par with 25% RDN through FYM + 75% RDF (T_2). The higher values of gross returns, net returns and benefit cost (B:C) ratio was obtained with application of 25% RDN through vermicompost + 75% RDF (T_3). Based on the above results, it can be concluded that application of 25% RDN through vermicompost + 75% RDF (T_3) enhanced the growth and yield of mustard and proved to be the most remunerative treatment.

Keywords: Mustard, FYM, RDF, Vermicompost, RDN

Introduction
Oilseeds are second largest agricultural commodity after cereals in India. Mustard crop play an important role in oilseeds and Rajasthan is the top most leading producing state in India. It has the unique significance in recent era of energy crisis. It play an important role in relieving malnutrition of human beings and animals. Mustard crop is second most important edible oilseed crop in India after groundnut and accounts for nearly one-third of the oil produced in country (Sahoo *et al.*, 2017) [24].

The seed and oil of mustard have a peculiar pungency, thus making it suitable for condiments and for the preparation of pickles and curries. The oil is utilized for human consumption, preparation of hair oils, medicines, soap making. Mustard seed contains 30-33% oil, 17-25% proteins, 8-10% fibers, 10-12% extractable substances (Mishra *et al.*, 2019). The cake obtained after extraction of oil is used as cattle feed and manure. The oil cake contains 25-30% crude protein, 5% nitrogen, 1.8-2.0% phosphorous and 1.0-1.2% potassium (Reddy and Ramu, 2018) [22].

At the end of fiscal year 2022 India was estimated to produce more than 11 million metric ton of rapeseed and mustard this was an increase from the previous fiscal year. Mustard seed production was estimated at 109.5 lakh tonnes in 2021-22. The area under coverage has been pegged at 87.44 lakh hectares while the average yield was seen at 1,270 kg per hectare (COOIT data,). Mustard data increased by 7.32 lakh hectare from 85.35 lakh hectare in 2021-22 to 92.67 lakh hactares in 2022- 23. Thus, out of 8.20 lakh hactares increase in area under

oilseeds, rapeseed and mustard alone accounted for 7.32 lakh hactares. As per the preliminary projections, mustard seed production is likely to cross 12.5 million tonnes in the 2022-23 crop year (July, June), which is 7% more than previous year.

Mustard is grown in Rajasthan, UP, Haryana, Madhya Pradesh and Gujarat states. In India mustard occupy 6.23 million ha area with production of 9.34 million tones and productivity of 1499 kg ha^{-1} respectively.

The estimated area, production and yield of rapeseed-mustard in the world is 36.59 million hectares (mha), 72.37 million tones (mt) and 1980 kg / ha Globally, India rank 2nd after Canada in acreage (19.81%) and rank 4th after Canada, European Union and China in production (10.37%) mustard seed production was estimated at 109.5 lakh tonnes in 2021-22. The area under coverage had been pegged at 87.44 lakh hectares while the average yield was about 1,270 kg per hectare.

Rajasthan is the largest producing state in the country. Mustard seeds production was expected to increase to 49.50 lakh tones during the rabi season of 2021-22 as against 35 lakh tones in the previous year (2020-21). Rajasthan has the highest acreage at 39.722 lakh ha, more than 35.3 lakh ha last year (2021-22).

Organic manures alone will not supply required nutrients to the crop within short period whereas application of inorganic fertilizers cause soil pollution and degradation. Hence, in order to improve crop productivity, soil health and less the negative environmental effect Integrated use of organic and inorganic fertilizer is a viable option.

Application of chemical fertilizers along with organic manures are necessary to improve the soil health (Prasad *et al*., 2010) [7]. The nutrient supplied to crops through Integrated Nutrient Management (INM) not only restores the soil fertility but also sustain desired level of production over the years (Pal and Pathak, 2016) [21].

The key component of the INM is to decrease the enormous use of chemical fertilizers and accelerating a balance between fertilizer inputs and crop nutrient requirement, optimizing the level of yield, maximizing the profitability, and subsequently reducing the environmental pollution. Yield potentials of the crop, can be maximized by balanced and efficient use of organic and inorganic sources of nutrient (Meena *et al*., 2015) [10].

Organic manures like sheep manure and vermicompost are a good source of organic matter which play a vital role in improving soil fertility. Farm yard manure not only provides most of the essential nutrients but also improves soil structure through binding effect on soil aggregates. Balanced nutrient management through the use of organic manures like FYM, vermicompost, neem cake, sheep manure in conjunction with inorganic fertilizers facilitate profitable and sustainable crop production besides improving physicochemical properties of soil. FYM contains 0.5% N, 0.2% P, and 0.5% K. Vermicompost contain 2-2-5% N, 1.5 – 2.2% P, and 1.8 to 2.25% K. Sheep manure contain N, P, K 3%, 1%, 2% respectively and neem cake contain N 5.3%, P (0.5-1%) and K (1-2%), these all-organic manures also provide micro nutrients like ca, Mg, Cu and Zn etc.

