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A study on effect of nutrient management practices on soil microbial counts and economics in chickpea in Karnataka state

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Abstract
A field experiment was conducted at Krishi Vignana Kendra, Kalaburagi, University of Agricultural Sciences, Raichur during *rabi* 2015-16. To study the "Nutrient management in chickpea (*Cicer arietinum* L.) in black soil under rainfed situation". The study objective was to assess chemical properties also apart from nutrient management. The findings reveal that, significant enhancement in the soil microorganism's viz., bacteria, fungi and actinomycetes noticed at harvest stages of chickpea. The significant increase in microbial counts was observed with the addition of organic manures in combination with fermented liquid organic manure. Among all the treatments at harvest, significantly higher dehydrogenase activity was recorded in FYM @ 5 t ha-1 + VC @ 2.5 t ha-1 + Jeevamrutha (13.11) which was due application of organic manure. Further, regaring economics, minimum cost of cultivation was recorded in (T1) during the study period.

Keywords: Soil chemical properties, fungi, bacteria, organic manures

Introduction
In the universe, soil microbial population is the world largest uncharted resource pool of biodiversity on this earth, the human efforts were made to study the nature and identification of such microorganisms in soils are accounted for only less than 10 per cent (Bhattacharyya, 2012) [1]. Further, the, soil microbial population consists of numerous microbes such as fungi, algae, bacteria, actinomycetes to name few and many others among microbial populations. These microbial populations influence the fertility status in soils due to its interactions, it is note worthy to mention that these organisms are always found to be interact with each other and they are not found in isolation, they are always grouped characterized by groups, highly dynamic and complex in nature. These microbes help the soils to build good growth in terms of soil fertility and overall health of soils at large scale. These microbial population essentially concludes the quantum of soil structure, availability of plant nutrients, organic matter content and other diversities in microbial population can be know by these interactions. Usually soil microbes are found in rhizosphere of plants around macropores and surface soils. Macropores are linked to content of organic matter. Microbial population and its diversity are connected with amount of organic matter. Hence, soil microbial and diversity and abundance are found maximum in the top 10 cm and decline with soil depth (Rana *et al.*, 2012) [2].
On the other end, the stability in production of any crops based systems or any production will largely depends upon the quality of soil-plant for mainatence of good soil health but also to avoid erosion and to reduce environmental impacts on soils and build better ecosystems for future needs. Hence, the success of any life in soils depends on integration of soil microbial interactions to improve the soil health quality (Requena *et al.* 2001) [3].
Soil acts as home for numerous bacteria, algae, fungi and insects apart from this soil acts as buffer in providing fresh water for drinking for many organisms including human beings. Apart from these importance to living aspects of life, soils are also very important for human societies helps in leading better life by depending for production of food, construction of houses and other materials used in construction purposes. Many studies reveals that bacterial population differs in the soil surface across the horizons and classification and genus diversity of microbes are influenced by plant root growth, nutrients and availability of carbon content in the soils (Eilers *et al.* 2012) [4].

Materials and Methods
A field experiment was conducted at Krishi Vignana Kendra, Kalaburagi, University of Agricultural Sciences, Raichur, conducted during rabi 2015-16. To study the "Nutrient

management in chickpea (*Cicer arietinum* L.) in black soil under rainfed situation". Analysis of microbial biomass and dehydrogenase activity in soil. Soil samples were collected from the rhizosphere of the plants at harvest. The soil samples collected were placed in a polyethylene bag and brought to laboratory and stored in refrigerator at 50^0C until used for analysis.

1. Enumeration of soil microorganisms

The rhizosphere soil samples collected from experimental soil were analyzed for different soil micro-organisms viz., bacteria, fungi and actinomycetes using standard dilution plate count technique and plating on specific nutrient media.

