



Biological Activity as Influenced by Cropping Systems in Various Farming System under Southern Transition Zone of Karnataka

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Abstract: Soils are the basic unit of the agricultural production, maintaining the soil health with respect to nutrient availability and organic carbon content infers the soil suitability to grow the crops. To protect the soil native population of microorganisms and their efficiency, selection of suitable farming types and cropping systems are very much important in order to harvest much benefits without compromising degradation, in that view an experiment was executed at Zonal Agricultural and Horticultural Research Station, Navile, Shivamogga during *Kharif* 2021 and 2022 in sandy loam soils under split plot design, where main plots comprises conventional, organic and natural farming along with subplots consists of sole crops of groundnut, maize, finger millet, intercropping of maize and finger millet with groundnut. Organic farming recorded higher population of beneficial microorganisms (N fixers, P and K solubilizers) and higher enzymatic activity (dehydrogenase, alkaline and acid phosphatase) which was significantly higher than conventional farming. Among cropping systems, intercropping method beneficial microorganisms and enzymatic activity were significantly higher than sole crops, particularly in maize as an intercrop. Irrespective of the farming types and cropping systems biological activities were higher at 67 days.

Keywords: Farming types, Cropping systems, Enzymatic activity, N fixers, Dehydrogenase

Soils are the lifeline of crop production, which not only supports the plant growth but acts as hot spot of biodiversity by encouraging growth and development of various living organisms in it. Soil ecology infers the interaction of different species with their surrounding soil environment for nutrient recycling, organic matter decomposition and soil structure (Pavao-Zuckerman 2008). Interaction of soil physical, chemical and biological entities will made complicated reactions into resolvable matter. Proper depiction of these three entities are required to answer any of the reactions, in that view biological properties plays significant role along with physical and chemical properties (Vellend et al., 2017). Biological properties includes the population of living organisms which majorly constitutes bacteria, fungi, protozoa, insects, earthworms and enzymatic activity in the soil (Deng et al., 2015). Biological activities answers to the activities of soil respiration, mineralization and fertility status.

Population of various microorganisms and their activity depends on different factors *viz.*, status of organic carbon content in the soil, water holding capacity, C N ratio of the organic source to maintain remarkable soil health status (Cheng et al., 2012). In that view, cropping pattern practiced in particular land followed by method of cultivation of crops also decides the efficiency of the biological entities over long period, to understand the efficiency of farming methods and cropping systems. The current study was undertaken to

understand the effect of different cropping systems and farming types on population of soil beneficial microbes.

MATERIAL AND METHODS

Field experiment was conducted at Zonal Agricultural and Horticultural Research Station, Navile, Shivamogga during *Kharif* 2021 and 2022 to evaluate the performance of groundnut following different farming types and groundnut based cropping system. The soil of the experimental site was sandy loam in texture with slightly acidic in nature (6.22) and lower in salt load, further soil was medium in organic carbon content (0.51 %), available nitrogen (262 kg ha⁻¹), available potassium (202 kg ha⁻¹) and higher in available phosphorus content (86.9 kg ha⁻¹). The field experiment was laid out in split plot design with three farming types *viz.*, conventional farming, organic farming and natural farming as main plots and five cropping systems *viz.*, groundnut + maize (4:1) intercropping, groundnut + finger millet (4:1) intercropping, sole groundnut, sole maize and sole finger millet as subplots (Table 1).

Conventional farming includes management of crops as per standard package of practice which includes seed treatment with biofertilizers, fungicides and insecticides followed by nutrients through both organic and chemical means, chemicals was used for insect, diseases and weeds (Ragini 2022). Natural farming treatment followed seed treatment with beejamrutha, nutrient management with

ghanajeevamrutha and jeevamrutha and insect pest management was done through botanical extracts (agniastra, neemastara and dashaparni kashayam) and diseases by sour butter milk and weeds through hand weeding and mulching.

