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Influence of organic nutrient source on soil properties and plant characteristic in mustard (*Brassica rapa* L.)

Diksha Sharma[1], Manju Kumari[2,*], Yachna[3] and Ishita[3]

[1]Department of Agriculture, Maharishi Markandeshwar University, Sadopur (Ambala) Haryana; [2]Department of Soil Science and Agricultural Chemistry, Lovely Professional University, Jalandhar - Delhi G.T. Road, Phagwara Punjab; [3]Department of UIBT and UIAS, Chandigarh University Mohali Punjab.

**Corresponding author:*
E-mail: mkmanjuthakur@gmail.com (Manju Kumari)

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ABSTRACT

A field experiment was conducted at Research Farm of the Department of Agriculture, Maharishi Markandeshwar University, Sadopur Ambala (Haryana) during *rabi* season of 2020-21. The trial was laid out in randomized block design (RBD) comprising eight treatments *viz*., T_1: Control, T_2: 100% of recommended dose of nitrogen (RDN) through vermicompost (VC), T_3: 75% of RDN through VC + 25% of farmyard manure (FYM), T_4: 50% of RDN through VC + 50% of FYM, T_5: 100% of RDN through *Jeevamrit*, T_6: 75% of RDN through *Jeevamrit* + 25% of *Panchgavya*, T_7: 50% of RDN through *Jeevamrit* + 50% *Panchgavya* and T_8: 100% of RDN through *Panchgavya* with three replications. The objective of the study was to enhance the growth and yield by using liquid manures with combination of solid organics and to improve the physico-chemical properties, nutrient content and uptake of mustard. The outcomes showed that growth and yield parameters were enhanced by the application of solid organic manures, *Jeevamrit* and *Panchgavya* when compared with control. The maximum plant height at 30, 60, 90, 120 days after sowing (DAS) and at harvest (33.3, 71.8, 131.1, 180.1 and 205.2 cm, respectively), number of primary and secondary branches per plant (9.2 and 19.0, respectively), dry matter accumulation (98.1 g plant^{-1}), number of siliquae per plant (366.9), number of seeds per siliqua (13.7), test weight (6.0 g), seed yield (18.9 q ha^{-1}), straw yield (30.4 q ha^{-1}) and biological yield (49.3 q ha^{-1}) was obtained under the treatment T_8 (100% RDN through *Panchgavya*). Additionally, there was an increase in the available N, P, K and organic carbon (OC) by the use of 100% RDN through panchgavya where as particle density and bulk density was highest in T_8 treatments. Marginal increase in particle density and porosity and gradual decrease in the pH and bulk density in all organic manure practices except for control. Apart from this, improvement in NPK uptake (46.84, 11.86 and 18.72 kg ha^{-1}, respectively) and NPK content (2.48, 0.63 and 0.99%, respectively) in mustard was also observed with the application of 100% RDN through panchgavya. Thus, application of solid and liquid organic manures could be used to sustain mustard productivity and maintain soil health.

1. INTRODUCTION

Brown sarson (*Brassica rapa*) belonging to the family Brassicaceae is one of the most important oilseed crop across the world since it is a major source of vegetable oil after soyabean and groundnut (Chetry *et al*., 2018). India accounts for 19.8% of the total area and 9.8% of total output and is referred to as the world's largest producer of oilseeds. The average yield of mixed oilseed crops in temperate and subtropical climates is 1135 kg ha^{-1}, whereas, the yield of rapeseed-mustard is around 1145 kg ha^{-1} (Choudhary *et al*., 2022). Rajasthan is the leading state regarding mustard production and accounts for 40.7% of the total acreage and 44.9% of the rapeseed-mustard production (Chand *et al*., 2021). *Brassica rapa* has two ecotypes, *i.e. Lotni* (self-incompatible) and *Tora* (self-compatible). In rainfed parts