2. Dehydrogenase activity (µg TPF/g soil)

The dehydrogenase activity in the soil samples was determined by following the procedure as described by Casida *et al.* (1964) [5]. Ten gram of soil and 0.2 g CaCo3 were thoroughly mixed and dispensed in the conical flasks. Each flask was added with 1.0 ml of 1.5 per cent, 2, 3, 5-triphenyl tetrazolium chloride (TTC), 1.0 ml of 1 per cent glucose solution and 8.0 ml of distilled water to leave a thin film of water above soil layer. The flasks were stoppered with rubber bunks and incubated at 30 ^{0}C for 24 hours. At the end of incubation, the contents of the flask were rinsed down into small beaker and a slurry was made by adding 10 ml of methanol. The slurry was filtered through Whatman No. 42 filter paper.

The repeated rinsing of soil with methanol was continued till the filtrate ran free of red colour. The filtrate was made up to 50 ml with methanol in volumetric flask. The intensity of red colour was measured at 485 nm against a methanol blank using spectrometer. The Dehydrogenase activity was calculated using the formula.

$$\text{Dehydrogenase activity } (\mu g \text{ TPF g } 24 \text{ h.}^{-1}) = \frac{\text{Graph ppm x } 33.7}{24 \text{ x Dry weight of soil}}$$

3. Economics of chickpea cultivation

B:C ratio were worked out by using the formula.

$$\text{Benefit: Cost (B: C)} = \frac{\text{Gross returns (Rs. ha}^{-1})}{\text{Cost of cultivation (Rs. ha}^{-1})}$$

Results and Discussions

The soil microbes like bacteria, fungi, actinomycetes and degydrogenase activity after harvest of chickpea as influenced by different organic and inorganic treatments in the study is presented in the Table 01 and figure 01. The data on soil microbial counts for bacteria, fungi, actinomycetes and degydrogenase activity by harvest of chickpea were statistically significant.

Bacteria: (No. X 10^7 cfu g^{-1} of soil)

At harvest, significantly higher bacterial counts was recorded in FYM @ 5 t ha^{-1}+ VC @ 2.5 t ha^{-1}+ Jeevamrutha (28.49) and was on par with VC @ 2.5 t ha^{-1}+ 100% RDF (27.66), VC @ 2.5 t ha^{-1} + Jeevamrutha (27.22) and FYM @ 5 t ha^{-1}+ Jeevamrutha (26.57). Significantly lower bacterial counts was recorded with RDF (21.61) over rest of the treatments except FYM @ 5 t ha^{-1}+ 50% RDF (22.12), RDF + Jeevamrutha (22.77), VC @ 2.5 t ha^{-1}+ 50% RDF (23.84), FYM @ 5 t ha^{-1}+ 75% RDF (24.19), VC @ 2.5 t ha^{-1}+ 75% RDF (25.21) and FYM @ 5 t ha^{-1}+ 100% RDF (26.57).

Fungi: (No. X 10^5 cfu g^{-1} of soil)

Among all the treatments at harvest, significantly higher fungal counts was recorded in FYM @ 5 t ha^{-1}+ VC @ 2.5 t ha^{-1} + Jeevamrutha (38.56) and was on par with VC @ 2.5 t ha^{-1} + Jeevamrutha (37.33), VC @ 2.5 t ha^{-1} + 100% RDF (37.19) and FYM @ 5 t ha^{-1} + Jeevamrutha (35.43). Significantly lower fungal counts was recorded with RDF (31.21) over rest of the treatments except FYM @ 5 t ha^{-1} + 50% RDF (32.16), RDF + LF (Jeevamruta) (32.96), VC @ 2.5 t ha^{-1} + 50% RDF (32.98), FYM @ 5 t ha^{-1} + 75% RDF (33.87), VC @ 2.5 t ha^{-1} + 75% RDF (34.52) and FYM @ 5 t ha^{-1} + 100% RDF (34.79).

