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Effect of Organic and Inorganic Nutrition on Fertility Status of Soil and Yield of Vegetable Cowpea

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Abstract: A field experiment was conducted during kharif, 2012 on loamy sand soil, to study the effect of organic and inorganic nutrition on fertility status of soil and yield of vegetable cowpea [*Vigna unguiculata* (L.) Walp.] var. RCV-7. The treatments consisted four organic manure (control, FYM @ 10 t ha^{-1}, vermicompost @ 5 t ha^{-1} and poultry manure @ 5 t ha^{-1}) and five levels of inorganic nutrients (control, elemental sulphur @ 20 kg ha^{-1}, elemental sulphur @ 20 kg ha^{-1} + ammonium molybdate @ 1.0 kg ha^{-1}, elemental sulphur @ 20 kg ha^{-1} + ammonium molybdate @ 1.0 kg ha^{-1} + ferrous sulphate @ 50 kg ha^{-1}, elemental sulphur @ 20 kg ha^{-1} + ammonium molybdate @ 1.0 kg ha^{-1} + ferrous sulphate @ 50 kg ha^{-1} + zinc sulphate @ 25 kg ha^{-1}). The experiment was laid out in randomized block design and replicated thrice. The levels of available nitrogen, phosphorus, potassium, sulphur, molybdenum, iron and zinc in soil at crop harvest were maximum and significantly higher under vermicompost @ 5 t ha^{-1} (V_5) over control. While significantly maximum organic carbon 0.278% was recorded with the application of FYM @ 10 t ha^{-1} (F_{10}) and under the M_3 (S + Mo + Fe). Under mineral nutrients treatments (M_0-M_4), the maximum available N, P, K, S, Mo, Fe and Zn in soil were recorded with the application of S + Mo + Fe + Zn (M_4). The results revealed that the application of vermicompost @ 5 t ha^{-1} and combined application of S + Mo + Fe were found significantly superior in increasing the green pod yield of cowpea over control.

Key words: Mineral nutrient, organic manure, green pod yield, cowpea.

Organic manure contains both macro and micro-nutrients. Improvement in available nutrient status of the soil with the incorporation of FYM alone or in combination with chemical fertilizers could be attributed to the slow decomposition of organic manure producing acids and enhancing soil biological activity. These in turn provide congenial soil physical conditions, conserve soil nitrogen and increase the availability of other nutrients. The mineralization of nutrients in the rhizophere improves crop growth and provides a better source-sink relationship by enhancing synthesis and allocation of metabolites to reproductive organs. The application of vermicompost not only adds plant nutrients and growth regulators to the soil, but also increases aeration water retention capacity, microbial population, humic substances of the soil. Incorporation of FYM or poultry manure alone or along with chemical fertilizer improves soil biological activity, which in turn provides a congenial physical condition and improved availability of nutrient in the rhizosphere. The present investigation was undertaken to study the effect of organic and inorganic nutrition on fertility status of the soil and yield of vegetable cowpea cv. RCV-7.

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Materials and Methods

The field experiments were conducted at S.K.N. College of Agriculture, Jobner, during 2012-2013 using cowpea cv. RCV-7. The soil was low in available nitrogen, medium in available phosphorus, sufficient in available potassium and deficient in sulphur, molybdenum, iron and zinc (134.90, 15.47, 190 kg ha^{-1} and 7.97, 0.12, 5.34 and 0.42 mg kg^{-1}, respectively). The soil was low in organic carbon (0.24%).

Treatments included four levels of organic nutrition (control, FYM 10 t ha^{-1}, vermicompost 5 t ha^{-1} and poultry manure 5 t ha^{-1}) and five levels of inorganic nutrition (control, elemental sulphur @ 20 kg ha^{-1}, elemental sulphur @ 20 kg ha^{-1} + ammonium molybdate @ 1.0 kg ha^{-1}, elemental sulphur @ 20 kg ha^{-1} + ammonium molybdate @ 1.0 kg ha^{-1} + ferrous sulphate @ 50 kg ha^{-1}, elemental sulphur @ 20 kg ha^{-1} + ammonium molybdate @ 1.0 kg ha^{-1} + ferrous sulphate @ 50 kg ha^{-1} + zinc sulphate @ 25 kg ha^{-1}) were replicated thrice and laid out

Table 1. Effect of organic and inorganic nutrition on available status of N, P, K and S, and Fe, Mo, Zn and OC in soil after crop harvest