All organic manures improve soil structure, porosity, water holding capacity, and physical condition of soil. It increases productivity and fertility of soil, improves the quality and yield of crop. It also increases oil and protein percentage of oilseed crops. It reduces cost of cultivation through fulfil the demand of nutrients and through enhance the resistance against insect ad diseases. Organic manures are ecofriendly do not put harmful impact on environment. Neem cake is an organic manure which give nutrients to crop with insecticidal effect.

Application of chemical fertilizers along with organic manures are necessary to improve the soil health (Prasad *et al*., 2010) [7]. The nutrient supplied to crops through INM not only restores the soil fertility but also sustain desired level of production over the years (Pal and Pathak, 2016) [21].

Keeping the above beneficial effect of organic manure and inorganic fertilizers on mustard, the theses topic selected effect of organic manure and fertilizers on productivity and nutritional quality of mustard (*Brassica juncea* L.). I chose this topic of thesis so that we can find out the effect of organic manure and fertilizer on productivity of mustard.

Materials and Methods

The experiment entitled “Effect of Organic Manure and Fertilizers on Productivity and Nutritional Quality of Mustard” was carried out during *rabi*, 2022-23 to achieve the objectives set forth for present investigation. The complete details of the experimental materials used and methods adopted in the present investigation are elucidated in this chapter under appropriate headings. the soil of experimental plot was sandy loam in texture, low in available nitrogen (270.00 kg ha^{-1}), medium in available phosphorous (29 kg ha^{-1}) and medium in available potassium (268 kg ha^{-1}). The soil was moderately alkaline in reaction having PH 8.4. This soil was favorable for normal growth of the crop. The experiment was taken during *rabi*, 2022-23 in a randomized block design (RBD) with nine treatments in three replications at Agronomy Farm School of Agricultural Science, Dr. K. N. Modi University, Newai. The experiment was carried out with 9 treatments *viz.*, Control (100% RDF -80:40:40 kg NPK ha^{-1}) (T_1), 25% RDN through Farm Yard Manure + 75% RDF (T_2), 25% RDN through Vermicompost + 75% RDF (T_3), 25% RDN through Sheep manure + 75% RDF (T_4), 25% RDN through Neem cake + 75% RDF (T_5), 50% RDN through FYM + 50% RDF (T_6), 50% RDN through Vermicompost + 50% RDF (T_7), 50% RDN through Sheep manure + 50% RDF (T_8), 50% RDN through Neem cake + 50% RDF(T9) sowing done at 30th October 2022 at spacing 40 c.m. x 10 c.m.

The recommended dose of fertilizer was applied as per treatments through Urea, DAP and MOP. Elemental Sulphur, ZnSO4. FeSO4 and gypsum were also applied as per treatments. Recommended practices and plant protection measures were undertaken as per recommendation. The crop was harvested on 3rd March, 2023.

Results and Discussion

Data regarding effect of various treatments on growth attributes such as plant height, Dry matter per plant and No. of branches etc. is presented in Table 1.

Plant height at harvest

The plant height was significantly influenced by different organic manure and fertilizers at maturity. A marginal increase in plant height was noticed at harvest stage from 90 DAS. Among the various integrated nutrient management treatments, the application of 25% RDN through vermicompost + 75% RDF (T_3) (170 cm) recorded

significantly highest plant height (170 cm) over control (T_1). The remaining combinations of organic and inorganic treatments were at par with 25% RDN through FYM + 75% RDF (T_2) (168 cm). 50% RDN through vermicompost + 50% RDF (T_7) recorded a plant height of 155 cm and 25% RDN through sheep manure + 75% RDF (T_4) recorded a plant height of (154 cm).

At different stages of observation, taller plants were produced with the application of 25% RDN through vermicompost + 75% RDF (T_3) and 25% RDN through FYM + 75% RDF (T_2). The increase in plant height might be due to availability of nutrients throughout the crop growth period by decomposition of FYM. Nitrogen may influence the different physiological processes such as a cell elongation cell division, and chlorophyll production which resulted in better growth attributes. The balanced nutrient application lead to higher mobility of nutrients to plants leading to accumulation of net photosynthates which enhanced the plant height.

These findings were in agreement with those reported by Devkota *et al*. (2020) [7], Lepcha *et al*. (2015) [15], Tripathi *et al*. (2011) [28]. Dry matter production at harvest. The influence of the different organic manure and fertilizer treatments i.e., 25% RDN through vermicompost + 75% RDF (T_3) (6541 kg ha^{-1}) had produced maximum dry matter and it was at par with 25% RDN through FYM + 75% RDF (T_2) (6438 kg ha^{-1}). The next best treatments were 50% RDN through vermicompost + 50% RDF (T_7) and 25% RDN through sheep manure + 75% RDF (T_4). The dry matter production was found to be lower with control at harvest stage (5124 kg ha^{-1}). The higher total dry matter production at all the growth stages was observed with combined application 25% RDN with vermicompost + 75% RDF (T_3) and 25% RDN through FYM + 75% RDF (T_2) might be due to the availability of nutrients throughout crop growth period for efficient branching.

