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Influence of different management practices on growth performance of black pepper (*Piper nigrum* L.)

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Abstract
A field experiment was conducted for two years (2018-19 to 2019-20) to evaluate the influence of different farming practices (Natural farming, organic and recommended package of practice (RPP) with the check as chemical farming) on plant growth, soil nutrient status, soil microbial and enzymatic activity in rhizosphere of black pepper at College of Horticulture, Sirsi, Karnataka. India. Among different farming practices, RPP recorded significantly higher plant height (2.60 cm), stem girth (0.664 cm), internodal length (8.608 cm), leaf length (15.607 cm), breadth (12.553 cm) and leaf area (465.5cm2) were also recorded highest in conventional followed by organic farming practice. The higher number of runners (4.56) was recorded in RPP and it is on par with organic farming practice (4.34). Treatment receiving Natural farming recorded the highest microbial population *viz*., Bacteria (70.48 x10^6 CFU soil^{-1}), fungi (17.49 x10^3 CFU soil^{-1}), actinomycetes (39.34 x10^4 CFU soil^{-1}), Free living nitrogen fixers (27.65 x10^4 CFU soil^{-1}) and P-solubilizers population (22.64 x10^4 CFU soil^{-1}) and enzymatic activity *viz.,* dehydrogenase activity (19.99 (µg TPF formed g^{-1} soil d^{-1}) and phosphatase activity (15.66 (µg PNP released g^{-1} soil h^{-1}). All these Paramerters are on par with organic farming practice when compared with RPP and control.

Keywords: Natural farming, organic farming, recommended package of practice, *Piper nigrum*

Introduction
The role of Natural Farming as an ecological farming practice is to create organically grown black pepper that is safe and of excellent quality and also improve soil quality and soil health. Currently, there is a need to acknowledge the information on the impacts of Natural Farming compared to organic farming and RPP approaches on black pepper plantations, notably in Karnataka's malnad districts.

Some studies on other crops had indicated positive outcomes using the Natural Farming method. Thus, this research discusses the essential role of organic inputs, chemical inputs and bio fertilizers in farming and their potential in pepper cultivation. Through the action of different treatments, the optimal treatment should be able to transform a degraded soil ecosystem into fertile and has high nutrient availability. The cost of inorganic fertilizers is skyrocketing, putting them out of reach for small and marginal farmers. With the use of inorganic fertilizers and insecticides, the population of beneficial organism's decreases and spontaneous soil nutrition regeneration ceases. Soil fertility declines as the soil become bare.

In organic farming practice, the use of fermented liquid manures and bio-fertilizers in such situations is, therefore practically a paying proposition. In these liquid manures, beneficial organisms survive and are helpful in phosphate solubilization, nitrogen fixation *etc*. The application of these organic liquid formulations will enhance the soil microbial activity and population to a larger extent. This in turn has a positive effect on the growth and yield of crops.

Natural farming practices can effectively prevent the entry of pesticides and toxicants into the food chain and prevent soil and water pollution. It is adopted with a blend of ecologically safe modern technologies.

Panchagavya, Jeevamruth Ganajeevamrutha and Beejamruth are cheaper eco-friendly organic preparations made by cow products namely dung, urine, milk, curd and ghee. The Panchagavya is an efficient plant growth stimulant that enhances the biological efficiency of crops. It is used to activate soil and to protect the plants from diseases and also increase the nutritional quality of fruits and vegetables. It is used as a foliar spray, as soil application along with irrigation water, seed or seedling treatment *etc*. Three per cent Panchagavya is an ideal concentration for foliar spray.

Jeevamruth promotes immense biological activity in the soil and makes the nutrients available to the crop. Beejamruth protects the crop from soil-borne and seed-borne pathogens and it improves seed germination also. Cow urine has got anti-fungal properties and is also a good source of plant nutrients (Devakumar *et al.*, 2008) [5]. It is being used in crop production for ages. But in organic farming and natural farming practice treatment source of the nutrient is organic. It needs more time for conversion of organic to inorganic. It provides lesser nutrients for a plant within a short time. Therefore, for sustainable crop production, integrated use of chemicals and organic fertilizer is a more viable option. It is characterized by reduced input of chemical fertilizer and combined use of chemical fertilizer with organic materials such as animal manure, crop residue, green manure and compost. From the results obtained, it can be concluded that the application of inorganic fertilizers supplemented with organic fertilizers could sustain the growth and optimum yield of pepper. Through the application of organic fertilizers plays a significant role in improving soil and crop sustainability, there is, however, a reduction in crop yield and this should be compensated by premium pricing of organic produce.

