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Effect of organic manures and phosphorus on cowpea and their residual effect on succeeding little millet

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Abstract
Field experiments were conducted during 2017-18 to 2018-19 at Tirupati (AP) to evaluate the direct and residual effects of organic and inorganic sources of nutrients on yield of cowpea-little millet cropping sequence. Three levels of organic manures (no organic manure, FYM @ 5 tonnes ha^{-1} and poultry manure @2 tonnes ha^{-1}) and 3 phosphorus levels (0, 40 and 60 kg P_2O_5 ha^{-1}) applied to cowpea and 3 graded levels of nitrogen *viz*., 0, 10 and 20 kg ha^{-1} applied to succeeding little millet. Yield attributes and yield of cowpea varied with manures and phosphorus levels. Poultry manure @ 2 tonnes ha^{-1} resulted in higher number of pods per plant, seeds per pod, pod and haulm yields which was on par with application of FYM @ 5 tonnes ha^{-1}. Among the phosphorus levels, application of 60 kg P_2O_5 ha^{-1} resulted in higher pod yield. Yield attributes and yield of little millet were influenced by the residual effect of organic manures and phosphorus applied to cowpea, as well as nitrogen levels applied to little millet, where 20 kg N ha^{-1} resulted in significantly higher values of yield attributes and yield compared to 10 kg N ha^{-1} and control. This study concluded that the application of poultry manure to preceding cowpea showed residual effect by saving nitrogen dose to succeeding little millet.

Keywords: FYM, poultry manure, cowpea, phosphorus, residual effect, direct effect, little millet

Introduction
Inclusion of legumes with the use of organic and inorganic sources of nutrients in cropping sequence results in improvement of base as well as succeeding crop to achieve food, nutritional security, increased productivity, profitability and sustainability.
Cowpea [*Vigna unguiculata* (L.) Walp] is of immense importance, as it is a multipurpose grain legume extensively cultivated in arid and semiarid tropics. The cowpea is used as grain, green pods and fodder. Cowpea is grown as a catch crop, weed smothering crop, intercrop, mixed crop and green manure crop. It has ability to fix atmospheric nitrogen in soil at the rate of 56 kg per hectare in association with symbiotic bacteria under favourable conditions (Yadav, 1986) [10].
The little millet is one among the six small millets grown in most of the regions of scanty and eratic rainfall on poor and marginal soils. Cultivation of this crop is mostly confined to hilly tract and poor tribal community of the country. The demand for little millet is increasing now-a-day due to its high nutritional profile with low glycemic index particularly by the people suffering from diabetes. It has good nutritive value as it is rich in carbohydrates (66.3%), protein (7.5 to 13.8%), fat (3.54%) crude fiber (5.73%), iron (1.38mg $100g^{-1}$) and calcium (21.21mg $100g^{-1}$) (Kulkarni *et al*., 1992) [5].
Organic manures although, not useful as sole sources of nutrients, are however, good complementary sources with inorganic fertilizers (Chaudhary *et al*., 2004) [2]. Phosphorus is the second most critical plant nutrient over all, but for pulses it assumes primary importance owing to its important role in root proliferation and there by atmospheric nitrogen fixation. The management of organic manures and phosphorus is considered for cropping system as a whole rather than for individual crop because they cannot be fully utilized by the crop to which these are added and a substantial amount is left into the soil for subsequent crops and their residual effects thus become an important dimension for their management (Ali and Mishra, 2000) [1]. As information on these aspects is lacking in cowpea-little millet cropping sequence. The present investigation was carried out.

Materials and Methods
The field experiments were conducted during two consecutive years (2017-2018 and 2018-19) at S.V. Agricultural college farm, Tirupati of Andhra Pradesh. The soil of the experimental