The population of beneficial micro flora was determined by serial dilution plate count technique. The population of N-fixers, P-solubilizing (PSM) microorganisms and Potash-solubilizing microorganisms was estimated by transferring 1 ml of 10^4 and 10^3 dilutions, respectively to sterile petri dishes. Approximately 20 ml of Waksman medium for N fixers, Sperber's medium for PSM and Alexandros for Potash solubilizing microorganisms were poured into the sterilized plates and kept for incubation in an inverted position at 30 ± 1 °C for a week time and emerged colonies were counted (Tate 1995). Activity of dehydrogenase, phosphatase and urease were estimated according procedure encasted by Casida et al. (1964), Tabatabai and Bremner (1972) and Kandeler and

Gerber (1988) respectively. Enzymatic activity was compared between 67 DAS and at harvest. The data was analyzed in the MS office excel spread sheets.

RESULTS AND DISCUSSION

Organic farming recorded significantly higher population of nitrogen fixers, phosphorus solubalizers and potassium solubalizers than conventional farming. The higher beneficial microorganisms were due to application of greater amount of organic manures in the particular treatment enhanced the substrate availability for their multiplication, along with organic manures improves the soil water holding capacity and increases the porosity which further helps to microorganisms for their active division. Natural farming recorded similar observation for beneficial microorganisms next to organic farming may be due to application of ghanajeevamrutha at the time sowing followed by application of liquid jeevamrutha at the interval of 20 days and mulching

Table 1. Details of the experiment

Design	Split plot	
Treatment combinations	15	
Replications	03	
Gross plot size	7.8 m × 4.2 m	
Net plot size	3.6 m × 3.0 m	
Season	Kharif 2021 and 2022	
Location	ZAHRS, Shivamogga Latitude: 13.9711 N Longitude: 75.5776 E	
Crops	Groundnut as main crop, Maize and Finger millet as intercrops and sole crops	
Variety	Groundnut	TMV-2
	Maize	P-3304
	Finger millet	GPU 28
Spacing	Groundnut	30 cm × 10 cm
	Maize	60 cm × 30 cm
	Finger millet	30 cm × 10 cm
Recommended dose of fertilizers	Groundnut	25: 50: 25 kg N, P ₂ O ₅ and K ₂ O ha ⁻¹
	Maize	100: 50: 25 kg N, P ₂ O ₅ and K ₂ O ha ⁻¹
	Finger millet	50: 37.5: 37.5 kg N, P ₂ O ₅ and K ₂ O ha ⁻¹
Organic manures	Groundnut	Based on P equivalent basis
	Maize	Based on N equivalent basis
	Finger millet	Based on N equivalent basis
Natural farming	Groundnut	1000 kg of ghanajeevamrutha at the time of sowing 500 l of jeevamrutha at 20 days interval
	Maize	
	Finger millet	
Date of sowing	2021	27-07-2021
	2022	24-07-2022

which created the favourable condition viz., organic source, moisture availability, soil temperature and micro climate for their multiplication. Similar observations were observed in earlier studies (Gore and Sreenivasa 2011, Chandrashekara et al., 2020, Choudhary et al., 2022).

Among cropping systems, the statistically higher nitrogen fixers, phosphorus solubalizers and potassium solubalizers were obtained in intercropping system as compared to sole crops, further under intercropping higher values were obtained in the groundnut + maize intercropping. However, groundnut + finger millet intercropping was on par with sole groundnut and significantly higher values over sole maize and sole finger millet. Higher values in the intercropping was due to inter specific interaction of cereal legume root structures enhances the release of various secondary metabolites from the roots which were rich in polysaccharides helps in enhancing the microbial multiplication and acts as extra dose for their effective activity. Concurrent findings were postulated by Devkumar et al. (2018), Thakur (2021), Aravind et al. (2022). Interactions were non-significant among of various farming types and cropping systems for nitrogen fixers, phosphorus and potassium solubalizers.

