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Effect on soil biological properties as influenced by different nutrient management approaches under pigeonpea cultivation in Vertisol

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Abstract
A study was conducted to know the effect of different nutrient management approaches along with FYM on soil biological properties in pigeonpea cultivation during 2016-17 and 2017-18 in farmer's field of Raichur district. The experiment was laid out in Randomized Block Design with three replications and ten treatments. The results revealed that, application of 150% RDF approach with FYM at 90 DAS and at harvest stage of pigeonpea significantly increased the beneficial microbial load of bacteria (37.08 and 22.47 X 10^7 cfu g^{-1}), fungi (37.08 and 22.47 X 10^7 cfu g^{-1}) and actinomycetes (16.07 and 9.63 X 10^4 cfu g^{-1}), microbial biomass (277 and 261 µg CO_2-C g^{-1} soil for 24 hrs) and enzyme activities of dehydrogenase (21.09 and 15.73 µg TPF g^{-1} soil for 24 hrs), phosphatase (69.37 and 66.8 µg PNP g^{-1} soil for 1 hr) and urease (170 and 161 µg NH_4- N g^{-1} soil for 2 hrs) in soil, respectively.

Keywords: Nutrient management, pigeonpea, RDF

Introduction
Leguminous crops are rich source of protein in vegetarian diet and play a significant role in preventing the widespread malnutrition in the country. Pigeonpea is a popular pulse crop of India and provides variety of protein rich vegetarian dishes for humans. Application of balanced fertilizer increases microbial load of bacteria, fungi and actinomycetes along with beneficial enzyme activities. It is the 5th prominent pulse crop in the world and 2nd in India after chick pea. In India, pigeonpea ranks second in both acreage (5.13 million ha) and production (4.23 million tonnes) among the pulses with average productivity of 824 kg ha^{-1} (Anonymous 2015) [1]. It occupies an area of 0.77 mha with a production of 0.53mt with an average productivity of 596 kg ha^{-1} in Karnataka (GOI, 2012).
Soil biological properties are regarded as soil quality indicators as they respond rapidly to environmental changes and these can be particularly useful for assessing soil fertility and quality in studies. The soil biological property responds very well to the inorganic and organic nutrient sources. Hence, the present study was undertaken to know the effect on soil biological properties as influenced by different nutrient management approaches in pigeonpea cultivation.

Material and Methods
An experiment was conducted at farmer's field of Raichur district. The dominant soil type was *Vertisol* meant with a clay texture containing 0.52% organic carbon and pH of 7.90. The pigeonpea variety TS-3R was used. The experiment was laid out with randomised block design with three replications and ten treatments. Treatment groups consisted of T_1: Absolute control, T_2: Farmer practice, T_3: RDF (25:50:00 kg ha^{-1} as per POP), T_4: 150% RDF, T_5: Soil Test Laboratory Method, T_6: Soil Test based NPK ± 25%, T_7: Soil Test based N ± 25% and P ± 50%, T_8: STCR Approach (Targeted yield of 15 q ha^{-1}), T_9: STCR Approach (Targeted yield of 18 q ha^{-1}) and T_{10}: STCR Approach (Targeted yield of 20 q ha^{-1}). Well decomposed FYM containing 0.5% N, 0.2% P_2O_5 and 0.5% K_2O was applied 10 days prior to sowing as per treatments. Soil sample from each treatment plot were collected at 90 DAS and at harvest stage of pigeonpea and were immediately stored in polythene bags. The soil samples were preserved and stored at 5 ^{0}C in a refrigerator until analysis.

Theses samples were utilized for the assay of soil microbial load of bacteria, fungi and actinomycetes, soil biomass and soil enzyme activity. Methods employed for the determination of above parameters as follows:

Table 1: The show parameters and method

Parameters	Method	Reference
Microbial flora (Bacteria, Fungi and Actinomycetes)	Serial dilution and agar plate method	Pramer and Schmidt (1964)
Microbial biomass	Fumigation extraction method	Vance *et al.* (1987)
Dehydrogenase enzyme	Triphenyl Formazan (TPF) method	Casida *et al.* (1965)
Phosphatase enzyme	p-nitrophenyl phosphate method	Tabatabi and Bremner (1969)
Urease enzyme	NH_4-N Distillation	Bremner and Keeney (1966)

The recorded data were subjected to statistical analysis using the analysis of variance technique for randomized block design as suggested by Panse and Sukhame (1967) [6].

Result and Discussion

The pooled data of results obtained from the present investigation on microbial load, soil microbial biomass and enzyme activity are presented in Table 2 and 3. The microbial population in soil showed similar trend at 90 DAS and at harvest stage of pigeonpea, The activity value depletion in harvest stage might be due to decreased in moisture content. In the present study, the obtained results are clearly indicated that the treatment applied with T_4: 150% RDF (with FYM @ 6 t ha^{-1}) have recorded significantly highest population of bacteria (37.08 and 22.47 X 10^7 cfu g^{-1}), fungi (26.19 and 10.83 X 10^4 cfu g^{-1}) and actinomycetes (16.07 and 9.63 X 10^4 cfu g^{-1}) at 90 DAS and at harvest stage of pigeonpea, respectively and was found on par with T_7: Soil test based N ± 25% and P ± 50% (36.44 and 21.70 X 10^7 cfu g^{-1}, 26.01 and 10.53 X 10^4 cfu $g^{-1}$and 15.82 and 9.37 X 10^4 cfu g^{-1}), respectively. The increment in population of bacteria, fungi and actinomycetes by higher level of fertilizer (*ie.*, 150% RDF) and generally applied FYM (@ 6 t ha^{-1}) might be due to increasing levels of N and P which increases the biomass, root exudates and ultimately provides carbon and energy to the soil microbes resulting into multiplication of microbial population (Geethakumari and Shivashankar, 1991) [3]. Similar findings were reported by Chand *et al.* (2010) [2].