field was sandy loam in texture, low organic carbon (0.39 %) and available N (168.5 kg ha^{-1}) medium in P_2O_5 (18.8 kg ha^{-1}), available K_2O (161.3 kg ha^{-1}) and neutral in reaction (6.94). The experiment was laid out in split-split design with three replications at same site during both the years. The treatments consisted of three organic manures, viz., control, (M_1) FYM @ 5 t ha^{-1} (M_2) and poultry manure @ 2 t ha^{-1} (M_3) as main plot treatments and three phosphorus levels, viz., 0 (P_1), 40 kg P_2O_5 ha^{-1} (P_2) and 60 kg P_2O_5 ha^{-1} as sub-plot treatments imposed to cowpea crop during *kharif* season. Three nitrogen levels 0 kg ha^{-1} (S_1), 10 kg ha^{-1} (S_2) and 20 kg ha^{-1} (S_3) as sub- sub plot treatments imposed to little millet during *rabi* season. As per treatments, FYM and poultry manure were incorporated 15 days before sowing and phosphorus was applied at basal to cowpea during both the years. Cowpea variety -TPTC-29 was sown in rows 30 cm apart using a seed rate of 20 kg ha^{-1}. The green pods of cowpea were picked in three spells and haulms were incorporated into the soil thoroughly for full decomposition followed by sowing of little millet. As per treatment half of the nitrogen dose was applied as basal and remaining half was applied after 30 DAS. Little millet variety 'OLM-203' was raised in rows 20 cm apart using a seed rate of 10 kg ha^{-1}.

Results and Discussion

Cowpea

The yield attributes and yield of cowpea was higher with incorporation of poultry manure, however, it was on par with those resulted due to FYM incorporation and both were significantly superior to no manure application during both the years of study (Table 1). This might be due to the fact that organic manures supplied balanced nutrition to the crop, improved soil condition and there by resulting in better growth and development leading to higher yield attributes and yield. The same was obvious through the findings of Yadav *et al.* (2007) [9], Rao *et al.* (2013) [7] and Singh *et al.* (2015) [8].

Number of pods $plant^{-1}$ and seeds per pod^{-1} showed increased trend with application of increased P levels. Similarly, successive increase in P levels had positive effect on pod as well as haulm yield over their preceding level. Application of 60 kg P_2O_5 ha^{-1} recorded higher pod yield and haulm yield which was comparable with that resulted with 40 kg P_2O_5 ha^{-1} and both were significantly superior over control (Table 1). Application of phosphorus might have resulted in increased the energy transfer as phosphorus is constituent of many enzymes and their remobilization to reproductive parts of the plants. Hence, resulted in increased flowering, fruiting and seed formation might attributed to more pod yield. These results are in conformity with the findings of Kumawat, (2006) [6]. Quantity of cowpea haulms incorporated was ranged from 9600 to 13162 kg ha^{-1} and 8414 to 11137 kg ha^{-1} during 2017 and 2018 on fresh wait bases, due to variation in growth of plants with varied treatments. The nitrogen content on dry weight bases ranged from 2.07 to 2.37 and 2.08 to 2.39 during 2017 and 2018. The residual effect of incorporated haulms reflected on succeeding little millet growth and yield.

Table 1: Yield attributes and yield of cowpea as influenced by organic manures and phosphorus levels

Treatments	No. of pods $plant^{-1}$		No. of seeds pod^{-1}		Green pod yield (kg ha^{-1})		Haulm yield (kg ha^{-1})	
	2017	2018	2017	2018	2017	2018	2017	2018
Organic manures								
M_1	5.01	4.98	6.16	7.03	1771	1916	9600	8414
M_2	6.79	6.81	7.89	8.86	2607	2754	12703	10794
M_3	7.26	7.30	7.93	9.01	2719	2872	13162	11137
SEM±	0.157	0.224	0.156	0.245	50.3	66.3	118.9	110.0
CD (P=0.05)	0.63	0.90	0.62	0.98	203	267	479	443
Phosphorus levels								
P_1	5.42	5.12	6.09	6.94	1964	2094	10061	8053
P_2	6.56	6.72	7.77	8.73	2492	2650	12571	10954
P_3	7.08	7.25	8.12	9.21	2641	2798	12833	11339
SEM.±	0.244	0.237	0.134	0.196	70.3	71.0	146.6	158.2
CD (P=0.05)	0.75	0.73	0.41	0.61	219	221	456	492
Interaction								
P at M								
SEM±	0.272	0.388	0.270	0.425	87.2	114.8	205.9	190.5
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
M at P								
SEM±	0.379	0.403	0.245	0.371	111.4	120.3	239.0	249.3
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Little millet

The yield attributes viz., number of panicles m^{-2}, length of panicle, weight of panicle, grain weight of panicle and yield of little millet was higher due to residual effect of poultry manure followed by FYM incorporation during both the years (Table 2). Similarly, residual effect of 60 kg P_2O_5 ha^{-1} reflected on enhanced yield attributes and yield of succeeding little millet. However it was on par with those resulted with 40 kg P_2O_5 ha^{-1}.