Among different farming types organic farming recorded significantly higher dehydrogenase and phosphatase activity (acid and alkaline) than conventional farming this may be due to greater amount of substrate availability in organic farming followed by avoiding chemical inputs enhanced the effectiveness. In converse, conventional

farming observed significantly higher values than organic and natural farming for urease activity at 67 DAS due to the supply of synthetic source of nitrogen in conventional farming enhanced the activity as it obtained the substrate for effective functioning ability as observed by Gowtham Chand et al. (2020) and Ragini (2022).

Among cropping systems, groundnut intercropped with maize was on par with groundnut intercropped with finger millet and significantly higher than sole crops of groundnut, maize and finger millet for dehydrogenase, alkaline phosphatase and acid phosphatase activity because inter specific interaction of roots of different crops under intercropping helps in production of flavanoids and polysaccharide compounds which helps in enhancing the soil dwell microorganisms, further improves their catalytic activity (Li et al., 2016). However, sole maize and sole finger millet recorded higher urease activity than sole groundnut and intercropping system at 67 days after sowing due to application of recommended dose of nitrogen increases the substrate for the enzyme activity as reported by Chen et al. (2018) and Babu et al. (2020).

Interaction of various farming types and cropping systems was non-significant differences for dehydrogenase, urease, acid phosphatase and alkaline phosphatase activity (Table 3).

Activity of nitrogen fixers and phosphorus solubalizers at 47 DAS was on par with their activity at 67 DAS, however, 20 per cent reduction in nitrogen fixers and phosphorus solubalizers each at 27 DAS. Population of microorganisms

Table 2. Effect of various farming types and cropping systems on beneficial microorganisms

Treatments	Nitrogen fixers (cfu × 10 ⁴ g ⁻¹)	Phosphorus solubalizers (cfu × 10 ⁴ g ⁻¹)	Potassium solubalizers (cfu × 10 ⁴ g ⁻¹)
Main plot (Farming types)			
M ₁ - Conventional farming	5.01	4.29	2.12
M ₂ -Organic farming	7.80	6.49	3.41
M ₃ - Natural farming	7.02	6.05	3.15
CD (p=0.05)	0.19	0.22	0.19
Sub plot (Groundnut based cropping systems)			
S ₁ -Groundnut + Maize intercropping	7.10	6.28	2.84
S ₂ - Groundnut + Finger millet intercropping	6.80	5.82	2.98
S ₃ - Sole Groundnut	6.67	5.51	2.96
S ₄ - Sole Maize	6.18	5.31	2.83
S ₅ - Sole Finger millet	6.31	5.14	2.85
CD (p=0.05)	0.30	0.32	NS
Interaction			
CD (p=0.05) (SP at same level of MP)	NS	NS	NS
CD (p=0.05) at same or different level of SP)	NS	NS	NS