Materials and Methods
A field experiment was conducted during 2018-19 and 2019-20 to evaluate the Influence of different Management practices on the growth performance of black pepper (*Piper nigrum*) at the College of Horticulture, sirsi, University of Horticultural Sciences, Bagalkot, Karnataka, India. The soil of the experimental plot is red laterite, grouped under the classification of Inceptisols. Before the start of the experiment, composite soil samples were drawn from the experimental plot from the upper 0 - 20 cm soil layer for physical properties and surface (0-15cm) and subsurface (15-30 cm) collected and analysed for the initial chemical properties presented in table 1 and 2.

Natural Farming, Organic farming and RPP with check as chemical farming are the different management practices that were treated on a standing crop of black pepper into the soil. Natural farming inputs were Jeevamrutha, Panchagvya, Ganajeevamrutha was applied to the base of the seedlings at vegetative stages. Whereas in RPP and organic farming, all cultural operations were carried out as per package of practice. Plant growth Parameters, Microbiological and enzymatic parameters and soil nutrient status were analyzed and recorded at initial and at harvest.

Enumeration of general microflora, beneficial microflora and enzyme assay
Soil samples collected from different treatment plots were used for enumeration of general microflora (Bacteria, Fungi and Actinomycetes) and beneficial microflora (P-solubilizers and Free living N fixers) were estimated by following the standard serial dilution and plate count method with suitable media.

Table 1: Initial Physical properties of the experimental site

Physical parameters	0-20 cm
Bulk density (Mg m^{-3})	1.13
Particle density (Mg m^{-3})	2.65
% Porosity	56.71
% MWHC	53.58
Soil type	Red lateritic
Soil depth	Moderately shallow
Soil texture	Sandy clay

Table 2: Initial chemical properties of soil at the experimental site

Particulars	Value	
Chemical properties	**0-15 cm**	**15-30 cm**
Soil pH	5.50	5.41
Electrical conductivity (dSm^{-1})	0.067	0.047
Organic carbon (%)	0.38	0.41
Available nutrients		
Available nitrogen (kg ha^{-1})	120.42	114.15
Available phosphorous (P_2O_5) (kg ha^{-1})	15.24	16.11
Available potassium (K_2O) (kg ha^{-1})	129.71	136.35
Available sulphur (mg kg^{-1})	22.12	21.42
Available calcium (meq per 100g soil)	4.20	3.35
Available magnesium (meq per 100g soil)	1.55	1.53
Available Zinc (ppm)	0.10	0.25
Available Copper (ppm)	3.5	2.96
Available Iron (ppm)	71.5	62.23
Available Manganese (ppm)	56.0	44.62

Bacteria population
The bacteria populations were estimated by using soil extract agar medium by standard plate count method. The plates were incubated for 48 h at 28 ºC. Colonies that appeared on the media were enumerated and expressed in terms of colonies forming units per gram of soil on a dry weight basis.

Fungi
The rhizosphere soil sample was sieved through the 1000 micromesh to remove the bigger particles and debris and were used for enumeration of fungi using Martin's rose Bengal agar medium (MRBA) by standard plate count method. The plates were incubated for 4 days at 28 ºC. Colonies that appeared on MRBA media were enumerated and expressed in terms of CFU per gram of soil on a dry weight basis.

Actinomycetes
Each soil sample was sieved through the 1000 micromesh to remove the bigger particles and debris and were used for enumeration of actinomycetes using Kuster’s agar medium by standard plate count method. The plates were incubated for 6 days at 28 ºC. Colonies that appeared on Kuster’s agar media were enumerated and expressed in terms of CFU per gram of soil on a dry weight basis.