Actinomycetes: (No. X 10^7 cfu g^{-1} of soil)

At harvest, significantly higher actinomycetes counts was recorded in FYM @ 5 t ha^{-1} + VC @ 2.5 t ha^{-1} + Jeevamrutha (21.13) and was on par with VC @ 2.5 t ha^{-1} + 100% RDF (19.72), VC @ 2.5 t ha^{-1} + Jeevamrutha (19.36) and FYM @ 5 t ha^{-1} + Jeevamrutha (18.41). Significantly lower actinomycetes counts was recorded with RDF (14.70) over rest of the treatments except FYM @ 5 t ha^{-1} + 50% RDF (15.04), RDF + Jeevamrutha (15.69), VC @ 2.5 t ha^{-1} + 50% RDF (16.33), FYM @ 5 t ha^{-1} + 75% RDF (16.89), VC @ 2.5 t ha^{-1} + 75% RDF (17.47) and FYM @ 5 t ha^{-1} + 100% RDF (18.17).

In the present study, significant improvement in the soil microorganisms viz., bacteria, fungi and actinomycetes noticed at harvest stages of chickpea (Table 01). The significant increase in microbial counts was observed with the addition of organic manures in combination with fermented liquid organic manure. Application of FYM + VC + Jeevamrutha, VC + Jeevamrutha and VC + 100% RDF recorded significantly higher bacterial, fungal and actinomycetes population at harvest. This could be due to cumulative effect of various sources of organic manures in increasing organic carbon content of soil which acted as carbon and energy source for microbes and their quick build up in the soil (Barik *et al.*, 2006 and Palekar, 2006) [6, 7]. Lower bacterial, fungal and actinomycetes population was noticed in RDF treatment. Because it did not cause significant changes in the soil microbial population, growth and functioning of soil microbial counts as carbon substrate availability is limited. These results are in line with the findings of Deshpande *et al.*, 2010 [8]. Who reported higher soil microbial population with addition of combined application of organics.

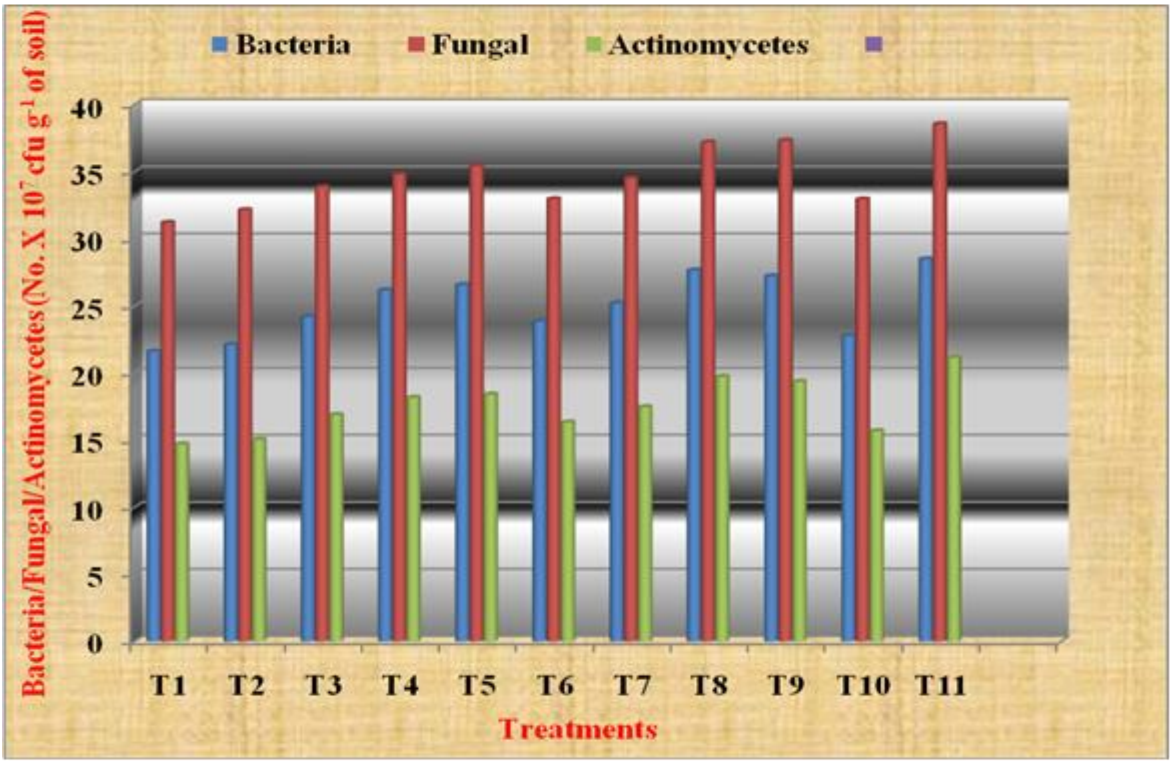

Fig 1: Soil microbial biomass of soil after harvest of the crop as influenced by nutrient management practices