of the country, it is cultivated either as a single crop or in combination with other important *rabi* crops (Gazal *et al*., 2013). It requires rational amount of nutrients for its proper growth and development. Nowaday, mustard production is decreasing because of the excessive use of synthetic fertilizers by farmers (Namdeo *et al*., 2021). Imprudent use of synthetic fertilizers in intensive cropping system has made the quality of the soil deteriorates. Moreover, productivity of brown sarson is reducing due to the nutritional imbalance (Bhat *et al*., 2018). Balanced use of fertilizers must be needed for the superior production and productivity of crops as well as for soil health. Therefore, incorporation of organic fertilizers in soil is a prudent way to maintain the productivity of mustard and soil fertility since the manure provides macro and micro-nutrients in readily available form. Application of manure, *Jeevamrit* and *Panchgavya* enhances physico-chemical properties of the soil and crop yield as well as improve the activity of soil microorganisms (Suchitra *et al*., 2017). The main objective of current study, therefore, was to study the response of brown sarson (*Brassica rapa*) to different solid and liquid manures on growth, yield, nutrient content, uptake and on soil properties.

2. MATERIALS AND METHODS

The experiment consisting of eight treatments *viz*., T_1: Control, T_2: 100% RDN through VC, T_3: 75% RDN through VC + 25% FYM, T_4: 50% RDN through VC + 50% FYM, T_5: 100% RDN through *Jeevamrit*, T_6: 75% RDN through *Jeevamrit* + 25% *Panchgavya*, T_7: 50% RDN through *Jeevamrit* + 50% *Panchgavya* and T_8: 100% RDN through *Panchgavya* was conducted at Research Farm of the Department of Agriculture, Maharishi Markandeshwar University, Sadopur-Ambala (Haryana) during *rabi* season of 2020-21. The treatments were replicated three times in a RBD.

The soil of the experimental field was sandy loam in texture with pH 8.61, OC 0.40%, available nitrogen 102.0 kg ha^{-1}, available phosphorus 15.2 kg ha^{-1} and available potassium 71.8 kg ha^{-1}. The recommended dose of fertilizers for brown sarson is N : P_2O_5 : K_2O - 80 : 40 : 40 kg ha^{-1}). The whole dose of FYM (N : P_2O_5 : K_2O -0.5 : 0.2 : 0.5%), VC (N: P_2O_5 : K_2O - 1.0 : 0.2 : 0.4%), *Jeevamrit* (N:P:K - 1.9:0.1: 0.2%) and *Panchgavya* (N:P:K - 229:209:232 ppm) was applied two days before sowing seeds. The seeds of mustard *cv.* Pioneer 45S46 was sown using a seed rate of 2.5 kg ha^{-1} in lines at 30 × 10 cm spacing in a gross plot size of 2.5 × 4 m^2. Observations *viz*., plant height (30, 60, 90, 120 DAS and at harvest), number of primary and secondary branches and dry matter per plant were recorded from 10 randomly selected plants from each plot. Yield attributes *viz*., number of siliquae per plant, number of seeds per siliqua, test weight were counted at harvest. Seed yield and straw yield were evaluated from the net plot and then converted to q ha^{-1}. Biological yield was calculated by recording the weight of entire harvested produce of each plot, whereas, harvest index (%) was calculated by the economic yield divided by biological yield.

3. RESULTS AND DISCUSSION

Growth Attributes

Application of solid and liquid manure significantly influenced the growth attributes of mustard (Table 1). Adoption of 100% RDN through *Panchgavya* resulted in significantly maximum plant height at 30, 60, 90, 120 DAS

Table: 1
Effect of solid and liquid manure on height (cm), number of branches per plant and dry matter accumulation at harvest of mustard plant

