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Effects of vermicompost and inorganic fertilizers on physico-chemical properties of soil in Indian mustard

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Abstract
A field experiment was conducted during Rabi season 2017-18 at the research farm of soil science and Agricultural chemistry department, SHUATS, laid out in randomized block design on sandy loam soil, containing sand 57%, silt 28%, and clay 14% (Inceptisols). It was observed that for postharvest soil properties in treatment $T_8 - I_2F_2$ ($N_{80}P_{40}K_{40}S_{20}$ and Vermicompost 6t ha^{-1}) were improved significantly due to organic and inorganic use of inputs. Organic carbon 0.62%, available nitrogen 253.80 kg ha^{-1}, phosphorus 23.50 kg ha^{-1}, potassium 205.50 kg ha^{-1}, Zinc 1.42 ppm, sulphur 9.30 ppm, pH 7.23 were found to be significant and EC at 0.24 dS m^{-1} were found to be non-significantly improved in this treatment.

Keywords: vermicompost, NPK and S, Soil properties, Mustard

Introduction
Oilseeds, the second largest agricultural commodity after cereals in India, play a significant role in India's agrarian economy, sharing 14% of the gross cropped area and accounting for nearly 1.5% of the gross national production and 8% of the value of all agricultural products. India is second in rapeseed and mustard production to China and first in area. In India it occupies 5.76 million ha area with 6.82 million tonnes of production. The average yield of mustard in country is 1184 kg ha^{-1} (Anonymous, 2015-2016). Rajasthan ranks first both in area (2.55 million ha) and production (3.27 million tonnes). Gujarat state has the highest productivity (1611 kg ha^{-1}) of mustard. In Uttar Pradesh, mustard was grown on 0.59 million hectare area with production of 0.60 million tonnes. Although it was a major oilseed crop. but its productivity in the state (1015 kg ha^{-1}) was much lower than its realizable yield potential of 2200 to 2400 kg ha^{-1} (Anonymous, 2015-16) Due to poor yield, oil seed production in the country does not meet the requirement of growing population. To bridge the gap between demand and supply, the country is forced to import edible oils and spends a lot of foreign exchange every year. The production of mustard can be increased by proper fertilizer management and putting more area under irrigation. Knowledge of the concentration of plant nutrients in a crop and the amount of nutrients removed by a particular crop from the soil may be a helpful guide for the formulation of a sound fertilizer management programme.

Intensive cropping has made the soil deficient in macro as well as micronutrients. This has resulted in decline in productivity and deterioration in soil health and productivity. The success of any cropping system depends upon the appropriate management of resources including balanced use of manures and fertilizers. Use of organic manures may prove a viable option for sustaining the productivity (Tejada *et al.* 2009) [8]. Vermicompost application has been known to improve physical, chemical and biological properties of soil (Nagavallemma *et al,* 2004. The vermicomposting is an eco-friendly and effective way to recycle agricultural and kitchen wastes. The material excreted through the anus of the earthworms in the form of manure is known as vermicompost. The earthworms act as natural bio ideal breeding home for aerobic bacteria which can multiply very fast and compete on aerobic bacteria and fungi. The biological recycling is process of transformation of organic waste into more elaborate products which are relatively richer in humic substances. The application of vermicompost not only adds plant nutrients (macro and micro) and growth regulators to one but also increases soil water retention, microbial population, and humic substances of the soil, mineralization and release of nutrients. Besides these, vermicompost also improves soil aeration, reduction of soil erosion, reduces of evaporation losses of water, accelerates the process of humification, stimulates the microbial activity, deodourification of obnoxious smell, destruction of pollutant in soil etc. (Manna and Biswas, 1996).

Materials and Methods

The Experiment was conducted during Rabi season 2017-2018 on crop research farm of department of Soil Science and Agricultural chemistry, Naini Agricultural institute. The area is situated on the south of Allahabad on the right side of the river Yamuna on the south of Rewa road at a distance of about 6 km from Allahabad city. It is situated at $25^{0}24^{1}23^{11}$ N latitude, $81^{0}50^{1}38^{11}$ E longitude and at the altitude of 98 meter above the sea level. The treatments consisted of nine combination of organic and inorganic source of fertilizers $T_0 - I_0F_0$ (control), $T_1 - I_0F_1$ ($N_0P_0K_0S_0$ and Vermicompost 3t ha^{-1}), $T_2 - I_0F_2$ ($N_0P_0K_0S_0$ and Vermicompost 6t ha^{-1}), $T_3 - I_1F_0$ ($N_{40}P_{20}K_{20}S_{10}$ and Vermicompost 0t ha^{-1}), $T_4 - I_1F_1$ ($N_{40}P_{20}K_{20}S_{10}$ and Vermicompost 3t ha^{-1}), $T_5 - I_1F_2$ ($N_{40}P_{20}K_{20}S_{10}$ and Vermicompost 6t ha^{-1}), $T_6 - I_2F_0$ ($N_{80}P_{40}K_{40}S_{20}$ and Vermicompost 0t ha^{-1}), $T_7 - I_2F_1$ ($N_{80}P_{40}K_{40}S_{20}$ and Vermicompost 3t ha^{-1}), $T_8 - I_2F_2$ ($N_{80}P_{40}K_{40}S_{20}$ and Vermicompost 6t ha^{-1}), The trial was laid out in a randomized block design with three replication; plot size was 2 x 2 m for crop seed rate is 5 kg ha^{-1} (*Brassica juncea* L.) Var. Varuna. The source of nitrogen, phosphorus, potassium, and sulphur were Urea, SSP, MOP, and $ZnSO_4$ respectively. Basal dose of fertilizer was applied in respective plots according to treatment allocation furrows opened by about 5 cm. All the agronomic practices were carried out uniformly to raise the crop. After crop harvesting the soil samples were collected from the soil 0-15 cm depth, air dried kept in an oven at 105^{0}C for 48 hrs. for drying, pass through 2 mm sieve, soils were analyzed by using the following standard procedures

