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Effect of organic and inorganic nutrition on symbiotic efficiency 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 symbiotic efficiency and yield of vegetable cowpea [*Vigna unguiculata* (L.) Walp.].The treatments consisted of four levels of 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}) were applied to the vegetable cowpea var. RCV-7. The experiment was laid out in randomized block design and replicated thrice. The resulted revealed that the application of vermicompost @ 5 t ha^{-1} and combined application of S+Mo+Fe were found significantly superior in increasing the number of total and effective nodule, leghemoglobin content in root nodules, chlorophyll content in leaves, green pod yield per ha^{-1} over control.

Keywords: Organic manure, mineral nutrients, vegetable cowpea, yield, leghaemoglobin, chlorophyll and nodules

Introduction
Organic materials are intrinsic and essential components of all soils and it makes a living dynamic system in the soil that supports all life residing in soil. Organic matter plays a vital role in improving the physical, chemical and biological condition of soil. Besides, addition of N, P, K, organic manures are a potential source of micronutrients and improve soil structure by providing binding action to soil aggregates, increases water holding capacity and improve buffering capacity of soils. Although release of nutrients are slow but steadily for longer duration thus preventing their losses by leaching and other means and improves nutrient use efficiency of the crop. The nutrients supplementation through organic sources also has been found to be a good carrier for flourishment of microbes resulting into sustained soil productivity and enhanced enzymatic activities. Legume-*Rhizobium symbiosis* has been found to be influenced by host-genotype and also by certain macro and micronutrient such as sulphur, molybdenum, iron and zinc.
The present investigation was undertaken to study the effect of organic and inorganic nutrition on symbiotic efficiency and yield of vegetable cowpea cv. RCV-7.

Material 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, phosphorus, potassium, 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 organic carbon (0.24 %).
Treatment consisting of 20 combination of 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 in Randomized Block Design and recommended dose of nitrogen @ 20 kg ha^{-1} and phosphorus @ 40 kg ha^{-1} were applied at sowing time.

Five plants from each plot were uprooted carefully and different observations such as total and effective number of nodules/plant were recorded at 45 DAS. The leghaemoglobin and chlorophyll content was measured by using method of Appleby *et al.* (1) and Witham *et al.* (11). The green pod yield of each plot was computed by totaling of yield and of pod per plot of all picking and recorded as pod yield q ha^{-1} and converted in term of pod yield q ha^{-1}.

Results and discussion

Effect of organic manure on symbiotic attributes

Number of total and effective nodule, leghaemoglobin and chlorophyll content of leaf were significantly influenced with the application of organic manures and highest significant increase in symbiotic attributes were recorded with the application of vermicompost @ 5 t ha^{-1} (V_5). The legumes are known to have symbiotic association with heterotrophic soil bacteria and contributes towards the nitrogen nutrition of legumes host plant specially at later stage of crop growth after the nodules have developed and are functional. The infection of bacteria and subsequent development of effective nodules as the result of several consecutive physiological and metabolic interactions. One of the fore most important requirements to have successful infection is the presence of sufficient number of viable infective cells of rhizobia for infection to root hairs, which depends on the physical and chemical properties of soil Presence of cells in soil, their viability and multiplication in the rhizosphere after the germination of seed are governed by physical, chemical and biological properties of soil. The level of success of infection also depends on the competitive ability of inoculated strain and health of host.

The application of organic substances in terms of either vermicompost or FYM resulted in improvement of fertility status of soil; enhanced population of desired microbes in root zone during early stage of infection, release of bacterial cells in the cortex plays a vital role in induction of nodule development, chlorophyll content of leaf and synthesis of leghaemoglobin (Lakshminarayan and Sharma, 1994) [9].

Balanced supply of nutrients for longer period and improved nutritional environment under better soil condition. Similar finding were also reported by Ghanshyam *et al.* (2010) [6]; Choudhary *et al.* (2011) [5]; Singh *et al.* (2010) [16].