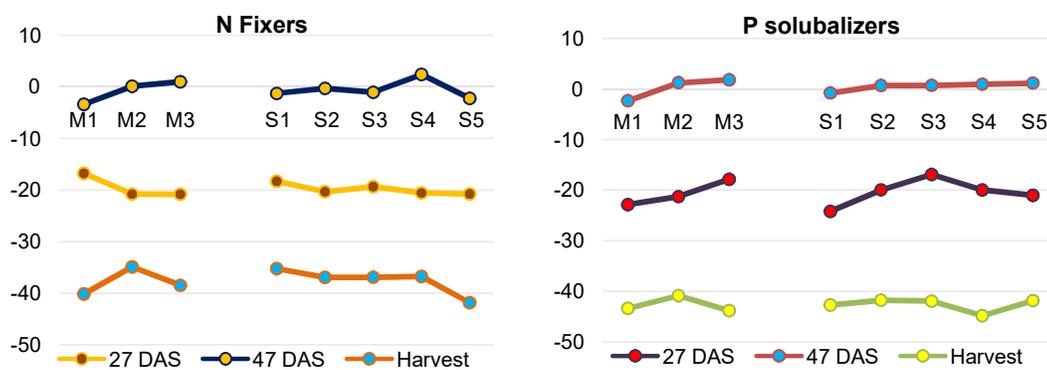


Fig.1a

Fig. 1b

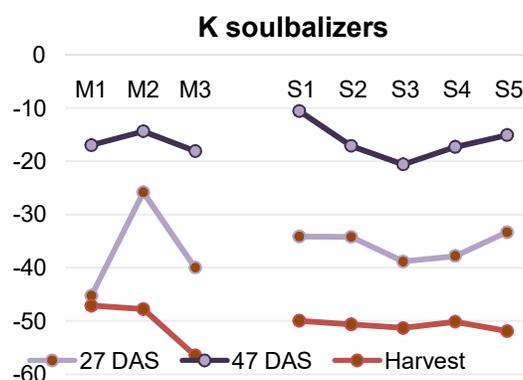


Fig.1c

Fig. 1. Percentage variation in the activity of beneficial microorganisms at 27 DAS, 47 DAS and at harvest compared at 67 DAS

Table 3. Effect of various farming types and cropping systems on enzymatic activity

Treatments	Dehydrogenase ($\mu\text{g TPF g}^{-1} \text{day}^{-1}$)	Acid phosphatase ($\mu\text{g pNP g}^{-1} \text{hr}^{-1}$)	Alkaline phosphatase ($\mu\text{g pNP g}^{-1} \text{hr}^{-1}$)	Urease ($\mu\text{g urea hydrolysed g}^{-1} \text{hr}^{-1}$)
Main plot (Farming types)				
M ₁ - Conventional farming	13.19	13.60	2.38	4.92
M ₂ -Organic farming	21.12	19.54	3.25	4.27
M ₃ - Natural farming	17.89	17.64	3.35	3.61
CD (p=0.05)	0.91	0.54	0.14	0.25
Sub plot (Groundnut based cropping systems)				
S ₁ -Groundnut + Maize intercropping	19.36	18.21	2.86	4.23
S ₂ - Groundnut + Finger millet intercropping	18.08	17.14	3.12	4.18
S ₃ - Sole Groundnut	17.80	17.45	2.97	4.00
S ₄ - Sole Maize	16.46	16.23	2.93	4.56
S ₅ - Sole Finger millet	15.30	15.60	3.07	4.37
CD (p=0.05)	1.20	0.67	0.12	0.20
Interaction				
CD (p=0.05) (SP at same level of MP)	NS	NS	NS	NS
CD (p=0.05) (MP at same or different level of SP)	NS	NS	NS	NS