Treatment	Plant height (cm) days after sowing					Number of primary branches per plant	Number of secondary branches per plant	Dry matter accumulation (g $plant^{-1}$)
	30	60	90	120	At harvest			
T_1: Control	28.6	66.9	126.2	173.1	199.4	8.3	17.3	87.9
T_2: RDN_{100} - VC	32.6	70.3	129.8	179.0	204.0	9.1	18.6	95.0
T_3: RDN_{75} - VC + RDN_{25} - FYM	32.2	70.0	129.0	178.1	203.3	8.9	18.3	93.1
T_4: RDN_{50} - VC + RDN_{50} - FYM	33.0	71.2	130.5	179.7	204.4	9.1	18.9	96.8
T_5: RDN_{100} - *Jeevamrit*	32.0	69.6	128.5	177.6	202.6	8.7	18.2	93.0
T_6: RDN_{75} - *Jeevamrit* + RDN_{25} - *Panchgavya*	30.1	68.2	127.1	175.3	201.0	8.4	17.7	92.4
T_7: RDN_{50} - *Jeevamrit* + RDN_{50} - *Panchgavya*	31.2	69.0	127.8	176.4	201.5	8.6	18.0	92.9
T_8: RDN_{100} - *Panchgavya*	33.3	71.8	131.1	180.1	205.2	9.2	19.0	98.1
SEm±	0.1	0.2	0.3	0.7	0.8	0.06	0.1	1.6
CD (P = 0.05)	0.4	0.7	0.8	2.2	2.3	0.2	0.3	4.8

FYM = Farmyard manure; RDN = Recommended dose of nitrogen; VC = Vermicompost

and at harvest (33.3, 71.8, 131.1, 180.1 and 205.2 cm, respectively), number of primary (9.2) and secondary branches per plant (19.0) and dry matter accumulation (98.1 g plant^{-1}), which were at par with treatment T_4 (50% RDN through VC + 50% FYM). These results are in close agreement with the results reported by Khare *et al*. (2016) and Murali *et al*. (2018) in soya bean and mustard, respectively. Similar results were also reported by Gowda *et al*. (2018) alluding plant vigour in terms of plant height, number of primary and secondary branches per plant in groundnut. The increase in growth parameters might be due the fact that the solid and liquid manures supplied sufficient nutrients to mustard plants for their growth.

Yield and Yield Attributes

The mustard crop responded very well to the application of both solid and liquid manures in terms of number of siliquae per plant, number of seeds per siliqua, test weight and seed yield (Table 2). The supply of 100% RDN through *Panchgavya* (T_8) resulted in maximum number of siliquae per plant (366.9) closely followed by the treatment T_4 (355.2) and T_2 (341.1), number of seeds per siliqua (13.7), which was statistically at par with T_4 (13.5), T_2 (13.3), T_3 (13.2) and T_5 (12.9), test weight (6.0 g), which was found at par with T_4 (5.9 g) and T_2 (5.9 g), seed yield (18.9 q ha^{-1}), which was at par with T_4 (18.3 q ha^{-1}) and T_2 (18.1 q ha^{-1}), a straw yield (30.4 q ha^{-1}), which was at par with T_4 (29.5 q ha^{-1}), T_2 (28.8 q ha^{-1}) and T_3 (28.1 q ha^{-1}) and biological yield (49.3 q ha^{-1}), which was found at par with T_4 (47.9 q ha^{-1}) and T_2 (46.9 q ha^{-1}). Similar results have been reported by Khare *et al*. (2016) and Murali *et al*. (2018) in soyabean and mustard. However, all the treatments were similar in respect of harvest index.