Treatments	Available content (kg ha^{-1})				Available content			
	N	P_2O_5	K_2O	S	Fe (mg kg^{-1})	Mo (mg kg^{-1})	Zn (mg kg^{-1})	OC (%)
Organic								
C_0 (control)	135.01	15.45	152.60	7.78	5.99	0.121	0.495	0.241
F_{10} (FYM 10 t ha^{-1})	147.08	18.06	174.25	8.25	6.68	0.128	0.535	0.269
V_5 (vermicompost 5 t ha^{-1})	158.4	20.10	190.25	8.65	7.28	0.138	0.570	0.277
P_5 (poultry manure 5 t ha^{-1})	162.01	20.85	195.40	8.78	7.41	0.142	0.585	0.278
SEm$\pm$	3.35	0.66	5.56	0.12	0.20	0.003	0.011	0.004
CD (P=0.05)	9.58	1.88	15.93	0.33	0.58	0.008	0.032	0.011
Inorganic nutrients								
M_0 (control)	129.91	14.67	150.41	7.72	5.35	0.120	0.458	0.211
M_1(S)	140.48	17.17	164.35	8.18	6.21	0.127	0.498	0.225
M_2 (S +Mo)	152.43	19.33	185.24	8.28	7.02	0.142	0.547	0.240
M_3 (S+Mo+Fe)	163.66	21.31	204.02	8.39	7.76	0.144	0.600	0.256
M_4 (S+Mo+Fe+Zn)	166.64	21.11	209.11	8.51	7.85	0.148	0.669	0.273
SEm$\pm$	3.74	0.73	6.22	0.13	0.23	0.003	0.012	0.004
CD (P=0.05)	10.80	2.12	17.96	0.37	0.66	0.009	0.036	0.013

in Randomized Block Design. Recommended doses of nitrogen @ 20 kg ha^{-1} and phosphorus @ 40 kg ha^{-1} were applied at sowing time.

The green pod yield of each plot was computed by sum of yield and of pod per plot of all pickings and recorded as total pod yield kg ha^{-1}. To assess the fertility status of soil, the soil sample (0-15 cm depth) from each plot at crop harvest was taken. The samples were passed through 2 mm plastic sieve to avoid metallic contamination. The recommended dose of N, P and K was applied in the whole field prior to sowing. Whereas, sulphur and FYM were applied about three weeks (21 days) before sowing of the crop. The vermicompost and poultry manure were mixed manually in the randomly selected beds just before sowing. Mo, Fe and Zn were applied through ammonium molybdate, ferrous sulphate and zinc sulphate, respectively, through broadcasting as per treatment in randomly selected beds.

Results and Discussion

Effect of organic nutrition on soil available nutrient status

The application of organic manure significantly influenced the available contents of N, P, K, S, Mo, Fe and Zn in the soil at crop harvest (Table 1). The nutrient contents were maximum under the treatment P_5 (poultry manure @ 5 t ha^{-1}). The treatment P_5 was found to be statistically at par with the treatment V_5 (vermicompost @ 5 t ha^{-1}). The higher availability of mineral nutrients in soil due to application of manures (vermicompost) could be ascribed to mineralization of manures, reduction in fixation and complexing properties of decomposition products of manures with micronutrients (Reddy and Reddy, 1998). Higher levels of mineral nutrients in vermicompost treated plots could also be attributed due to chelating action of organic compounds released during decomposition of organic manures, which protect these cations from fixation, precipitation, oxidation and leaching (Yadav and Kumar, 1998) of nutrients at harvest. The increase in availability of nutrients at harvest of the crop may also be due to enhanced microbial activity and nitrogen fixation by the crop, cyclic transformation of insoluble micronutrients (Mann *et al.,* 1978), enhanced mobility (Varalakshmi *et al.,* 2005), solubilization of native forms of nutrients.

Effect of mineral nutrition on soil available nutrient status of N, P, K, S, Mo, Fe, Zn

The application of mineral nutrients significantly increased the available mineral contents of soil at harvest of the crop (Table 1). The maximum contents of N, P, K and Fe were recorded under the treatment M_3, whereas S, Mo and Zn were maximum and significantly higher under the treatment M_1, M_2 and M_4, respectively. The improvement in nutrient status of the soil may be ascribed to more biomass (leaves, roots and dead cell of

Table 2. Nutrient composition of vermicompost and poultry manure

Nutrients	Vermicompost	Poultry manure
N (%)	1.74	1.30
P (%)	0.89	1.80
K (%)	0.86	0.80

microbes) added to soil by legumes (Hegde and Sarati, 1978), increase in symbiotic nitrogen fixation, increase in soil biomass and microbial activity. The poultry manure was rich in phosphorus (Table 2). The increase in available content of the nutrients may also be due to direct addition of these nutrients in the fields of the experimental crop. Synergism between nitrogen and iron, phosphorus and molybdenum and positive interaction between Mo and Zn may also be responsible for increase in available content of these nutrients. Similar findings were also reported by Sharma and Jain (2012).

