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Effect of organic manures on yield and nutrient uptake by cowpea and changes in soil nutrient status

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Abstract
A field experiment was carried out at Department of Agronomy, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (Maharashtra) during *Rabi* seasons of 2004 on lateritic soil, comprising thirteen treatment combinations where four sources of manures i.e. FYM, poultry manure, vermicompost and goat manure and three levels of manures i.e. @ 2.5, 5.0, 7.5 t ha^{-1} were applied, with one absolute control. The data revealed that application of manures through appropriate source and adequate levels to cowpea (Var. Konkan Sadabahar) is essential for enhancing grain yield, nutrient uptake, physico-chemical properties of soil as well as availability of macro-nutrients over absolute control. For this purpose, application of poultry manure was observed to be superior source as compared to FYM, vermicompost and goat manure; whereas in case of levels, application of manures @7.5 t ha^{-1} to cowpea was found to be more effective than their lower levels and rest of the treatment combinations.

Keywords: Cowpea, organic manures, nutrient uptake, soil properties

Introduction
Cowpea [*Vigna unguiculata* (L.) Walp.] is more cosmopolitan and is grown in most of the regions of India. In Maharashtra, especially cowpea is gaining popularity among farmers because of its manifold uses as food, fodder, vegetable, organic manure and for protecting the largest section of human and animal population and for soil conditions too. The estimated area under cowpea in Maharashtra is 18.1 thousand hectares with production of 12 thousand tonne with an average productivity of 663 kg ha^{-1}. Invention of very short duration (60–70 days) and strictly determinate genotype of cowpea is Konkan Sadabahar, developed and released by Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, opened a new avenue of pulse production. Exploitation of the potential of such a short duration crop on various fronts of cropping system may lead to significant advancement in yield of leguminous crops.
Application of chemical fertilizers increases the yield of the crop, but also has an adverse effect on soil and environment. Therefore, it is need to organize the supply of nutrients to crop through organic and renewable sources. Use of organic manures, apart from improving physical and biological properties of soil, helps in improving the use of efficiency of chemical fertilizers. Decreasing soil fertility has also raised concerns about the sustainability of agricultural production at current levels. Further, growing awareness on health and environmental issues in agriculture has demanded production of organic foods, which are emerging as an attractive source of rural income generation. Therefore, present investigation was carried out to determine the effect of organic manures on growth and yield of cowpea and changes in soil properties in lateritic soils of Konkan.

Material and Methods
The experiment was carried out during *Rabi* seasons of 2004 at Department of Agronomy, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (Maharashtra) on lateritic soil. This soil is classified into Gimhavane Series, which is a member of fine, mixed, isohyperthermic family of Fluventic Ustropepts (Bhattacharjee *et al*. 1978) [2]. The soil of the experimental plot was clay loam in texture, slightly acidic in reaction and low electrical conductivity. The status of soil organic carbon was very high (1.31%), whereas the content of available N, P_2O_5 and K_2O in soil were 340.0, 6.60 and 188.0 kg ha^{-1}, respectively. The field experiment was laid out in a factorial randomized block design comprising thirteen treatment combinations where combinations of four sources of manures i.e. FYM, poultry manure, vermicompost and goat manure and three levels of manures i.e. @ 2.5, 5.0, 7.5 t ha^{-1} were applied. The test crop cowpea (Var. Konkan Sadabahar) was sown by dibbling method at a distance of 30 x 15 cm.

Treatment wise quantities of manures were calculated and applied before sowing of the crop.

The pH and EC of the soils were estimated by using soil: water suspension (1:2.5) (Jackson, 1967) [5], organic carbon by wet oxidation method (Black, 1965) [4], available N by alkaline $KMnO_4$ method developed by Subbiah and Asija (1956) [9], available P_2O_5 by Bray–I spectrophotometric method (Black, 1965) [4] and available K_2O by flamephotometry (Jackson, 1967) [5].

Results and Discussions

Seed and Stover Yield

It was observed that organic manures influenced seed yield and stover yield of cowpea (Table 1). Application of poultry manure resulted in significant increase in seed yield (10.41 q ha^{-1}) and stover yield (12.63 q ha^{-1}) of cowpea over the application of FYM, vermicompost and goat manure. This may be due to higher available nutrients released by poultry manure during the process of mineralization and also higher nutrient content compared to the organic sources of nutrients. Further, there was linear increase in seed and stover yield with increase in level of organic manure. In interaction effects among sources and levels of organic manures, the treatment receiving poultry manure @7.5 t ha^{-1} produced the highest seed yield (12.75 q ha^{-1}) and stover yield (14.86 q ha^{-1}), which was significantly superior over all other treatment combinations. The superiority of poultry manure in increasing the yield of various crops was also reported by Ananda *et al.* (2006) [1].

