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Effect of organic and bio fertilizers practices on soil microbial population in black pepper (*Piper nigrum* L.)

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Abstract
Field experiment was conducted at Horticultural Research Station, Yercaud, Tamil Nadu Agricultural University, Coimbatore during the period June 2008 to April 2009 to find out the influence of organic and biofertilizers on soil microbial activity in black pepper (*Piper nigrum* L.). the experiment was laid out with six treatments replicated four times in a randomized block design. Among the treatments of organic manures and biofertilizers, the microbial population on bacteria (x10^3 CFU g^1 soil), fungi (x10^4 CFU g^{-1} soil) and actinomycetes (x10^7 CFU g^{-1} soil) was higher in the combined application (T_5) of FYM, Azospirillum, Phosphobacteria and VAM at initial, flowering and harvesting stage.

Keywords: Black pepper, FYM, azospirillum, phosphobacteria, VAM, soil microbial properties

Introduction
India is known as the "Land of spices" from time immemorial and emerged as a leading country in respect of area, production and export of spices in the world. Black pepper (*Piper nigrum* L.) is the most important spice of the world referred as 'King of Spices' cultivated for its green and dried berries. Considering its economic importance, the local and global demand is estimated to be increased from the present level. But in India, the productivity of this spice is low owing to several constraints associated with production. Practically, the monoculture and heavy application of chemical fertilizers may cause depletion of certain nutrients in soil and certain others would generally accumulate in excess resulting in nutrient imbalance which effects the soil productivity. Among the means available to achieve sustainability in agricultural production, organic manure and bio-fertilizer play an important role because they possess many desirable soil properties and exert beneficial effect on the biological characteristics. The soil microbial biomass is the living part of the soil organic matter formed by fungi, bacteria, protozoa, and algae representing an important source of nutrients that may supply plant demands due to its rapid cycling (Sicardi *et al.,* 2004) [6]. Soil microbial activity and diversity play important roles in the sustainability by keeping essential functions in soil health, involving carbon and nutrient cycling (Izquierdo *et al*., 2005) [3]. Inoculation with VAM and and N_2-fixing bacteria may increase the growth and microbial activity (Tilak 1993) [7] and Bopaiah and Khader (1989) [2] observed that combined application of Azopsirillum, Azotobacter and Phosphobacteria improved growth of balck pepper. Use of biofertilizers for crop production is gaining lot of importance because they are eco-friendly, low cost agriculture input, capable of improving crop yields and quality. Bio fertilizers contains large population of agriculturally beneficial microorganisms in a live state and are able to mobilize the nutritionally important elements through biological processes. Nowadays, a lot of attention is being given to organic and bio fertilizer application in horticultural crops to reduce the dose of inorganic fertilizers and also reduce the production cost. With the above background, present investigation was proposed to study the effect of organics and biofertilizers (Azospirillum, Phosphobacteria and VAM) on soil microbial activity in black pepper.

Materials and Methods
An experimental study on "Standardization of organic practices in black pepper cv., Panniyur - 1" was carried out at the Horticultural Research Station, Yercaud, Tamil Nadu Agricultural University, Coimbatore during the period June 2008 to April 2009. There were six treatments namely T_1- FYM 10 Kg + 5 Kg Coir Compost + 50 g Phosphobacteria + 50 g Azospirillum, T_2

- FYM 10 Kg + 1 Kg Vermi Compost + 50 g Phosphobacteria, T_3 - FYM 10 kg + 1 Kg Neem Cake + 50 g Phosphobacteria + 50 g Azospirillum, T_4 - FYM 10 Kg + 50 g Azospirillum + 50 g Phosphobacteria, T_5 - FYM 10 Kg + 50 g Azospirillum + 50 g Phosphobacteria + 200 g VAM and T_6 - 100 g of N + 40 g of P_2O_5 + 140 g of K_2O (Recommended dose for Package of Practices - Control) replicated four times in a randomized block design.