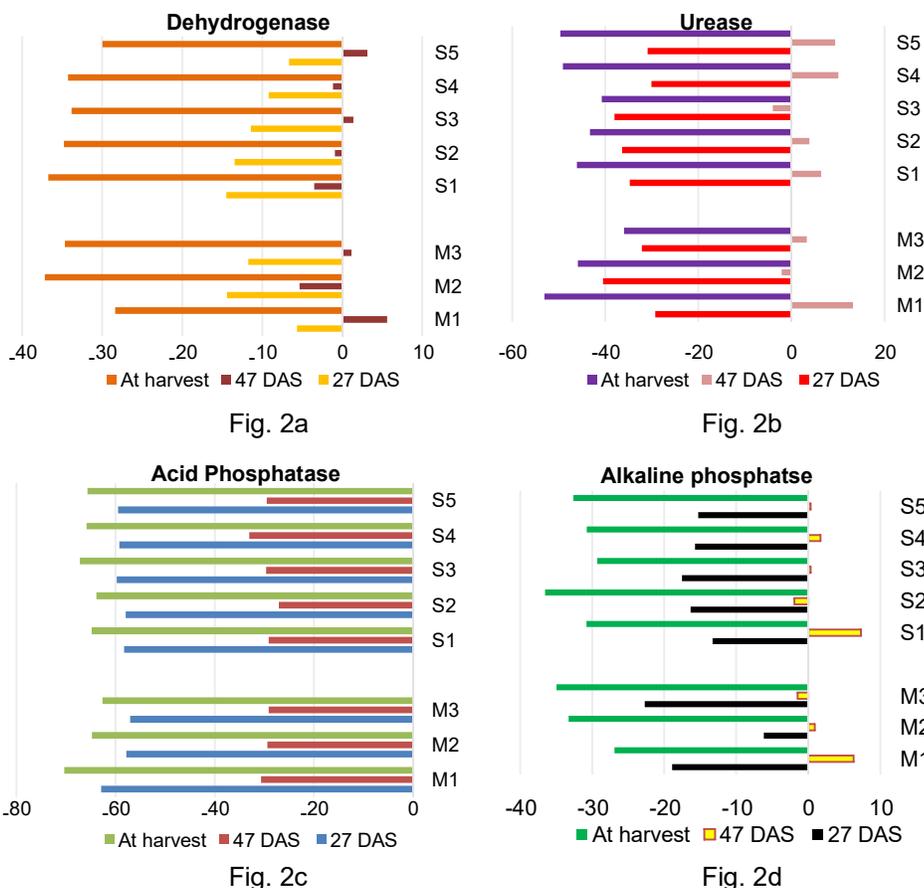


Fig 2. Percentage variation in the activity of enzymes at 27 DAS, 47 DAS and at harvest compared at 67 DAS

reduced drastically at the time of harvest to the extent of 30 per cent for nitrogen fixers and beyond 40 per cent for phosphorus solubalizers. Further, potassium solubalizers was recorded up to 20, 40 and 50 per cent reduction at 47 DAS, 27 DAS and at harvest, respectively as compared to 67 DAS. Population of microorganisms was directly related to the amount of organic substrate availability, moisture content of the soil followed by activeness of root system of the crops and its interaction with rhizosphere, in that view, activity of roots and release of nutrients to the soil nutrient pool by the microorganisms was maximum at flowering which was coincides between 40-70 DAS resulting in greater amount microbial activity during peak stage of crop development (Fig. 1). These results were in line with earlier findings (Chakraborty and Sarkar 2019, Amalraj et al., 2013, Aulakh et al., 2013).

Activeness of all the enzymes was higher at 67 DAS as compared to their vigour at 27 DAS and at harvest, however, on par at 47 DAS except for acid phosphatase activity which infers that there was a drastic reduction in the performance of all the major enzymes. Performance of enzymes at harvest was reduced beyond 30, 40, 60 and 20 per cent for dehydrogenase, urease, acid and alkaline phosphatase

activity, respectively due to reduction in root exudates production along with lower moisture availability. Activity at 27 DAS was also lower because of delayed release of nutrients from the organic sources as observed by Li et al. (2019) and Sharma et al. (2022) (Fig. 2).

CONCLUSIONS

Organic carbon in the soil plays major role in the effective performance of the biological activities, amount of the organic matter in the soil was also influences the soil physical and chemical properties. Adding greater amount of organic matter in organic farming treatment noticed higher values of nitrogen fixers, phosphorus and potassium solubalizers population similarly, soil enzymatic performance was also follows same trend except for urease activity. Intercropping system performed better with respect to soil beneficial microorganisms and enzymatic performance as compared to sole cropping system, particularly maize intercropped with groundnut yielded more vivacity among the cropping systems.

CONTRIBUTION

SV Akarsh developed, performed the experiments,

analyzed the data and wrote the manuscript. HK Veeranna contributed to the final version of the manuscript and supervised the project, further M Dinesh Kumar, GK Girijesh, BC Dhanajaya and MS Nandish provided critical feedback and helped in to shape the research, analysis and manuscript.

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