Free living N fixer and P-Solublizer

Enumeration of N fixers was carried out by plate technique using Norries N free agar medium. The plates were incubated for 7 days at 28º C. Colonies that appears on the Norries N free agar medium were enumerated and expressed in terms of CFU per gram of soil on a dry weight basis. enumeration of P solubilizers using Pikovskayas agar medium by standard plate count method. The plates were incubated for 6 days at 28 ºC. Colonies that appeared on Pikovskayas's agar media were enumerated and expressed in terms of CFU per gram of soil on a dry weight basis.

Enzyme activity

The enzymatic activities *viz.*, dehydrogenase and phosphatase were done by using the rhizosphere soil sample of black pepper plants. The estimation of dehydrogenase activity in the soil samples was determined by following the procedure as described by Casida *et al*. (1964) [2]. The estimation of phosphatase activity of soil samples was determined by following the procedure of Evazi and Tabatabai (1979) [6].

Table 3: Initial Microbiological properties of rhizosphere soil of the experimental site

General Microbial Analysis		Beneficial Microbial Analysis		Soil Enzyme assay	
Total bacteria	$16.4x10^6$	Total Free living nitrogen fixers	$10.5x10^4$	Dehydrogenase activity	3.68 µgTPF/g/h
Total Fungi	$4.4x10^6$	Total Phosphate solubilizers	$9x10^4$	Phosphatase activity	0.75 Pnp/g/h
Total actinomycetes	$5.3x10^3$				

Plant growth parameters

The observations on the plant parameters *viz.*, plant height (cm), stem girth (cm), internodal length (cm), leaf petiole (cm), leaf Length (cm), leaf breadth (cm), number of runners and leaf area(cm) were recorded during 2018-19 and 2019-20 after planting.

Soil chemical Properties

Soil samples were collected in accordance with established protocol. Air dried soil samples were crushed to pass through a 2-mm sieve. The pH of aqueous suspensions (1:2.5 soil/solution ratio) was determined using a combination glass–calomel electrode. Electrical conductivity (dS m1) was measured using a conductivity bridge in the supernatant liquid of a soil/water suspension (1:2). (Richards 1954) [12]. The wet digestion method of Walkley and Black was used to determine soil organic carbon (OC) (1934). The alkaline permanganate method, as described by Subbiah and Asija, was used to determine available nitrogen (N) (1956) [14]. The Bray II method was used to determine available phosphorus (P) (Bray and Kurtz 1945) [1]. The soil's cation exchange capacity (CEC) was evaluated using Jackson's technique (1974). 1 M ammonium acetate (NH_4OAc) was used to extract exchangeable cations [calcium (Ca), potassium (K), and magnesium (Mg) (pH 7.0). Rich (1965) [11] used flame photometry to evaluate potassium level, whereas ethylenediaminetetraacetic acid (EDTA) titration was used to determine Mg.

Statistical analysis of the data

The Data recorded on various growth and yield parameters were subjected to Fisher's method of analysis of variance and interpretation of data as given by Gomez and Gomez, (1984). The level of significance used in the 'F' test and 't-test was P = 0.05.

Result and Discussion

Plant growth parameters

The plant height of pepper was significantly influenced by different farming practices. Among the four different farming practices, RPP recorded the highest plant height (260.5 cm), stem girth (0.433 cm), number of runners (4.56), leaf area (465.5 cm2). Organic farming practice recorded the highest in internodal length (8.608 cm), leaf petiole (6.801 cm). Observations of organic farming practices were on par with RPP practices. Lowest plant height (163.4 cm), Stem girth (0.433 cm), internodal length (6.101 cm), leaf petiole (4.966 cm), leaf length (4.966 cm), leaf breadth (4.966 cm), and leaf area (3.48.4), was recorded in Natural farming Practices followed by Chemical farming. The effect of RPP practices and organic farming practices did not differ significantly irrespective of all the plant parameters (Table 4). Zuraini *et al*., (2010) [16] and Yap (2014) estimated pepper growth parameters was recorded highest in conventional practice followed by organic. Whereas control check resulted lesser concerning plant growth parameter and yield of pepper. By the findings of Patil *et al.*, (2017) [10], plant parameters *viz.*, root length, root dry weight and number of leaves was found to be significantly highest in cuttings inoculated with microbial consortia with neem when compared to single inoculation and control check recorded lesser. In the present investigation, enhanced growth parameters of black pepper in the treatment receiving RPP and organic farming might due to integrated plant nutrition.