Effect of organic manure and mineral nutrients on organic carbon content of soil

The application of organic manures and mineral nutrients significantly increased the carbon content of the soil (Table 1). The significantly maximum organic carbon was recorded in the plots that received FYM @ 10 t ha^{-1} and mineral nutrient level M_4. The significant increase in organic carbon content in the manurial treatment could be attributed to direct incorporation of the organic matter in the soil (Swarup, 1991). Addition of organic manure might have also stimulated growth and activity of microbes (Babulkar *et al*., 2000) and due to better root growth (Varalakshmi *et al*., 2005). The results are in line with the findings of Bhandari *et al.* (2000).

The level of built up of microbial biomass depends on available organic carbon, nutrients and other soil characteristics. Addition of nutrients in a nutrient deficient soil, as in present experimental soil, is likely to respond to applied nutrients to have high biomass as well as biomass C, N, P and S. Higher available nutrients in biomass and nutrient availability in soil are positively correlated. The addition of mineral nutrients might have resulted in the proliferation of root and shoot growth (Babulkar *et al*., 2000) and might be due to the fact that organic and inorganic fertilizers contribute to increased biomass of the root system (Bhriguvanshi, 1988), which might have in turn increased organic carbon content of the soil. Similar findings were also reported by Thakur *et al.* (2011).

Table 3. Effect of organic and inorganic nutrition on green pod yield of vegetable cowpea

Treatments	Green pod yield (t ha^{-1})
Organic	
C_0 (control)	15.53
F_{10} (FYM 10 t ha^{-1})	17.25
V_5 (vermicompost 5 t ha^{-1})	18.57
P_5 (poultry 5 t ha^{-1})	19.01
SEm$\pm$	0.40
CD (P=0.05)	1.14
Inorganic nutrients	
M_0 (control)	14.61
M_1 (S)	16.40
M_2 (S +Mo)	17.97
M_3 (S+Mo+Fe)	19.38
M_4 (S+Mo +Fe+Zn)	19.59
SEm$\pm$	0.45
CD (P=0.05)	1.29

Effect of organic manure on yield

The sole application of organic manures (FYM @ 10 t ha^{-1}, vermicompost @ 5 t ha^{-1}, poultry manure @ 5 t ha^{-1}) and of inorganic sources (S, Mo, Fe and Zn) significantly increased the green pod yield (Table 3). The significantly high green pod yield 19.01 and 19.59 t ha^{-1} were recorded under treatments P_5 (poultry manure @ 5 t ha^{-1}) and conjoint application of sulphur, molybdenum, iron and zinc (M_4). The yields in treatments P_5, V_5 and M_4, M_3 were statistically at par. The higher increase in the yield has been reported to be associated with the release of macro and micronutrients during microbial decomposition (Singh and Ram, 1992). The beneficial effects of FYM/vermicompost addition also improved the soil physical properties (Kofoed, 1987). Organic matter was also a source of energy for soil microflora, which brings about the transformation of inorganic nutrients in soil in available form or applied in the form of fertilizers, which are utilized by growing plants (Sharma *et al*., 2002). These findings corroborate with the results of several other workers (Ghanshyam *et al.,* 2010; and Singh *et al*., 2008).

Effect of mineral nutrients on yield

The application of multinutrients combination significantly increased the yield of green pods of vegetable cowpea. The improvement in vegetable cowpea was significant under M_3 (S + Mo + Fe), which remained at par with M_4 (Table 2). The application of mineral fertilizers alone might supply one or two nutrients only, but conjoint use of macro and micro-nutrient fertilizers and organic manure would provide all the essential nutrients in proper ratio to plant and soil and also reduce the possibilities of multiple micronutrient deficiencies in particular. It is well established fact that pulse crops require 15-20 kg N, 40-60 kg P_2O_5 and 20 kg S ha^{-1} for successful production (Hand Book of Agriculture, 2011). The responses of some of the micronutrients viz., Mo, Fe and Zn have also been found to be promising in increasing the productivity of the soils (Masood Ali and Mishra, 2000). Significant response of pulses to mineral nutrients has also been reported by Chavan *et al.* (2012).

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