Effect of mineral nutrient on symbiotic attributes

The number of total and effective root nodules, synthesis of leghaemoglobin contents in nodules and chlorophyll content in leaves significantly enhanced with each successive addition of mineral nutrients level and the significant increase in these symbiotic attributes was recorded with the combined application of S+Mo+Fe (M_3).The stimulating effect of S, Mo and Fe on symbiotic attributes might be due to increased availability of these nutrients to the crop and the microorganisms responsible for enhanced nodulation, synthesis of leghaemoglobin and chlorophyll contents of leaves. The sulphur is required for synthesis of the S-containing amino acids, coenzyme and chlorophyll content of leaves. Whereas the molybdenum is an essential compound of nitrogenase, which is activity involved in nitrogen fixation by root nodule bacteria of leguminous crop. The iron is a structural component of porphyrin molecules, cytochromes, heam, hematin, ferrichrome and leghaemoglobin. The balanced supply of S, Mo and Fe might have improved over all development of crop plant and symbiotic attributes of the crop. Similar finding were also reported by (2008) [12]; Singh *et al*. (2008) [13] and Gupta *et al.* (2012) [7].

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. The highest significantly green pod yield 190.09 and 195.85 q ha^{-1} were recorded under treatment P_5 (poultry manure @ 5 t ha^{-1}) and conjoint application of sulphur, molybdenum, iron and zinc (M_4). Treatment P_5 V_5 and M_4 M_3 were also recorded statistically at par.

The higher increase in the yield has been reported to be associated with the release of macro and micronutrients during the course of microbial decomposition (Singh and Ram 1992) [15]. The beneficial effects of FYM/ Vermicompost addition are also related to improvement in soil physical properties (Kofoed, 1987) [8]. The beneficial response of vermicompost to yield of pods might also be attributed to the availability of sufficient amounts of readily usable form of plant nutrients throughout the growth period and specially at critical growth periods of crop resulting in better uptake, plant vigour and superior yield attributes (Brar and Pasrich, 1998 and Bansal *et al.*, 2000) [3, 2]. These finding corroborates with the results of several other workers Ghanshyam *et al.* (2010) [6]; Singh *et al.* (2010) [16]; Singh *et al*. (2008) [14] and Ramawter *et al*. (2013) [11].

Effect of mineral nutrient on yield

The application of multinutrients combination significantly increased the yield of green pods of vegetable cowpea. The significant improvement in vegetable cowpea was noticed under the treatment level M_3 (S+Mo+Fe) and the treatment level M_3 remained at par with the treatment M_4.

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 reduces the possibilities of multiple micronutrients 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. The responses of some of the micronutrients *viz*, Mo, Fe and Zn have also been found promising in increasing the productivity of the soils (Masood Ali and Mishra, 2000). Significant response of pulses to mineral nutrients have also been reported by several workers Gupta *et al.* (2012) [7] and Chavan *et al.* (2012) [4].

Table 1: Effect of organic and inorganic nutrition on leghaemoglobin content, total nodules, effective nodules and chlorophyll content at flowering of vegetable cowpea

Treatments	Leghaemoglobin (mg g^{-1} fresh nodules)	Total nodules	Effective nodules	Chlorophyll content (mg g^{-1})
Organic				
C_0(control)	0.95	18.43	16.28	1.88
F_{10} (FYM 10 t ha^{-1})	1.39	21.07	19.01	2.17
V_5 (vermicompost 5 t ha^{-1})	1.68	23.04	21.34	2.36
P_5 (poultry 5 t ha^{-1})	1.78	23.51	21.89	2.45

SEm+	0.04	0.60	0.72	0.06
CD (P=0.05)	0.13	1.72	2.06	0.18
Inorganic nutrients				
M_0(control)	0.92	17.18	14.54	1.68
M_1 (S)	1.19	19.99	17.72	2.01
M_2 (S +Mo)	1.55	22.03	20.20	2.28
M_3 (S+Mo+Fe)	1.74	24.03	22.54	2.49
M_4 (S+Mo+Fe+Zn)	1.84	24.33	23.14	2.61
SEm+	0.05	0.67	0.80	0.07
CD (P=0.05)	0.14	1.94	2.32	0.20

Table 2 : Effect of organic and inorganic nutrition on green pod yield of vegetable cowpea

Treatments	Green pod yield (q ha^{-1})
Organic	
C_0(control)	155.25
F_{10} (FYM 10 t ha^{-1})	172.48
V_5 (vermicompost 5 t ha^{-1})	185.66
P_5 (poultry 5 t ha^{-1})	190.09
SEm+	3.99
CD (P=0.05)	11.42
Inorganic nutrients	
M_0(control)	146.13
M_1 (S)	163.99
M_2 (S +Mo)	179.62
M_3 (S+Mo+Fe)	193.75
M_4 (S+Mo +Fe+Zn)	195.85
SEm+	4.46
CD (P=0.05)	12.88

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