Microbial analysis

Soil samples were collected from the pepper rhizosphere for enumeration of microbial load at initial and at harvest. Ten grams of soil was serially diluted up to 10^{-6} by using sterilized distilled water and cell count per gram of rhizosphere soil was enumerated for bacterial population (10^6 CFU $soil^{-1}$), fungal population (10^3 CFU $soil^{-1}$), actinomycetes population (10^4 CFU $soil^{-1}$), P-solubilizers (10^4 CFU $soil^{-1}$) and free-living N-fixer (10^4 CFU $soil^{-1}$) by following serial dilution plate count technique and the result is depicted in table 5. The soil was analyzed for Initial microbial count *viz*., G bacteria (16.4 x 10^6 CFU/gm of soil), fungi (4.4 x 10^3 CFU/gm of soil), actinomycetes (5.3 x 10^{-4} CFU/ gm of soil), P-solubilizers (9 x 10^3 CFU g^{-1} soil) and Free living Nitrogen fixers (10.5 x 10^3 CFU g^{-1} soil). (Table 1, 5 and Fig. 1.)

Among the different farming practices, Natural farming practice and organic farming practice recorded maximum number of total microbial *Viz.*, bacterial ($70.48x10^6$ CFU soil-1, Pooled), fungi ($17.49x10^3$CFU $soil^{-1}$, Pooled), actinomycetes (39.34 x 10^4 CFU $soil^{-1}$, Pooled), P-solubilizers (22.46 x 10^4 CFU soil-1, Pooled) and free living N-fixer (27.65 x 10^4 CFU $soil^{-1}$, Pooled) when compared to RPP and check chemical farming. Devakumar *et al.*, (2008) [5] reported in organic liquid formulations such as jeevamrutha and panchagavya recorded higher bacteria, fungi, actinomycetes, N – fixers and P–solubilizers. Natarajan (2007) reported that the Panchagavya contains macronutrients like N, P and K, essential micronutrients, many vitamins, essential amino acids, growth-promoting factors like IAA, GA, which may provide nutrition to rhizosphere microorganisms and thus help to increase their population. However, herbicides and pesticides also affect the microbes physiologically: a) by changing their biosynthetic mechanism (change in the level of protein biosynthesis is reflected in the ratio of extracellular and intracellular enzymes); b) by affecting protein biosynthesis (induction or repression of synthesis of certain enzymes); c) by affecting the cellular membranes (changes in transport and excretion processes); d) by affecting plant growth regulators (transport of indoleacetic acid, gibberellin synthesis and ethylene level); e) applied in high doses, they may kill microorganisms (Cook and Hutter, 1981) [4].

Similarly, the effect of herbicides and pesticides on soil microbial population (*viz*., Bacteria, fungi and actinomycetes) decreased, when compared to the control. Sebiomo *et al*. (2011) [13] determined the effects of herbicides might affect the microbial population and microbial community structure in agricultural soils (Changpeng *et al*., 2010) [3].

Enzyme activity

The soil was analyzed for enzyme assay, *Viz*., Dehydrogenase activity and Phosphatase activity at Initial and harvest.

Among the four different farming practices, Natural farming practice recorded the highest Dehydrogenase activity (15.66 µg PNP released g^{-1} soil h^{-1}) and Phosphatase activity (19.99 µg TPF formed g^{-1} soil d^{-1}) and was on par and organic farming practice when compared to conventional and check chemical control (Table 6 and fig. 2). The increase in total rhizosphere microbial population in the rhizosphere of black pepper can be ascribed to the production of root exudates by black pepper due to improved nutrition might have stimulated the total microbial population, dehydrogenase and phosphatase activity.