Table 1: Effect of different levels of organic manures on seed yield (q ha^{-1}) and stover yield (q ha^{-1}) of cowpea

Sources (S)	**Seed Yield (q ha^{-1})**				**Stover Yield (q ha^{-1})**			
	Organic Manure Levels (L) (t ha^{-1})				**Organic Manure Levels (L) (t ha^{-1})**			
	2.5	**5.0**	**7.5**	**Mean**	**2.5**	**5.0**	**7.5**	**Mean**
Absolute control	-	-	-	6.70	-	-	-	8.96
FYM	7.90	8.98	10.63	9.17	10.02	11.25	12.16	11.14
Poultry manure	8.86	9.63	12.75	10.41	10.96	12.08	14.86	12.63
Vermicompost	8.45	9.36	11.11	9.64	10.46	11.64	13.36	11.82
Goat manure	7.71	8.62	9.68	8.67	9.84	10.76	11.98	10.86
Mean	8.23	9.15	11.04		10.32	11.43	13.09	
	Sources (S)	Levels (L)	Interaction (S x L)		Sources (S)	Levels (L)	Interaction (S x L)	
SE+	0.12	0.11	0.21		0.11	0.09	0.18	
CD (P=0.05)	0.36	0.31	0.61		0.31	0.27	0.53	

Uptake of nutrients

Data with respect to total uptake of N, P and K showed significant variation in uptake of N, P and K (Table 2). Among the manures, application of poultry manure recorded maximum N uptake (63.15 kg ha^{-1}), P uptake (7.76 kg ha^{-1}) and K uptake (34.13 kg ha^{-1}) followed by vermicompost. Application of manures @ 7.5 t ha^{-1} significantly increased the uptake of N, P and K over their respective lower levels. However, interaction effect among the manures and their levels were found to be non significant. As the uptake is product of nutrient content and yield, the significant increase in uptake with organic manures could be attributed to increasing availability of nutrients from manures that the organic manures after decomposition release macro-and micro-nutrients to soil solution, which becomes available to the plants, resulting in higher uptake. Significant increase in uptake of NPK by cowpea was also reported by Kadam (2000) [6] and Bhikane (2002) [3].

Changes in chemical properties of soils

The pH of soil after harvest of cowpea was significantly increased by graded levels of organic manures as compared to absolute control and its initial value (6.31) (Table 3). Among organic manures, application of poultry manure recorded higher soil pH (6.48) followed by vermicompost (6.43), goat manure (6.43) and FYM (6.42). The ability of poultry manure to increase soil pH was also attributable to the presence of basic cations in the poultry manure released upon microbial decarboxylation (Natsher and Schwetnmann, 1991) [8]. The interaction effect among the levels and sources of manures were found to be non significant. The increase in pH of acid soil due to addition of organic manures is attributed to the deactivation of Fe^{3+} and concomitant release of basic cations during their decomposition (Lal and Mathur, 1988) [7].

The maximam increase in soil EC was observed in the treatments of poultry manure (0.086 dS m^{-1}) followed by vermicompost (0.082 dS m^{-1}), FYM (0.072 dS m^{-1}), goat manure (0.077 dS m^{-1}) and absolute control (0.057 dS m^{-1}) (Table 3). The laterite and lateritic soils which generally depleted of total soluble salts due to intensive leaching, showed slight increase due to the application of organic manure which might be due to the possible built up of the soluble nutrient drawn from manures on mineralization.

The organic carbon content of soil after harvest of cowpea crop was increased significantly with poultry manure application (1.50%) over FYM (1.39%) and goat manure (1.42%) and was at par with vermicompost (1.47%) application (Table 3). As the level of manures addition increased, the organic carbon content of soil was also increased. The improvement in soil organic carbon in organic manures treated plots might be ascribed to direct addition of organic matter through organic manures and also due to addition of considerable amount of leaf litter of crop.

Changes in nutrient status of soils

The marked increased in available N, P_2O_5 and K_2O due to different organic manures was in the order of poultry manure > vermicompost > goat manure > FYM. Among sources of manures, poultry manure showed its superiority over rest of the sources (Table 4). Similarly, graded levels of manures significantly increased the available nutrient status of soil. The application of organic manure might have increased the microbial population leading to mineralization of organically bound N into plant available form and also helped in the solubility of native insoluble phosphates, thus increasing the available phosphorous content in soil. Applied organic matter leads to the formation of a coating on the sesquioxides; because of this the phosphate fixing capacity of soil was

reduced. The higher availability of K in soil may be due to beneficial effect of organic manures on the reduction of potassium fixation; added organic matter interacted with K clay to release K from non-exchangeable fraction to the available pool.