Table 1: Results of physic-chemical properties of pre-soil samples. (Before sowing of crop)

Particulars	Results	Scientist
Sand (%)	57	Bouyoucous (1927)
Silt (%)	28	
Clay (%)	14	
Texture of soil	Sandy loam	
Particle density (g cm^{-3})	2.45	Muthuaval *et al*. (1992)
Bulk density (g cm^{-3})	1.35	Muthuaval *et al*. (1992)
Soil pH	7.6	Jackson (1958)
EC (dS m^{-1})	0.26	Wilcox (1950)
Organic carbon (%)	0.35	Walkley and Black (1947)
Available Nitrogen (kg ha^{-1})	223.4	Subbaih and Asija (1956)
Available Phosphorus (kg ha^{-1})	21	Olsen *et al*. (1954)
Available Potassium (kg ha^{-1})	152.2	Toth and prince (1949)
Available Sulphur (ppm)	5	Chesin and yien (1950)
Available Zinc (ppm)	0.9	Lindsay and Norvell (1978)

Table 2: Effect of different levels of N, P, K, S and Vermicompost on physico-chemical properties of soil in Indian mustard

Treatments	Soil bulk density(g cm^{-3})	Soil particle density(g cm^{-3})	Soil pH	EC (dS m^{-1})	Available Nitrogen (kg ha^{-1})	Available Phosphorus (kg ha^{-1})	Available Potassium (kg ha^{-1})	Available Zinc(ppm)	Available Sulphur(ppm)	Organic carbon (%)
$T_0(I_0F_0)$	1.33	2.72	7.60	0.20	229.07	14.73	185.10	1.19	7.07	0.42
T_1 (I_0F_1)	1.29	2.63	7.53	0.20	235.20	14.93	192.33	1.13	7.53	0.45
T_2 (I_0F_2)	1.27	2.41	7.40	0.20	234.10	15.93	192.50	1.14	7.83	0.53
T_3 (I_1F_0)	1.29	2.41	7.43	0.20	237.40	16.60	196.27	1.21	7.93	0.44
T_4 (I_1F_1)	1.25	2.53	7.40	0.21	242.40	19.30	197.00	1.23	8.10	0.51
T_5 (I_1F_2)	1.27	2.62	7.23	0.22	243.00	20.70	197.03	1.23	8.50	0.63
T_6 (I_2F_0)	1.24	2.32	7.47	0.23	245.47	22.17	202.80	1.35	8.53	0.46
T_7 (I_2F_1)	1.23	2.31	7.30	0.23	247.47	21.13	204.77	1.39	9.03	0.56
T_8 (I_2F_2)	1.22	2.30	7.23	0.24	253.80	23.50	205.50	1.41	9.30	0.62
Mean	1.27	2.47	7.40	0.21	240.88	18.78	197.03	1.25	8.20	0.51
C.D at 5%	0.012	0.02	0.084	-	3.573	1.732	2.255	0.053	0.294	0.02
F test	S	S	S	NS	S	S	S	S	S	S

Results and Discussion

The results in given Table 3 indicate some of the important parameter on physical properties on mustard crop. Vermicompost and inorganic fertilizers in conjunction on EC was found non-significant and Bulk density, particle density, pH, Organic carbon (%), available nitrogen (kg ha^{-1}), available phosphorus (kg ha^{-1}), available potassium (kg ha^{-1}), available Zinc and available sulphur (ppm) was found significant. And their values were recorded as 0.24, 1.22, 2.30, 7.23, 253.80, 23.50, 205.50, 1.41, and 9.30 respectively in the treatment T_8 that was significantly higher as compared to other treatment combination. pH was recorded 7.23 in the treatment T_8 that were significantly lower as compared to other treatment combination. The slight decreased in soil pH and increased in soil EC (dSm^{-1}), Organic carban (%), available nitrogen (kg ha^{-1}), available phosphorus (kg ha^{-1}), available potassium (kg ha^{-1}), available Zinc and available sulphur (ppm) may be due to increase in levels of organic and inorganic fertilizer and plant growth, which is turn increased the plant residues into soil. It may be concluded from trial that the various level of NPK S, and Vermicompost used from different sources in the experiment, the treatment $T_8 - I_2F_2$ ($N_{80}P_{40}K_{40}S_{20}$ and Vermicompost 6t ha^{-1}) was found to be the best, for improvement in physical and chemical properties of soil.

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