Chemical properties of soil

The pH, Ec, organic carbon, Nitrogen, Phosphorous, Potassium, Sulphur, Carbon and magnesium are the important chemical properties of soils and data pertaining to them are presented in Table 2. The result revealed that there was a non-significant difference among different farming practices for soil pH, EC. Among the four different farming practices, RPP practice recorded the highest N (237 kg/ha), P (14.459 kg/ha), K (30.18 kg/ha), S (17.25 ppm) followed by Organic Farming practice and whereas OC (0.729%), C (7.06 ppm) and Mg (2.76 ppm) recorded highest in Natural farming Practice followed by Organic Farming practice and the lowest available N (199.42 kg/ha), P (11.318 kg/ha), K (246.46 kg/ha) and S (12.2 ppm) content was noticed in Natural farming practice followed by Control Check (Table 2 pooled). The effect of RPP practices and organic farming practices did not differ significantly irrespective of all the soil chemical properties (Table 7).

Table 4: Influence of different management practices on Plant growth parameters of black pepper

Treatments	2018-2019							
	Plant height (cm)	Stem Girth (cm)	Internodal Length (cm)	Leaf petiole (cm)	Leaf Length (cm)	Leaf breadth (cm)	Number of runners	Leaf area (cm)
T_1: Chemical farming	129.6	0.25	4.48	2.13	8.05	5.97	1.60	239.2
T_2: Organic farming	137.0	0.32	4.59	3.44	7.444	6.45	2.24	277.0
T_3: ZBNF	92.2	0.20	3.02	2.22	6.424	5.15	1.82	200.6
T_4: RPP	154.4	0.33	4.69	3.11	8.052	6.11	2.86	283.4
S.Em +	2.81	0.01	0.09	0.09	0.206	0.19	0.15	13.775
C.D. at 5%	8.65	0.03	0.28	0.28	0.633	0.59	0.46	42.44

Treatments	2019-2020							
	Plant height (cm)	Stem Girth (cm)	Internodal Length (cm)	Leaf petiole (cm)	Leaf Length (cm)	Leaf breadth (cm)	Number of runners	Leaf area (cm)
T_1: Control	206.6	0.60	7.36	5.40	15.11	11.26	3.53	275.2
T_2: Organic	217.0	0.64	8.03	6.71	15.39	12.15	4.20	349.4
T_3: ZBNF	142.4	0.46	6.15	5.48	13.37	9.23	3.10	295.6
T_4: Conventional	212.2	0.66	7.81	5.94	14.99	11.11	3.40	364.2
S.Em +	15.65	0.04	0.41	0.24	0.54	0.39	0.34	30.03
C.D. at 5%	48.23	0.123	1.26	0.74	1.68	1.22	1.05	92.53

Treatments	Pooled (2018-19 to 2019-20)							
	Plant height (cm)	Stem Girth (cm)	Internodal Length (cm)	Leaf petiole (cm)	Leaf Length (cm)	Leaf breadth (cm)	Number of runners	Leaf area (cm^2)
T_1: Chemical farming	232.9	0.549	8.16	4.83	15.60	11.60	3.36	376.8
T_2: Organic farming	245.5	0.641	8.608	6.80	15.14	12.53	4.34	451.7
T_3: ZBNF	163.4	0.433	6.101	4.96	13.11	9.76	3.37	348.4
T_4: RPP	260.5	0.664	8.599	6.08	15.54	11.67	4.56	465.5
S.Em +	8.78	0.017	0.252	0.16	0.32	0.24	0.23	16.67
C.D. at 5%	27.05	0.053	0.777	0.49	1.01	0.76	0.72	50.25

Table 5: Influence of different management practices on soil general microflora and beneficial microflora of black pepper rhizosphere soils

