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Soil Enzyme Activities as Influenced by Natural, Organic and Conventional Farming Practices in Sugarcane Based Intercropping System

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ABSTRACT

A field experiment was carried out in seasonal sugarcane planting at Agricultural Research Station, Hukkeri (Dist. Belagavi) during 2019-20 on medium black clay loam soils to study the effect of different farming practices, planting row arrangement and intercropping systems on soil enzyme activity of sugarcane rhizosphere. Experiment was laid out in split-split plot design with eighteen treatment combinations and replicated thrice with the cultivar Co 86032. The treatments included were three farming practices such as recommended package of practices (RPP: M_1), organic farming (OF: M_2) and natural farming (ZBNF: M_3), in sub plots two planting row arrangement viz., paired row planting (60-180-60 cm × 60 cm: S_1) and wide row planting (240 cm × 60 cm: S_2) and in sub plots three intercropping systems were taken viz., Sugarcane + Onion – Turmeric (I_1), Sugarcane + Onion + Cowpea + Coriander + Green Chilli (I_2) and Sole sugarcane (I_3). The results indicated that different farming practices and intercropping systems influenced significantly on soil enzyme activities in sugarcane rhizosphere. Organic farming practice recorded higher dehydrogenase activity (34.75 and 27.69 µg TPF formed g^{-1} of soil day^{-1}) and phosphatase activity (568.0 and 454.1 µg pNP g^{-1} of soil hr^{-1}) at 180 DAP and at harvesting stage than RPP and natural farming. Whereas, higher urease activity was observed under RPP than organic and natural farming practices at 180 DAP and at harvesting stage. Further intercropping system, sugarcane + onion – turmeric recorded higher dehydrogenase activity (35.38 and 27.24 µg TPF formed g^{-1} of soil day^{-1}) and phosphatase activity (540.2 and 456.0 µg pNP g^{-1} of soil hr^{-1}) at 180 DAP and at harvesting stage than compared with other intercropping systems.

Keywords Dehydrogenase, Farming practices, Organic farming, Phosphatase, Urease enzyme.

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INTRODUCTION

Sugarcane is an important agro-industrial crop, plays a pivotal role in national economy by sustaining second largest growing industry in the country next to the textiles. In India it's grown over an area of 4.86 m ha with a production of 376.9 m t, with a productivity of 70.6 t ha^{-1} (Anon 2020). Among major sugarcane growing states in India, Karnataka stands third with respect to area (0.45 m ha) and production (40.61 m t) and stands second in average productivity (90.0 t ha^{-1}) as well as sugar recovery (Anon 2020). In recent years sugarcane is facing serious problems in terms of sustainability and it is affected by the multiple factors like climate change, escalating cost of production, labor scarcity, slashing sugar price, declining soil health.

In the wake of green revolution, agriculture is heavily dependent on fertilizers and chemicals through their imbalanced and indiscriminate usage, this in turn leads to increased pollution of soil, water and environment in turn resulting in health hazards. Organic and natural farming (ZBNF) are gaining much importance and popularity in recent days with increasing health concern among the farmers and consumers. In this context, the nutrient requirements of the crop have to be met only through organics and biological activities. Organic and natural production practices reduce the use of chemical fertilizers and pesticides and increase sustainable production practices (Gomiero *et al*. 2011). Organic soil amendments such as manure like farm yard manure (FYM), vermicompost, enriched pressmud, *ghanajeevamrutha* and liquid manures like *jeevamrutha* and *panchagavvya* may increase soil microbial diversity, richness, and community structure (Lupatini *et al*. 2017, Smith *et al*. 2020). It helps to enhance and maintain soil organic carbon status for sustained cane yield (Kuri and Chandrashekara 2015). The biological condition of a soil can serves as a marker of the soil status and is closely linked to its natural fertility. Soil enzymes are continually playing dynamic roles in the maintenance of soil health.

Soil microorganisms produce extracellular enzymes to decompose organic residues and litter inputs in order to obtain the materials required for energy production and growth (German *et al*. 2011). These enzymes can become stabilized to soil particles and colloids, accruing over time (Burns 1982). By releasing enzymes to the soil solution, microorganisms have the potential to either mineralize or immobilize essential nutrients and increase or decrease, respectively, their availability to crops.

Soil enzymes are the direct mediators for the biological catabolism of soil organic and mineral components. They are often closely associated with SOM, soil physical properties, and microbial activities and biomass. They are the better indicators of soil health as changes in enzymes occurred much earlier than other soil parameters, thus providing early indications of changes in soil health. Their activities can also be used as measures of microbial activity and soil productivity. Although they are present in a very nominal quantity, their role in soil quality can never be ignored.