The integration of inorganic and organic sources supplied enough amounts of nutrients and organic matter which influenced the soil environment in positive ways for plant growth. The favorable soil condition might have helped in better proliferation of root and uptake of nutrients that have accelerated the formation of new tissues which ultimately increased the total dry matter production. Taller plants produced as a result of combined application of vermicompost and inorganic manures produced more dry matter because of more opportunity for production

Table 1: Growth characters influenced by different treatments

S. No.	Treatments	Plant height Harvest stage	Dry matter production kg per ha. At Harvest stage	No. of branches $plant^{-1}$
1.	T_1–Control(100% RDF -80:40:40kg NPK ha^{-1})	148	5124	6
2.	T_2 - 25% RDN through Farm Yard Manure + 75% RDF	168	6438	9
3.	T_3 – 25% RDN through Vermicompost + 75% RDF	170	6541	10
4.	T_4 - 25% RDN through Sheep manure + 75% RDF	154	6052	8
5.	T_5- 25% RDN through Neem cake + 75% RDF	152	5761	7
6.	T_6- 50% RDN through FYM + 50% RDF	154	5927	8
7.	T_7- 50% RDN through Vermicompost + 50% RDF	155	6296	9
8.	T_8- 50% RDN through Sheep manure + 50% RDF	151	5508	7
9.	T9- 50% RDN through Neem cake + 50% RDF	149	5336	6
	S.Em±	4.1	78.19	0.11
	CD (P=0.05)	12	233	0.3

and accumulation of photosynthates.

The results of present research study are in close agreement with those of Yadav *et al.* (2018) [29], Rundala *et al.* (2013) and Kashved *et al.* (2010) in mustard.

Number of branches $plant^{-1}$

The number of branches $plant^{-1}$ were significantly influenced by different organic manure and fertilizers.

The highest number of branches $plant^{-1}$ at harvest were recorded with 25% RDN through vermicompost + 75% RDF (T_3) (10), which was statistically at par with 25% RDN through FYM + 75% RDF (T_2) (9) and was significantly superior over the other combinations of organic and inorganic treatments.

Yield attributes: Among the various integrated nutrient management treatments application of 25% RDN through vermicompost + 75% RDF (T_3) had shown significantly higher plant height (180 cm), leaf area index (3.84) compared to all other combination of organic and inorganic treatments as well as control (100% RDF) and was statistically at par with 25% RDN through FYM + 75% RDF (T_2).

Table 2: Yeild attributes and yield effected by different treatments

S. No.	Treatments	No. of siliqua $plant^{-1}$	No. of seeds $siliqua^{-1}$	Length of siliqua (cm)	Test weight (g)	Seed yield (Kg ha^{-1})	Stover yield (Kg ha^{-1})
1.	T_1–Control (100% RDF 80:40:40 kg NPK ha^{-1})	120	10	4.4	3.4	1101	3925
2.	T_2 - 25% RDN through Farm Yard Manure + 75% RDF	132	13	4.9	3.8	1580	4717
3.	T_3 – 25% RDN through Vermicompost + 75% RDF	137	13	5.0	3.8	1683	4788
4.	T_4 - 25% RDN through Sheep manure + 75% RDF	126	11	4.7	3.7	1428	4526
5.	T_5- 25% RDN through Neem cake + 75% RDF	124	11	4.6	3.6	1327	4371
6.	T_6- 50% RDN through FYM + 50% RDF	123	11	4.6	3.6	1373	4492
7.	T_7- 50% RDN through vermicompost + 50% RDF	125	12	4.7	3.7	1458	4614
8.	T_8- 50% RDN through Sheep manure + 50% RDF	122	11	4.5	3.5	1263	4244
9.	T9- 50% RDN through Neem cake + 50% RDF	121	10	4.5	3.4	1210	4025
	S.Em±	3.43	0.15	0.06	0.05	37.01	56.89
	CD(P=0.05)	9	0.4	0.2	NS	110	170

Conclusion

Dry matter production and other growth characters with application of integrated nutrient management treatments had no significant effect on dry matter production at 30 DAS. At 60, 90 DAS and harvest stage application of 25% RDN through vermicompost + 75% RDF (T_3) had shown significantly highest dry matter production of 6332 kg ha^{-1} and other growth characters over the other treatments and it was statistically on par with 25% RDN through FYM + 75% RDF (T_2).

Yield attributes *viz.*, number of branches $plant^{-1}$, number of siliqua $plant^{-1}$, length of siliqua, number of seed siliqua-1 and test weight were significantly influenced by integrated nutrient management treatments. Among the various integrated nutrient management treatments application of 25% RDN through vermicompost + 75% RDF (T_3) had shown significantly higher number of branches $plant^{-1}$ (11), number of siliqua $plant^{-1}$ (138), length of siliqua (5.1 cm), number of seed $siliqua^{-1}$ (14) and test weight (3.9 g) which was superior to rest of treatments and was statistically at par with 25% RDN through FYM + 75% RDF (T_2).

The highest seed yield of 1684 kg ha^{-1} and stover yield of 4789 kg ha^{-1} were recorded with application of 25% RDN through vermicompost + 75% RDF (T_3) compared to all remaining treatments and control (100% RDF) and it was statistically at par with 25% RDN through FYM + 75% RDF (T_2). Harvest index was remained non- significant in response to INM treatments.

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