Soil microbial biomass is a sound indicator of soil health since it regulates nutrient cycling and acts as a highly labile source of plant available nutrients. Comparison of different nutrient management approaches revealed that application of 150% RFD (T_4) resulted significantly higher soil microbial biomass carbon (277 and 261 µg CO_2-C g^{-1} soil for 24 hrs) at 90 DAS and at harvest stage of pigeonpea, respectively. There is increased in level of soil microbial biomass carbon with increased fertilizer level. The results aare in agreement with these reported by Gogoi *et al.* (2010) [4].

The dehydrogenase, phosphatase and urease enzyme activity are indicators of the biological activity in soils. At 90 DAS and at harvest stage of pigeonpea, T_4: 150% RDF recorded the higher dehydrogenase, phosphatase and urease activity of 21.09 and 15.73 µg TPF g^{-1} soil for 24 hrs, 69.37 and 66.8 µg PNP g^{-1} soil for 1 hr and 170 and 161 µg NH_4- N g^{-1} soil for 2 hrs, respectively, being on par with T_7: Soil test based N ± 25% and P ± 50% (20.80 and 15.03 µg TPF g^{-1} soil for 24 hrs, 67.70 and 66.17 µg PNP g^{-1} soil for 1 hr and 167 and 158 µg NH_4- N g^{-1} soil for 2 hrs). The lower value of activity of dehydrogenase (11.09 and 5.49 µg TPF g^{-1} soil for 24 hrs), phosphatase (48.82 and 46.37 µg PNP g^{-1} soil for 1 hr) and urease (116 and 106 µg NH_4- N g^{-1} soil for 2 hrs) enzymes were noticed with absolute control (T_1). Similar results were reported by Geethakumari and Shivashankar (1991) [3]. Masto *et al.* (2006) [5] found that enzyme activity was dependent on addition of number and amount of nutrient.

Thus cultivation of pigeonpea with the application of fertilizer dose according to 150% RDF with FYM approach is in better preposition for maintaining good soil health regarding to biological properties of soil under rainfed condition in Vertisols of North eastern dry zone of Karnataka.

Table 2: Soil microbial population in soil sample estimated at different growth stages of pigeonpea as influenced by different nutrient management approaches

Treatment	Bacteria (10^7 cfu g^{-1})		Fungi (10^4 cfu g^{-1})		Actinomycetes (10^4 cfu g^{-1})		Biomass (µg CO_2-C g^{-1} soil for 24 hrs)	
	90 DAS	At harvest	90 DAS	At harvest	90 DAS	At harvest	90 DAS	At harvest
T_1: Absolute control	21.51	13.92	15.34	4.85	8.46	3.68	216	199
T_2: Farmers practice	27.30	16.08	21.04	7.19	12.78	6.82	246	223
T_3: RDF	30.95	18.17	23.63	9.08	14.09	7.84	257	243
T_4: 150% RDF	37.08	22.47	26.19	10.83	16.07	9.63	277	261
T_5: STL method	33.79	19.09	25.10	9.64	15.02	8.56	268	248
T_6: Soil Test based NP ± 25%	35.88	20.35	25.46	10.10	15.31	8.82	272	252
T_7: Soil Test based N ± 25% and P ± 50%	36.44	21.70	26.01	10.53	15.82	9.37	274	255
T_8: STCR approach (Targeted yield: 15 q ha^{-1})	28.16	16.32	22.93	7.84	13.13	7.17	248	236
T_9: STCR approach (Targeted yield: 18 q ha^{-1})	29.99	17.73	23.51	8.81	13.66	7.53	255	239
T_{10}: STCR approach (Targeted yield: 20 q ha^{-1})	32.52	18.91	24.11	9.28	14.58	8.37	267	245
S. Em.±	0.47	0.41	0.52	0.20	0.31	0.18	5.67	5.27
C.D. at 5%	1.41	1.22	1.53	0.61	0.93	0.52	16.85	15.66

Note: FYM @ 6 t ha^{-1} and deficient nutrients were applied for all treatments except T_1

Table 3: Soil enzymatic activity in soil sample collected at different growth stages of pigeonpea as influenced by different nutrient management approaches

Treatment	Dehydrogenase activity (µg TPF g^{-1} soil for 24 hrs)		Phosphatase activity (µg PNP g^{-1} soil for 1 hr)		Urease activity (µg NH_4-N g^{-1} soil for 2 hrs)	
	90 DAS	At harvest	90 DAS	At harvest	90 DAS	At harvest
T_1: Absolute control	11.09	5.49	48.82	46.37	116	106
T_2: Farmers practice	16.03	12.02	60.60	55.80	129	121
T_3: RDF	17.52	13.53	63.76	59.50	144	136
T_4: 150% RDF	21.09	15.73	69.37	66.81	170	161
T_5: STL method	19.58	14.39	64.93	62.09	157	149
T_6: Soil Test based NP ± 25%	20.44	14.81	66.56	64.78	164	153
T_7: Soil Test based N ± 25% and P ± 50%	20.80	15.03	67.70	66.17	167	158
T_8: STCR approach (Targeted yield: 15 q ha^{-1})	16.46	12.67	61.16	56.17	132	127
T_9: STCR approach (Targeted yield: 18 q ha^{-1})	17.31	13.30	62.42	58.10	141	132
T_{10}: STCR approach (Targeted yield: 20 q ha^{-1})	19.17	14.12	64.57	61.08	152	144
S. Em.±	0.40	0.29	1.39	1.32	3.26	3.07
C.D. at 5%	1.19	0.88	4.13	3.92	9.70	9.12

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