Soil enzymatic activity will be higher in the intercropping system than in monoculture because intercrops influences soil microbial composition—thus, it can enhance soil microbial activity, which has a significant relationship with the improvement of soil enzyme activities.The soil microbial community produces extracellular enzymes that are responsible for degrading plant residues and maintaining nutrient cycles in the soil (Curtright and Tiemann 2021). Crop diversification enhances the soil microflora through production of root exudates and better microclimate. Intercropping increases potential enzyme activity by 13 % (Curtright and Tiemann 2021). Soil enzymes are biologically significant as they participate in the transformation, cycling of mineral elements and influence their availability to plant. Enzyme activities are very much influenced by the addition of organic manures and plant root exudates due to increase in soil microbial activity (Kalappanavar and Gali 2018). In this view the study was undertaken to investigate the influence of natural, organic and conventional farming practices in sugarcane based intercropping systems on soil enzymatic activity.

MATERIALS AND METHODS

A field experiment was carried out at Agriculture Research Station, Hukkeri Dist Belagavi, Karnataka,

India during 2019-20 in seasonal planting season. The soil was medium black clay in texture having pH 8.20 with electrical conductivity of 0.283 dSm^{-1}. The soil had medium in organic carbon content (0.68 %), low in available nitrogen (241.2 kg ha^{-1}), medium in available P_2O_5 (38.54 kg ha^{-1}) and high in available K_2O (433.6 kg ha^{-1}). The experiment was laid out in split-split plot design consist of three main plots of farming practices viz., M_1: Recommended package of practices (RPP), M_2:Organic farming (FYM @ 25 t ha^{-1} (basal) + nutrient managed by supplying FYM, vermicompost and enriched pressmud 1/3rd each equivalent to recommended dose of nitrogen + bio-fertilizers PSB and *Azospirillum* @ 10 kg ha^{-1} each) and M_3: Natural farming [Settling treatment with *beejamrutha* + soil application of *ghanajeevamrutha* @ 1000 kg ha^{-1} + soil application of *jeevamrutha* @ 500 liter ha^{-1} at fortnightly intervals and foliar spray of *jeevamrutha* @ 10 % at monthly interval up to 240 day after planting (DAP) + mulching with crop residues + plant protection with natural pesticides / fungicides like *neemastra, agniastra, bramhastra, shuntiastra* and fermented butter milk]; two planting methods in sub plots viz., paired row planting (PRP) - 60-180-60 cm × 60 cm (S_1) and wide row planting (WRP) - 240 cm × 60 cm (S_2) in which three inter-cropping systems were introduced viz., Sugarcane + Onion – Turmeric (I_1), Sugarcane + Onion + Cowpea + Coriander + Green Chilli) (I_2) and sole sugarcane (I_3) in sub-sub plots. Furrows were opened at spacing of 60 cm. Settlings of sugarcane cultivar Co 86032 were transplanted in respective furrows. Intercrops were sown on either side of furrows opened in space provided between sugarcane rows. Nutrient management in recommended package of practices (RPP) as per UAS, Dharwad recommendations (FYM @ 25 t ha^{-1}, 250:75:190 N, P_2O_5, K_2O kg ha^{-1}, respectively and $ZnSO_4$ and $FeSO_4$ @ 25 kg ha^{-1} each, bio fertilizers PSB and *Azospirillum* @ 10 kg ha^{-1} each) were followed. Proportionate to population, nutrients were applied to all the intercrops for respective farming practices.

Collection and analysis of rhizosphere soil samples

The soil samples were collected from rhizosphere of sugarcane from each plot at 180 DAP and at harvest and used for determination of soil enzyme activities.

Dehydrogenase activity : Dehydrogenase enzyme activity in the soil sample was determined by following the procedure as described by Casida *et al*. (1964). Ten gram of soil and 0.2 gram of $CaCO_3$ were thoroughly mixed and dispensed in test tubes. Each tube was added with one ml of 1.5 % aqueous solutions of 2,3,5- triphenyl tetrazolium chloride (TTC), one ml of 1 % glucose solution and 8 ml of distilled water which was sufficient to leave a thin film of water above the soil layer. The test tubes were stoppered with rubber bands and incubated at 30°C for 24 hours. At the end of incubation, the contents of the tube were rinsed down into a small beaker and converted into slurry by adding 10 ml methanol, the slurry was filtered through whatman No. 42 filter paper. Repeated rinsing of soil with methanol was continued till filtrate ran free of red color. The intensity of red color was measured at 485 nm, against a methanol blank using spectrophotometer. The concentration of formazan formed in the soil sample was determined using graded concentrations of formazan. The results were expressed in µg TPF formed g^{-1} soil day^{-1}.

