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 10^7 cfu g^-1), microbial biomass (277 and 261 µg CO_2 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). 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 T0: Absolute control, T1: Farmer practice, T2: RDF (25:50:00 kg ha^-1 as per POP), T3: 150% RDF, T4: Soil Test Laboratory Method, T5: Soil Test based NPK ± 25%, T6: Soil Test based N ± 25% and P ± 50%, T7: STCR Approach (Targeted yield of 15 q ha^-1), T8: STCR Approach (Targeted yield of 18 q ha^-1) and T9: 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 harvested and stored at 5 °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:

| Parameters          | Method                        | Reference          |
|---------------------|-------------------------------|--------------------|
| Microbial flora     | 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 Brenner (1969) |
| Urease enzyme       | NH₄-N Distillation            | Brenner 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 T₆: 150% RDF (with FYM @ 6 t ha⁻¹) have recorded significantly higher population of bacteria (37.08 and 22.47 X 10⁶ cfu g⁻¹), fungi (26.19 and 10.83 X 10⁶ cfu g⁻¹) and actinomycetes (16.07 and 9.63 X 10⁶ cfu g⁻¹) at 90 DAS and at harvest stage of pigeonpea, respectively and was found on par with T₁: Soil Test based N ± 25% and P ± 50% (36.44 and 21.70 X 10⁶ cfu g⁻¹) and T₅: RFD (Targeted yield: 15 q ha⁻¹) have recorded significantly highest population of bacteria (27.72 and 15.82 X 10⁶ cfu g⁻¹) and 97.37 and 9.37 X 10⁶ 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% RDF (T₆) resulted significantly higher soil microbial biomass carbon (277 and 261 μg CO₂-C g⁻¹ soil for 24 hrs) at 90 DAS and at harvest stage of pigeonpea, respectively. There is increase in level of soil microbial biomass carbon with increased fertilizer level. The results aare in agreement with these reported by Gogoti 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, T₆: 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 NH₄-N g⁻¹ soil for 2 hrs, respectively, being on par with T₆: 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 NH₄-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 NH₄-N g⁻¹ soil for 2 hrs) enzymes were noticed with absolute control (T₁). 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 (10⁶ cfu g⁻¹) | Fungi (10⁴ cfu g⁻¹) | Actinomycetes (10³ cfu g⁻¹) | Biomass (μg CO₂-C g⁻¹ soil for 24 hrs) |
|----------------------------|-----------------------|--------------------|-----------------------------|--------------------------------------|
|                            | 90 DAS At harvest     | 90 DAS At harvest  | 90 DAS At harvest           | 90 DAS At harvest                   |
| T₁: Absolute control       | 21.51                 | 13.92              | 15.34                       | 4.85                                 |
| T₂: Farmers practice       | 27.30                 | 16.08              | 21.04                       | 7.19                                 |
| T₃: RFD                    | 30.95                 | 18.17              | 23.63                       | 9.08                                 |
| T₄: 150% RDF               | 37.08                 | 22.47              | 26.19                       | 10.83                                |
| T₅: STL method             | 33.79                 | 19.09              | 25.10                       | 9.64                                 |
| T₆: Soil Test based N ± 25%| 35.88                 | 20.35              | 25.46                       | 10.10                                |
| T₇: Soil Test based N ± 25%| 36.44                 | 21.70              | 26.01                       | 10.53                                |
| T₈: STCR approach (Targeted yield: 15 q ha⁻¹)| 28.16            | 16.32              | 22.93                       | 7.84                                 |
| T₉: STCR approach (Targeted yield: 18 q ha⁻¹)| 29.99            | 17.73              | 23.51                       | 8.81                                 |
| T₁₀: STCR approach (Targeted yield: 20 q ha⁻¹)| 32.52            | 18.91              | 24.11                       | 9.28                                 |
| S. Em±                      | 0.47                  | 0.41               | 0.52                        | 0.20                                 |
| C.D. at 5%                  | 1.41                  | 1.22               | 1.53                        | 0.61                                 |

Note: FYM @ 6 t ha⁻¹ and deficient nutrients were applied for all treatments except T₁
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: 20 q ha\(^{-1}\)) | 17.31  | 13.30      | 62.42  | 58.10      | 141    | 132        |
|                            | S. Em.± | 0.40       | 0.29   | 1.39       | 1.32   | 3.26       | 3.07 |
| S. Em.±                    | 1.19    | 0.88       | 4.13   | 3.92       | 9.70   | 9.12       |
| C.D. at 5%                 |         |            |        |            |        |            |

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