The rhizosphere soil sample was collected at the initial (before treatment), flowering stage and harvesting stage.

The observations that were recorded are bacteria (x10^3 CFU g^1 soil), fungi (x10^4 CFU g^{-1} soil) and actinomycetes (x10^7 CFU g^{-1} soil) at initial, flowering and harvesting stage.

Results and Discussions

In the present study among all the treatments, (T_5 - FYM 10 Kg + 50 g Azospirillum + 50 g Phosphobacteria + 200 g VAM) registered higher bacteria, fungi and actinomycetes population both the stages than the absolute control (Table 1).

The bacteria population in the soil ranged from (19.54 to 26.44 CFU g^{-1} at flowering stage and in harvesting stage population in the soil ranged from (15.82 to 23.56 CFU g^{-1}). The higher bacterial population was recorded by T_5 (26.44 and 23.56 CFU g^{-1}) at both the stages and in minimum number of population occurred in T_6 (19.54 and 15.82 CFU g^{-1})

In fungi, also (T_5) registered higher fungi population (10.56 and 8.85 CFU g^{-1}) at both the stages than the control. Which was on par with T_3. In actinomycetes, population dynamics also revealed some difference among the treatments. Population of actinomycetes per gram of soil varied from (7.50 and 8.85 CFU g^{-1}) and (6.71 and 8.21 CFU g^{-1}) at flowering and harvesting stages. The lowest population count was registered in T_6 (7.50 and 6.71 CFU g^{-1}) at both the stages.

In the present study, FYM, Azospirillum, Phosphobacteria and VAM had significantly more influence on the soil microbial population. The result obtained in this study is supported by the report of Rajalingam (2000) [5] in tea, Krishna kumar *et al*. (2005) [4] in rice and Aswathy *et al*. (2017) [1] in Black pepper. The attributed reason could be the enhanced organic carbon content of the soil as a result of organic manure application. Besides this, the organic manure addition viz., FYM would have resulted in increased secondary and micronutrients in the soil which might have helped to increase the microbial population. Combined use of organic manures with bio fertilizers might have improved the microbial load of the soil, this increasing the microbial population viz., bacteria, fungi and actinomycetes conspicuously increased with application of different organic N sources than the control.

Table 1: Effect of organic practices on soil microbial population at various stages

Treatments	Bacteria (x 10^3 CFU g^{-1} soil)		Fungi (x 10^4 CFU g^{-1} soil)		Actinomycetes (x 10^7 CFU g^{-1} soil)	
Initial population	18.9		7.5		6.0	
	Flowering stage	Harvesting stage	Flowering stage	Harvesting stage	Flowering stage	Harvesting stage
T_1	19.82	17.11	9.84	8.21	8.22	7.22
T_2	20.56	18.45	10.35	8.01	8.52	8.05
T_3	24.25	21.80	10.12	8.55	7.89	7.32
T_4	22.50	19.11	10.00	8.39	8.41	7.64
T_5	26.44	23.56	10.56	8.85	8.85	8.21
T_6	19.54	15.82	9.42	7.89	7.50	6.71
SEd	0.32	0.28	0.14	0.11	0.11	0.10
CD (P = 0.05)	0.68	0.59	0.30	0.25	0.25	0.22

Conclusion

Salient findings from the present study revealed the efficacy of organic and biofertilizers supplements in improving microbial fauna and soil health. The general and beneficial microbial population was more for combined application than sole application. The population was higher in the combined application (T_5) of FYM, Azospirillum, Phosphobacteria and VAM. Aswathy *et al*. (2017) [1] reported that application of *Phosphorous solubilising bacteria* along with Azospirillum, humic acid and fish amino acid resulted better growth and was more effective through increasing the general and beneficial microbial population in the rhizosphere of plants. Kuntal das *et al.* (2007) also reported the combined application biofertilizers significantly increased soil microbial population and increase the fertilizer use efficiency thereby increase the yield.

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