Phosphatase activity : The reaction mixture comprising of 1 g of soil, 0.2 ml toluene, 4 ml modified universal buffer (pH 7.5) and 1 ml of P-nitrophenol phosphate solution were mixed and incubated at 37°C for one hour. One ml of 0.5 M $CaCl_2$ and 4 ml of 0.5 M NaOH were added, swirled and filtered. The intensity of yellow color was measured at 420 nm against the reagent blank (Eivazi and Tabatabai 1977). The results were expressed in µg pNP released g^{-1} soil hr^{-1}.

Urease activity : The reaction mixture comprising of 10 g of soil, one ml of toluene, 20 ml of phosphate buffer (pH 6.7) and 10 ml of 10 % urea solution in distilled water was incubated at 30°C for 24 hours, later 15 ml of 1 N KCl solution containing 150 ppm $HgCl_2$ was added. One ml of aliquot filtrate was mixed with 2 ml of 10 kg per cent sodium tartarate solution and 0.5 ml of Nessler's reagent. The intensity of yellow color developed was read in spectrophotometer after 30 minutes at 410 nm (Tabatabai and Bremner 1972) against blank. The results were expressed in µg NH_4-N g^{-1} soil day^{-1}.

Statistical analysis : The data recorded during the course of investigation were compiled and analyzed

for statistical significance as per the analysis of variance for split plot design. Fisher's method of analysis of variance (ANOVA) as described by Gomez and Gomez (1984). Standard error of mean and coefficient of variability have been worked out for set of observations under each character at P=0.05 to interpret the significance.

RESULTS AND DISCUSSION

Effect of farming practices and intercropping systems on soil enzymes activity in sugarcane rhizosphere

Dehydrogenase activity in sugarcane rhizosphere

Dehydrogenase is an extra cellular enzyme in the soil and considered to play an important role in the initial stage of oxidation of soil organic matter by transferring hydrogen or electron from substrates to acceptors indicates the microbial activity in the soil. Measurement of dehydrogenase activity represents immediate metabolic activities of soil microorganism at the time of the test. Soil dehydrogenase activity is an oxidative degradation process i.e., dehydrogenation of organic matter by transferring hydrogen and electrons from substrate to acceptors. Dehydrogenase enzymes play a significant role in the biological oxidation of soil organic matter. Dehydrogenase activity thus serves as an indicator of the microbiological redox systems and may be considered a good measure of microbial oxidative activities in soils (Casida *et al*. 1964). Dehydrogenase indicates the total range of oxidative activity of soil microflora (Liang *et al*. 2014).

In the present study dehydrogenase activity significantly influenced by different farming practices and intercropping systems at 180 DAP and at harvesting stages of test (Table 1 and 2). Where in, organic farming practice (M_2) recorded significantly higher dehydrogenase activity (34.75 and 27.69 µg of TPF g^{-1} of soil day^{-1}) at 180 DAP and at harvesting stage, respectively than RPP and natural farming. However, natural farming (M_3) was on par with organic farming with respect to dehydrogenase activity. While, RPP recorded lower dehydrogenase activity at both stages of sugarcane. This might be due to application of organics such as FYM, vermicompost, enriched pressmud and *jeevamrutha* were found to boost enzyme catalyze involved in biochemical reactions and nutrient cycling in soil better than RPP. Further, the dehydrogenase activity in natural farming was on par with organic farming due to addition of microbial consortia like *ghanajeevamrutha* and *jeevamrutha* at frequent intervals coupled with mulching materials. The results are in conformity with the findings of Aluri (2013), Kuri (2014) in sugarcane, Vinay *et al*. (2020) in maize. Dehydrogenase activity with application of organic sources might be linked to more substrate availability in the soil. Increased soil organic carbon, utilized as a carbon substrate resulting to increase microbial abundance which led to increased dehydrogenase activity (Nooli 2019). This reflects the greater biological activity in the soil and the stabilization of extracellular enzymes through complexation with humic substances (Basak *et al*. 2013).

Among the intercropping systems, I_1 (sugarcane + onion – turmeric) resulted significantly higher dehydrogenase activity (35.38 and 27.24 µg of TPF g^{-1} of soil day^{-1}) at 180 DAP and at harvesting stage, respectively than other intercropping systems. While, I_3 (sole sugarcane) recorded lower dehydrogenase activity at both stages of sugarcane. It was due to roots of different plant species interact directly with each other and microclimate created at soil surface due to mutual shading under intercropping system; there by, subsequent root exudation is liable to alter microbial diversity, enzymatic activity and crop productivity (Li *et al*. 2013, Singh *et al*. 2017, Lian *et al*. 2019). The variations in soil enzyme activity are due to variation in microbial count across the systems could be attributed to a combined effect of greater root biomass, exudates, mucilage and microclimate of community (Li *et al*. 2013).