Table 1: Soil microbial counts and Dehydrogenase activity of soil after harvest of the crop as influenced by nutrient management practices

Treatment details	Bacteria (No. X 10^7 cfu g^{-1} of soil)	Fungi (No. X 10^5 cfu g^{-1} of soil)	Actinomycetes (No. X 10^3 cfu g^{-1} of soil)	Dehydrogenase activity (µg TPF h^{-1} g^{-1} soil)
T_1 : RDF(10:25:0 $N:P_2O_5:K_2O$ kg ha^{-1})	21.61	31.21	14.70	7.17
T_2 : FYM @ 5 t ha^{-1} + 50% RDF	22.12	32.16	15.04	8.35
T_3 : FYM @ 5 t ha^{-1} + 75% RDF	24.19	33.87	16.89	9.89
T_4 : FYM @ 5 t ha^{-1} + 100% RDF	26.18	34.79	18.17	10.93
T_5 : FYM @ 5 t ha^{-1} + Jeevamrutha	26.57	35.43	18.41	11.54
T_6 : VC @ 2.5 t ha^{-1} + 50% RDF	23.84	32.98	16.33	9.54
T_7 : VC @ 2.5 t ha^{-1} + 75% RDF	25.21	34.52	17.47	10.66
T_8 : VC @ 2.5 t ha^{-1} + 100% RDF	27.66	37.19	19.72	12.86
T_9 : VC @ 2.5 t ha^{-1} + Jeevamrutha	27.22	37.33	19.36	12.61
T_{10} : RDF + Jeevamrutha	22.77	32.96	15.69	8.61
T_{11} : FYM @ 5 t ha^{-1} + VC @ 2.5 t ha^{-1} + Jeevamrutha	28.49	38.56	21.13	13.11
S.Em ±	1.20	1.45	1.13	1.12
CD (0.05)	3.54	4.28	3.33	3.31

RDF: Recommended Dose of Fertilizer, FYM: Farm Yard Manure, VC: Vermicompost

Dehydrogenase activity: (µg TPF h^{-1} g^{-1} soil)

Among all the treatments at harvest, significantly higher dehydrogenase activity was recorded in FYM @ 5 t ha^{-1} + VC @ 2.5 t ha^{-1} + Jeevamrutha (13.11) and was on par with VC @ 2.5 t ha^{-1} + 100% RDF (12.86), VC @ 2.5 t ha^{-1} + Jeevamrutha (12.61) and FYM @ 5 t ha^{-1} + Jeevamrutha (11.54). Significantly lower dehydrogenase activity was recorded with RDF (7.17) over rest of the treatments except FYM @ 5 t ha^{-1} + 50% RDF (8.35), RDF + LF (Jeevamruta) (8.61), VC @ 2.5 t ha^{-1} + 50% RDF (9.54), FYM @ 5 t ha^{-1} + 75% RDF (9.89), VC @ 2.5 t ha^{-1} + 75% RDF (10.66) and FYM @ 5 t ha^{-1} + 100% RDF (10.93).