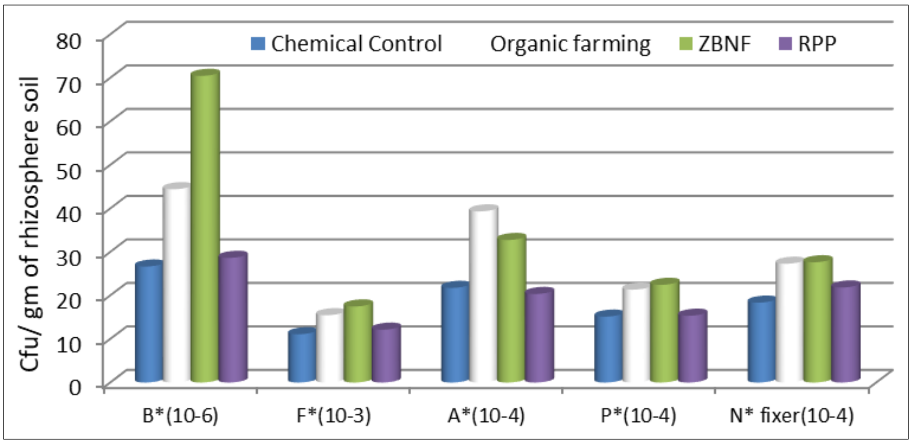
Treatments	2018-19					2019-20					Pooled data				
	B* (10^{-6})	F* (10^{-3})	A* (10^{-4})	P* (10^{-4})	N fixer* (10^{-4})	B* (10^{-6})	F* (10^{-3})	A* (10^{-4})	P* (10^{-4})	N fixer* (10^{-4})	B* (10^{-6})	F* (10^{-3})	A* (10^{-4})	P* (10^{-4})	N* fixer (10^{-4})
Control	11.9	3.84	8.15	5.45	11.21	29.52	14.54	27.22	19.4	14.32	26.66	11.11	21.76	15.15	18.37
Organic farming	26.57	6.97	22.73	8.86	18.46	35.72	17.02	33.22	25	17.7	44.43	15.48	39.34	21.36	27.31

ZBNF	49.572	8.82	12.2	10.01	16.45	41.82	17.34	41.12	24.9	22.4	70.482	17.49	32.76	22.46	27.65
RPP	12.95	4.73	5.45	6.21	14.5	31.42	14.84	29.82	18.3	14.7	28.66	12.15	20.36	15.36	21.85
S.EM	0.394	0.382	0.77	0.354	0.357	1.24	1.038	1.835	1.228	0.582	0.877	0.704	0.841	0.738	0.505
CD at 0.5%	1.214	1.178	1.102	1.091	1.101	3.83	3.19	5.655	3.783	1.795	2.689	2.169	2.592	2.276	1.557

B: Bacterial population, F: Fungal population, A: Actinomycetes Population, PSB: Phosphorous solubilizing microorganism
N Fixer: Free-living nitrogen fixer, *: CFU/g of soil (Colony-forming unity per gram of soil)

Table 6: Influence of different management practices on dehydrogenase and phosphatase activity of black pepper rhizosphere soils

Treatments	Dehydrogenase activity (µg TPF formed g^{-1} soil d^{-1})			Phosphatase activity (µg PNP released g^{-1} soil h^{-1})		
	2018-19	**2019-20**	**Pooled data**	**2018-19**	**2019-20**	**Pooled data**
Control	9.13	7.44	12.85	6.61	3.41	8.31
Organic farming	14.26	11.4	19.93	10.18	6.38	13.37
ZBNF	13.82	12.33	19.99	12.14	7.04	15.66
RPP	10.13	9.38	14.82	7.14	4.63	9.46
S.EM	1.37	1.195	1.51	1.04	1.029	0.893
CD at 0.5%	4.22	3.683	4.653	3.21	4.445	2.751



B: Bacterial population, F: Fungal population, A: Actinomycetes Population, PSB: Phosphorous solubilizing microorganism
N Fixer: Free-living nitrogen fixer, *: CFU/g of soil (Colony-forming unity per gram of soil)

Fig 1: Soil general microflora and beneficial microflora of black pepper rhizosphere soils.