In addition to the residual effect of manures reflected on yield of little millet, direct application of nitrogen also altered the yield attributes and yield. Significantly, higher grain yield was recorded with 20 kg N ha^{-1} (Table 3). This might be attributed to better availability and uptake of nitrogen which in turn lead to efficient metabolism and higher biomass accrual and efficient translocation of photosynthetic from source to sink. The increase in sink capacity resulted in improved yield attributes and consequently enhanced the grain yield. The above results are in conformity with the findings of Kalaghatagi *et al*., 2000 [4] and Hasan *et al*., 2013 [3].

Regarding the interaction effect, the grain yield of little millet was significant with combined effect of residual manures and direct nitrogen doses, where, the poultry manure residual effect along with 20 kg N ha^{-1} resulted in highest grain yield of little millet (Table 4).

With respect to the economics, the gross, net returns and returns per rupee invested followed the similar trend of effect as that of grain yield of little millet, where numerically higher income was reflected with poultry manure application in combination with 60 kg P_2O_5 to cowpea and their residual effect with 20 kg N ha^{-1} to little millet (Table 5).

Interaction effect of manorial residually with 20 kg N was progressively increased with poultry manure followed by FYM residually. The interaction data with respect to returns per rupee invested clearly indicated that poultry manure saves the nitrogen to succeeding little millet (Table 6).

Table 2: Yield attributes of little millet as influenced by nitrogen and residual effect of manures and phosphorus applied to preceding cowpea

Treatments	Number of panicles m^{-2}		Length of panicle (cm)		Weight of panicle (g)		Grain weight $panicle^{-1}$		1000 grain weight (g)	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
Organic manures										
M_1	218	213	24.0	21.7	2.62	2.66	1.92	2.03	2.50	2.45
M_2	244	238	24.8	23.6	2.95	2.89	2.25	2.10	2.53	2.44
M_3	245	239	25.3	24.1	2.98	2.92	2.28	2.14	2.57	2.49
SEM ±	0.90	0.60	0.35	0.19	0.014	0.013	0.014	0.013	0.014	0.010
CD (P = 0.05)	3.5	2.3	NS	0.7	0.05	0.05	0.05	0.05	NS	NS
Phosphorus level										
P_1	231	224	24.3	22.5	2.84	2.81	2.14	2.07	2.50	2.47
P_2	237	231	24.8	23.5	2.85	2.82	2.15	2.10	2.55	2.45
P_3	240	234	24.9	23.4	2.86	2.83	2.16	2.11	2.55	2.47
SEM ±	1.54	1.44	0.36	0.30	0.014	0.013	0.014	0.013	0.021	0.008
CD (P = 0.05)	4.7	4.4	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen levels										
S_1	206	200	23.1	21.8	2.72	2.69	2.02	1.95	2.53	2.43
S_2	235	229	25.2	23.2	2.84	2.82	2.14	2.09	2.54	2.45
S_3	266	260	25.9	24.4	2.99	2.96	2.29	2.23	2.53	2.51
SEM ±	2.19	1.80	0.36	0.31	0.014	0.013	0.014	0.013	0.019	0.009
CD (P = 0.05)	6.3	5.1	1.0	0.9	0.03	0.03	0.03	0.03	NS	0.02

Table 3: Grain yield (kg ha^{-1}) of little millet as influenced by nitrogen and residual effect of manures and phosphorus applied to preceding cowpea