The dehydrogenase activity in soil was influenced significantly due to application of organic manures in chickpea crop (Table 1) at harvest. significantly higher dehydrogenase activity was recorded in T11 which received FYM @ 5t ha^{-1} + VC @ 2.5t ha^{-1} + Jeevamrutha (13.11) and was on par with T8 VC @ 2.5 t ha^{-1} + 100% RDF (12.86), VC @ 2.5 t ha^{-1} + Jeevamrutha (12.61). However, significantly lower dehydrogenase activity was recorded with RDF alone treatment (7.17). This might be due to the presence of substrate through organic manures like FYM, vermicompost and jeevamrutha etc. and increased buildup in the microbial population resulting in the dehydrogenase enzyme activity in soil (Gayatri Verma and Mathur, 2009) [9]. Also might be ascribed to the increased microbial activity as a result of increased availability of substrate namely organic carbon through organic manures causing biological explosion (increase in microbial population) which in turn might have released enzymes of extracellular origin. Similar results were observed by Kanwar *et al.* (2006) [10].

Effect of nutrient management practices on economics of chickpea cultivation

Application of (T11) FYM @ 5 t ha^{-1} + VC @ 2.5 t ha^{-1} + Jeevamrutha was recorded the maximum cost of cultivation (Rs. 31145 ha^{-1}) and minimum cost of cultivation was recorded in (T1) control (Rs. 25060 ha^{-1}). Higher gross returns (Rs. 67257 ha^{-1}) in treatment combination of (T11) FYM @ 5 t ha^{-1} + VC @ 2.5 t ha^{-1} + Jeevamrutha and lowest gross returns (Rs. 47317 ha^{-1}) was obtained in control (T1). Higher net returns (Rs. 36112 ha^{-1}) were recorded in (T11)

FYM @ 5 t ha^{-1} + VC @ 2.5 t ha-[1] + Jeevamrutha. Lowest net return was observed in (T1) control (Rs. 22257 ha^{-1}). Higher B:C ratio (Rs.2.16 ha^{-1}) was recorded in (T11) FYM @ 5 t ha^{-1} + VC @ 2.5 t ha^{-1} + Jeevamrutha, lowest B:C ratio (Rs.1.89 ha^{-1}) recorded in control (T1).

Conclusion

Soil biological properties viz., bacteria, fungi and actinomycetes biomass count at harvest of chickpea was significantly higher with FYM @ 5 t ha^{-1} + VC @ 2.5 t ha^{-1} + Jeevamrutha, VC @ 2.5 t ha^{-1} + 100% RDF and VC @ 2.5 t ha^{-1} + Jeevamrutha over rest of the treatments when compared to their initial values before sowing. Significantly lower microbial population was observed with RDF treatment. However, in case of economics, Application of FYM @ 5 t ha^{-1} + VC @ 2.5 t ha^{-1} + Jeevamrutha recorded significantly higher B: C ratio (2.16) as compared to all other treatments, and lower B: C ratio (1.89) with rest of the treatments. It could due to the higher the yield obtained than the RDF treatment.

Table 2: Economics of chickpea as influenced by nutrient management practices

Treatment Details	Cost of cultivation (Rs. Ha ^{1})	Gross Returns (Rs. ha^{-1})	Net Returns (Rs. ha^{-1})	B:C ratio
T_1 : RDF(10:25:0 N:P_2O_5:K_2O kg ha^{-1})	25060	47317	22257	1.89
T_2 : FYM @ 5 t ha^{-1} + 50% RDF	25185	47841	22656	1.90
T_3 : FYM @ 5 t ha^{-1} + 75% RDF	26859	52905	26046	1.97
T_4 : FYM @ 5 t ha^{-1} + 100% RDF	29560	59016	27976	2.10
T_5 : FYM @ 5t ha^{-1} + Jeevamrutha	29570	59714	30144	2.02
T_6 : VC @ 2.5 t ha^{-1} + 50% RDF	27725	52905	25180	1.91
T_7 : VC @ 2.5 t ha^{-1} + 75% RDF	28899	56048	27149	1.94
T_8 : VC @ 2.5 t ha^{-1} + 100% RDF	30820	61111	30291	1.98
T_9 : VC @ 2.5 t ha^{-1} + Jeevamrutha	30670	60064	29394	1.96
T_{10} : RDF + Jeevamrutha	26975	51857	24882	1.92
T_{11} : FYM @ 5 t ha^{-1} + VC @ 2.5 t ha^{-1} + Jeevamrutha	31145	67257	36112	2.16

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