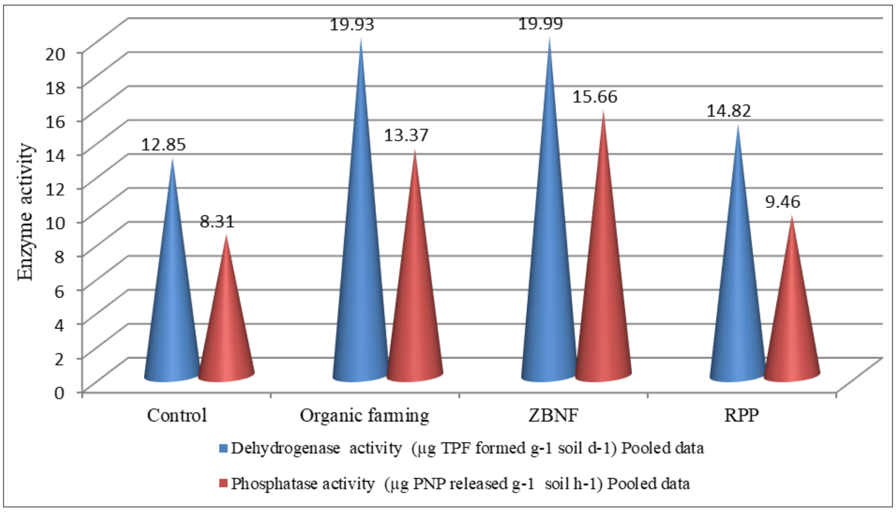


Fig 2: Dehydrogenase and phosphatase activity of black pepper rhizosphere soils

Table 7: Influence of different management practices on nutrient status of black pepper

Treatments	2018-19								
	pH (1:2.5)	**EC (dS/m)**	**OC %**	**N kg/ha**	**P kg/ha**	**K kg/ha**	**S ppm**	**C ppm**	**Mg ppm**
T_1: Control	5.776	0.094	0.498	250.88	11.48	328.178	11.7	6.36	2.12
T_2: Organic	6.186	0.07	0.708	218.266	9.556	308.366	14.9	5.96	2.4
T_3: ZBNF	6.08	0.064	0.63	213.25	9.298	282.536	13.6	6.96	2.8
T_4: RPP	6.01	0.098	0.696	255.9	10.772	322.56	16.2	6.08	3.2
S.Em +	0.097465	0.012	0.064	11.757	0.855	23.37	1.3	0.54	0.23

Treatments	pH (1:2.5)	EC (dS/m)	OC %	N kg/ha	P kg/ha	K kg/ha	S ppm	C ppm	Mg ppm
C.D. at 5%	0.300321	0.038	0.197	36.22	2.63	72.03	4.02	1.688	0.709
	2019-20								
Treatments	pH (1:2.5)	EC (dS/m)	OC %	N kg/ha	P kg/ha	K kg/ha	S ppm	C ppm	Mg ppm
T_1: Control	6.076	0.08	0.522	185.8	15.262	273	13.8	7	2.48
T_2: Organic	6.186	0.066	0.852	193.4	17.44	227.8	17.2	7.08	2.08
T_3: ZBNF	6.184	0.06	0.828	185.6	13.338	210.4	10.8	7.16	2.72
T_4: RPP	6.128	0.08	0.702	218.4	18.146	289.8	18.3	7.12	2.28
S.Em +	0.043	0.009	0.07	12.167	1.27	21.61	1.986	0.461	0.263
C.D. at 5%	1.131	0.029	0.217	37.49	3.92	66.59	6.119	1.421	0.812

Treatments	Pooled data (2018-2019 and 2019-2020)								
	pH (1:2.5)	EC (dS/m)	OC %	N kg/ha	P kg/ha	K kg/ha	S ppm	C ppm	Mg ppm
T_1: Control	5.926	0.087	0.51	218.34	13.371	300.589	12.75	6.68	2.3
T_2: Organic	6.186	0.068	0.78	205.833	13.498	268.083	16.05	6.52	2.24
T_3: ZBNF	6.132	0.062	0.729	199.425	11.318	246.468	12.2	7.06	2.76
T_4: RPP	6.069	0.089	0.699	237.15	14.459	306.18	17.25	6.6	2.74
S.Em +	0.041	0.009	0.044	9.092	0.77	17.155	1.257	0.381	0.193
C.D. at 5%	0.127	0.02	0.136	28.014	2.39	52.86	3.87	1.173	0.596

Conclusion
The present investigation clearly brought out that among management practices, the recommended package of practice (RPP) followed by organic farming practice found to be significant in improving the growth performance and nutrition of black pepper under laterite soil conditions.

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