		2017-18					2018-19				
		S_1	S_2	S_3	Mean for M	Mean for P	S_1	S_2	S_3	Mean for M	Mean for P
M_1	P_1	1036	1173	1460	1283	1376	1002	1129	1412	1233	1317
	P_2	1096	1240	1536			1046	1186	1476		
	P_3	1116	1320	1574			1066	1266	1514		
M_2	P_1	1260	1444	1651	1474	1426	1179	1363	1560	1392	1364
	P_2	1233	1471	1667			1153	1391	1581		
	P_3	1233	1558	1754			1153	1478	1667		
M_3	P_1	1164	1468	1729	1514	1470	1123	1427	1659	1464	1408
	P_2	1269	1595	1725			1219	1545	1675		
	P_3	1302	1617	1757			1252	1567	1711		
Mean for S		1190	1432	1650			1133	1373	1584		

	2017-18		2018-19	
	SEM ±	CD (P = 0.05)	SEM ±	CD (P = 0.05)
M	23.21	90.6	23.45	91.5
P	16.05	49.4	14.96	46.1
S	13.47	38.6	12.79	36.7
MXP	27.81	NS	25.91	NS
MXS	23.34	66.9	22.16	63.5
PXS	23.34	NS	22.16	NS
MXPXS	40.43	NS	38.39	NS

Table 4: Interaction effect of organic manures and nitrogen levels on grain yield (kg ha^{-1}) of little millet

2017-18					2018-19				
	S_1	S_2	S_3	Mean of M		S_1	S_2	S_3	Mean of M
M_1	1083	1244	1523	1283	M_1	1038	1194	1467	1233
M_2	1242	1491	1690	1474	M_2	1161	1411	1603	1392
M_3	1245	1560	1737	1514	M_3	1198	1513	1682	1464
Mean of S	1190	1432	1650		Mean of S	1133	1373	1584	
MXS	SEM ±	CD (P = 0.05)			MXS	SEM ±	CD (P = 0.05)		
	23.34	66.9				22.16	63.5		

Table 5: Yield and economics of little millet as influenced by nitrogen and residual effect of manures and phosphorus applied to preceding cowpea

Treatments	Straw yield (kg ha^{-1})		Gross returns (` ha^{-1})		Net returns (` ha^{-1})		Returns per rupee invested	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
Organic manures								
M_1	1568	1532	26458	25435	14677	13654	2.24	2.15
M_2	1712	1662	30353	28671	18572	16890	2.57	2.43
M_3	1815	1763	31195	30174	19414	18393	2.64	2.55
SEM ±	26.7	27.0	477.4	482.3	477.4	482.3	0.041	0.041
CD (P = 0.05)	104	105	1863	1883	1863	1883	0.16	0.16
Phosphorus level								
P_1	1633	1598	28347	27151	16566	15370	2.40	2.30
P_2	1709	1657	29378	28109	17597	16328	2.49	2.38
P_3	1752	1701	30281	29020	18500	17239	2.56	2.46
SEM ±	16.4	16.8	329.4	307.6	329.4	307.6	0.028	0.026
CD (P = 0.05)	50	51	1014	947	1014	947	0.08	0.08
Nitrogen levels								
S_1	1465	1422	24539	23371	12889	11721	2.10	2.00
S_2	1705	1662	29495	28289	17714	16508	2.50	2.40
S_3	1925	1873	33971	32620	22059	20708	2.85	2.73
SEM ±	13.8	14.2	276.4	263.0	276.4	263.0	0.023	0.022
CD (P = 0.05)	39	41	793	754	793	754	0.06	0.06

Table 6: Interaction effect of organic manures and nitrogen levels on returns per rupee invested of little millet

2017-18					2018-19				
	S1	S2	S3	Mean of M		S1	S2	S3	Mean of M
M1	1.91	2.17	2.63	2.24	M1	1.83	2.09	2.53	2.15
M2	2.19	2.60	2.92	2.57	M2	2.05	2.47	2.77	2.43
M3	2.20	2.72	3.00	2.64	M3	2.12	2.64	2.90	2.55
Mean of S	2.10	2.50	2.85		Mean of S	2.00	2.40	2.73	
MXS	SEM ±	CD (P = 0.05)			MXS	SEM ±	CD (P = 0.05)		
	0.041	0.11				0.039	0.11		

Conclusion

The experimental results concluded that in the areas where cowpea little millet crop sequence is fallowed, manures application to preceding crop preferably poultry manure conserve the nitrogen dose to succeeding little millet crop.

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