Physico-chemical Properties

Physical properties of soil significantly influenced by the application of manures in mustard. Addition of organic manures tended to improve physico-chemical properties of soil. The maximum bulk density (1.36 g cm^{-3}) was observed in T_1 (control) whereas treatment T_8 (100% RDN through *Panchgavya*) recorded minimum bulk density (1.24 g cm^{-3}). Significantly the maximum particle density (2.60 g cm^{-3}) and porosity (52.30%) was observed in treatment T_8 (100% RDN through *panchgavya*) which was at par with treatment T_4 (2.59 g cm^{-3} and 51.35%) and T_2 (2.57 g cm^{-3} and 50.58%). Whereas, maximum EC and pH was recorded with T_1 (control) (0.47 dS m^{-1}) and (8.61). Decrease in bulk density with the use of organics has been reported by Kumar *et al*. (2017) in cotton. Kumari *et al*. (2019) revealed that solid and liquid manures are responsible for rapid increase in the process of decomposition of organic sources of nutrition which results in deduction in pH due to release of organic acids (Table 3). Reduction in soil pH and EC with the use of organic manures has been reported by Kumawat *et al*. (2013). Similar decrease in pH and EC with the use of VC application has been reported by Kansotia *et al*. (2015) and Sharma *et al*. (2017) in Indian mustard. Significantly higher OC content (0.53%) was obtained with the application of 100% RDN through *Panchgavya* followed by use of T_4 (50% RDN through VC + 50% FYM). Kumawat *et al*. (2013) reported that soil organic carbon (SOC) is negatively associated with soil pH and therefore, *Panchgavya* use resulting in increase in OC with decrease in pH in groundnut. The results are in close conformity with those of Kansotia *et al*. (2015) and Sharma *et al*. (2017) in Indian mustard where VC application resulted in significant rise in OC.

Plant Available Nutrients

The impact of manures on available NPK in soil is presented in Table 4. Significant difference was observed in available soil NPK due to the different organic manures used. Among the treatments, application of 100% RDN

Table: 2
Effect of solid and liquid manure on yield attributes and yield of mustard

Treatment	Number of siliquae per plant	Number of seeds per siliqua	Test weight	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)
T_1: Control	285.1	11.5	4.7	12.2	22.2	34.4	35.6
T_2: RDN_{100} - VC	341.1	13.3	5.9	18.1	28.8	46.9	38.5
T_3: RDN_{75} - VC + RDN_{25} - FYM	324.9	13.2	5.7	17.5	28.1	45.6	38.3
T_4: RDN_{50} - VC + RDN_{50} - FYM	355.2	13.5	5.9	18.3	29.5	47.9	38.1
T_5: RDN_{100} - *Jeevamrit*	317.1	12.9	5.7	16.0	27.0	43.1	37.1
T_6: RDN_{75} - *Jeevamrit* + RDN_{25} - *Panchgavya*	301.3	12.0	5.4	15.3	25.1	40.4	37.7
T_7: RDN_{50} - *Jeevamrit* + RDN_{50} - *Panchgavya*	297.4	12.6	5.5	15.3	26.8	42.2	36.3
T_8: RDN_{100} - *Panchgavya*	366.9	13.7	6.0	18.9	30.4	49.3	38.3
Sem±	1.34	0.47	0.09	0.44	1.02	1.12	1.00
CD (P = 0.05)	4.08	1.44	0.28	1.32	3.08	3.40	NS

FYM = Farmyard manure; RDN = Recommended dose of nitrogen; VC = Vermicompost

Table: 3
Effect of solid and liquid manure on physico-chemical properties of soil in mustard

Treatment	Bulk density (g cm^{-3})	Particle density (g cm^{-3})	Porosity (%)	EC (dS m^{-1})	pH	OC (%)
T_1: Control	1.36	2.27	40.08	0.47	8.61	0.40
T_2: RDN_{100} - VC	1.27	2.57	50.58	0.4	18.57	0.48
T_3: RDN_{75} - VC + RDN_{25} - FYM	1.32	2.42	45.45	0.43	8.59	0.44
T_4: RDN_{50} - VC + RDN_{50} - FYM	1.26	2.59	51.35	0.40	8.58	0.49
T_5: RDN_{100} - *Jeevamrit*	1.31	2.43	46.09	0.40	8.57	0.48
T_6: RDN_{75} - *Jeevamrit* + RDN_{25} - *Panchgavya*	1.3	2.31	41.99	0.43	8.59	0.45
T_7: RDN_{50} - *Jeevamrit* + RDN_{50} - *Panchgavya*	1.29	2.46	47.55	0.43	8.58	0.47
T_8: RDN_{100} - *Panchgavya*	1.24	2.60	52.30	0.40	8.57	0.53
Sem±	0.01	0.01	0.36	0.01	0.01	0.01
CD (P = 0.05)	0.02	0.02	1.08	0.02	0.02	0.02