Table 2: Effect of different levels of organic manures on total N, P and K uptake by cowpea

Sources (S)	**Total N uptake** (kg ha^{-1})				**Total P uptake** (kg ha^{-1})				**Total K uptake** (kg ha^{-1})			
	Organic Manure Levels (L) (t ha^{-1})				**Organic Manure Levels** (L) (t ha^{-1})				**Organic Manure Levels** (L) (t ha^{-1})			
	2.5	**5.0**	**7.5**	**Mean**	**2.5**	**5.0**	**7.5**	**Mean**	**2.5**	**5.0**	**7.5**	**Mean**
Absolute control	-	-	-	38.00	-	-	-	2.92	-	-	-	19.95
FYM	45.08	51.49	59.31	51.96	4.43	5.01	5.71	5.05	25.26	28.50	31.85	28.54
Poultry manure	52.66	59.27	77.53	63.15	6.66	7.28	9.34	7.76	29.37	32.19	40.82	34.13
Vermicompost	48.71	56.70	67.61	57.67	5.55	6.16	7.20	6.30	27.56	30.61	35.62	31.26
Goat manure	44.76	52.10	58.85	51.90	4.88	5.40	6.04	5.44	25.17	27.76	31.08	28.00
Mean	47.80	54.89	65.83		5.38	5.96	7.07		26.84	29.77	34.84	
	Sources (S)	Levels (L)	Interaction (S x L)		Sources (S)	Levels (L)	Interaction (S x L)		Sources (S)	Levels (L)	Interaction (S x L)	
SE±	1.37	1.19	2.37		0.14	0.13	0.25		0.54	0.47	0.93	
CD (P=0.05)	4.00	3.46	NS		0.42	0.36	NS		1.57	1.36	NS	

Table 3: Effect of different levels of organic manures on chemical properties of soil at harvest of cowpea

Sources (S)	**pH (1:2.5)**				**Electrical conductivity (dS m^{-1})**				**Organic carbon (%)**			
	Organic Manure Levels (L) (t ha^{-1})				**Organic Manure Levels (L) (t ha^{-1})**				**Organic Manure Levels (L) (t ha^{-1})**			
	2.5	**5.0**	**7.5**	**Mean**	**2.5**	**5.0**	**7.5**	**Mean**	**2.5**	**5.0**	**7.5**	**Mean**
Absolute control	-	-	-	6.29	-	-	-	0.057	-	-	-	1.33
FYM	6.36	6.43	6.47	6.42	0.066	0.072	0.078	0.072	1.38	1.39	1.40	1.39
Poultry manure	6.42	6.50	6.53	6.48	0.079	0.088	0.091	0.086	1.43	1.49	1.58	1.50
Vermicompost	6.41	6.44	6.45	6.43	0.079	0.081	0.085	0.082	1.42	1.48	1.50	1.47
Goat manure	6.40	6.44	6.45	6.43	0.077	0.078	0.077	0.077	1.39	1.43	1.43	1.42
Mean	6.40	6.45	6.48		0.075	0.080	0.083		1.40	1.45	1.48	
	Sources (S)	Levels (L)	Interaction (S x L)		Sources (S)	Levels (L)	Interaction (S x L)		Sources (S)	Levels (L)	Interaction (S x L)	
SE±	0.007	0.006	0.013		0.0015	0.0013	0.0026		0.01	0.01	0.02	
CD (P=0.05)	0.021	0.018	NS		0.004	0.0038	NS		0.03	0.027	0.05	

Table 4: Effect of different levels of organic manures on available N, P_2O_5 and K_2O of soil at harvest of cowpea

Sources (S)	**Available N (kg ha^{-1})**				**Available P_2O_5 (kg ha^{-1})**				**Available K_2O (kg ha^{-1})**			
	Organic Manure Levels (L) (t ha^{-1})				**Organic Manure Levels (L) (t ha^{-1})**				**Organic Manure Levels (L) (t ha^{-1})**			
	2.5	**5.0**	**7.5**	**Mean**	**2.5**	**5.0**	**7.5**	**Mean**	**2.5**	**5.0**	**7.5**	**Mean**
Absolute control	-	-	-	328	-	-	-	6.57	-	-	-	175
FYM	342	351	360	351	6.62	6.70	6.81	6.71	197	206	228	211
Poultry manure	350	362	370	361	6.84	6.98	7.07	6.96	251	309	336	299
Vermicompost	348	355	365	356	6.72	6.84	6.98	6.85	211	278	314	267
Goat manure	345	353	362	353	6.67	6.79	6.85	6.77	211	264	305	260
Mean	346	355	364		6.71	6.83	6.93		217	264	296	
	Sources (S)	Levels (L)	Interaction (S x L)		Sources (S)	Levels (L)	Interaction (S x L)		Sources (S)	Levels (L)	Interaction (S x L)	
SE±	0.40	0.34	0.69		0.008	0.007	0.013		3.78	3.27	6.54	
CD (P=0.05)	1.16	1.01	2.01		0.02	0.02	0.04		11.02	9.54	19.09	

Conclusion

Application of manures through appropriate source and adequate levels to cowpea (Var. Konkan Sadabahar) in lateritic soils of Konkan is essential for enhancing grain yield, nutrient uptake and chemical properties of soil over absolute control. For this purpose, application of poultry manure was observed to be superior source as compared to FYM, vermicompost and goat manure; whereas in case of levels, application of manures @7.5 t ha^{-1} to cowpea was found to be more effective than their lower levels and rest of the treatment combinations. It is, therefore, concluded that in lateritic soil of Konkan for cowpea, application of poultry manure @ 7.5 t ha^{-1} be adopted for the purpose of increasing crop productivity as well as improving soil fertility.

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