FYM = Farmyard manure; RDN = Recommended dose of nitrogen; VC = Vermicompost

Table: 4
Effect of solid and liquid manure on physico-chemical properties of soil in mustard

Treatment	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
T_1: Control	102.0	15.2	71.8
T_2: RDN_{100} - VC	121.5	17.6	77.3
T_3: RDN_{75} - VC + RDN_{25} - FYM	119.8	16.5	74.3
T_4: RDN_{50} - VC + RDN_{50} - FYM	125.8	20.5	76.9
T_5: RDN_{100} - *Jeevamrit*	122.4	19.2	76.4
T_6: RDN_{75} - *Jeevamrit* + RDN_{25} - *Panchgavya*	115.6	16.1	74.8
T_7: RDN_{50} - *Jeevamrit* + RDN_{50} - *Panchgavya*	118.1	18.4	75.6
T_8: RDN_{100} - *Panchgavya*	134.3	19.4	78.1
Sem±	3.4	0.6	0.5
CD (P = 0.05)	10.3	1.7	1.5

FYM = Farmyard manure; RDN = Recommended dose of nitrogen; VC = Vermicompost

through *Panchgavya* gave best results in terms of available N and K *i.e.* (134.3 kg ha^{-1}) and (78.1 kg ha^{-1}) whereas T_4 (50% RDN through VC + 50% FYM) recorded maximum available P (20.5 kg ha^{-1}). Control recorded the lowest available NPK content of 102.0, 15.2 and 71.8 kg ha^{-1}, respectively. The same result of increase in available NK was reported by Sharma *et al*. (2017) related to bulky manures in Indian mustard. Mineralization of N into inorganic sources from organic form of nutrients resulted in increased available N by the application of VC and FYM. Application of organic manures resulted in direct addition of P into the soil due to the release of organic acids during the decomposition of organic materials (Kumari *et al*., 2019).

Nutrient Content in Seeds

Organic manures level significantly affected the nutrient content in seeds and highest NPK content of 2.48, 0.63 and 0.99%, respectively was obtained with application of 100% RDN through *Panchgavya*. In contrast, lowest content of NPK was recorded in control (2.16, 0.43 and 0.78%, respectively). Similar results were also reported by Sharma *et al*. (2017).

Nutrient Uptake by Seeds

The application of organic manures significantly increased nutrient uptake of mustard. Maximum nutrient uptake (46.84, 11.86 and 18.72 kg ha^{-1}, respectively) was noticed with 100% RDN through *Panchgavya* as compared to other treatments, whereas, the lowest NPK uptake in seeds of mustard was observed in control (26.52, 5.28 and 9.55 kg ha^{-1}, respectively). Kumar *et al*. (2019) reported that addition of manures provides plant nutrients in available form resulting in improvement in physical and chemical properties which promote root and shoot growth. Sharma *et al*. (2017) observed rise in seed N uptake in Indian mustard by the use of VC.

4. CONCLUSIONS

Based on the results, it can be concluded that application of 100% RDN through *Panchgavya* was found to be

superior among different organic sources of nutrition for the growth and yield of mustard. Similarly, nutrient content and uptake was recorded to be the highest with application of 100% RDN through *Panchgavya*. Adoption of solid and liquid manures significantly improved physico-chemical properties of soil as compared to control. Hence, it can be concluded that the use of 100% RDN through *Panchgavya* may be included as one of the best alternative in organic package of practices for cultivation of mustard crop and also for maintaining the soil health.

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