Phosphatase activity in sugarcane rhizosphere

Phosphatase activity is essential for conversion of organic substrates containing phosphorus into inorganic form through hydrolysis in the soil phosphatase being an important enzyme in soil is an oxidoreductase which plays a key role in P cycle of the environment (Eivazi and Tabatabai 1977).

In the present investigation soil phosphatase enzyme activity significantly influenced by different

Table 1. Soil enzyme activities at 180 DAP of seasonal sugarcane as influenced by different farming practices, spacings and intercropping systems.

Treatments		Soil enzyme activity							
		Dehydrogenase (µg TPF formed g^{-1} soil day^{-1}				Phosphatase (µg pNP g^{-1} of soil hr^{-1})			
		RPP	OF	NF	Mean S	RPP	OF	NF	Mean S
S: Row spacings (cm)			M × S				M × S		
S_1: 60-180-60 cm × 60 cm		33.28	35.06	34.25	33.28	511.6	563.5	531.5	535.5
S_2: 240 cm × 60 cm		32.04	34.44	34.32	32.04	507.7	572.5	523.5	534.5
I: Intercropping systems			M × I		Mean I		M × I		Mean I
I_1: Sc + O - T		34.57	36.48	35.11	35.38	497.7	579.5	543.3	540.2
I_2: Sc + O + Cp + Co + GC		32.22	34.78	33.55	33.52	516.0	561.8	524.6	534.1
I_3: Sole sugarcane		31.19	32.99	34.19	32.79	515.1	562.8	514.5	530.8
		M × S × I		S × I		M × S × I		S × I	
	I_1	35.08	37.14	35.39	35.87	493.9	581.8	547.9	541.2
S_1: 60-180-60 cm ×	I_2	32.17	34.74	33.12	33.35	511.7	557.7	526.1	531.9
60 cm (PRP)	I_3	32.58	33.29	34.23	33.37	529.3	550.9	520.5	533.6
	I_1	34.05	35.81	34.83	34.90	501.6	577.1	538.7	539.1
S2: 240 cm × 60 cm	I_2	32.27	34.82	33.98	33.69	520.4	565.8	523.2	536.4
(WRP)	I_3	29.79	32.68	34.15	32.21	501.0	574.7	508.5	528.1
M: Farming practices		32.66	34.75	34.28		509.6	568.0	527.5	
Source of variations		SEm ±		CD (p=0.05)		SEm ±		CD (p=0.05)	
M - Farming practices		0.34		1.32		7.2		28.1	
S - Spacings		0.32		NS		6.4		NS	
I - Intercropping systems		0.55		1.60		8.2		NS	
M × S		0.55		NS		11.2		NS	
M × I		0.95		NS		14.3		NS	
S × I		0.78		NS		11.6		NS	
M × S × I		1.34		NS		20.2		NS	

Table 1. Continued.

Treatments		Soil enzyme activity Urease (NH^4-N g^{-1} of soil day^{-1})			
		RPP	OF	NF	Mean S
S: Row spacings (cm)			M × S		
S_1: 60-180-60 cm × 60 cm		22.60	20.90	20.17	21.22
S_2: 240 cm × 60 cm		23.77	21.20	20.10	21.69
I: Intercropping systems			M × I		Mean I
I_1: Sc + O - T		24.17	22.32	19.29	21.92
I_2: Sc + O + Cp + Co + GC		23.09	21.13	20.89	21.70
I_3: Sole sugarcane		22.30	19.71	20.22	20.74
			M × S × I		S × I
S_1: 60-180-60 cm ×	I_1	23.71	22.30	19.62	21.88
60 cm (PRP)	I_2	22.46	21.21	20.73	21.47
	I_3	21.63	19.21	20.14	20.32
S_2: 240 cm ×	I_1	24.62	22.34	18.95	21.97
60 cm (WRP)	I_2	23.72	21.04	21.04	21.93
	I_3	22.96	20.21	20.31	21.16
M: Farming practices		23.18	21.05	20.13	
Source of variations			SEm ±	CD (p=0.05)	
M - Farming practices			0.24	0.96	
S - Spacings			0.17	NS	
I - Intercropping systems			0.35	NS	
M × S			0.30	NS	

Table 1. Continued.

M × I	0.61	NS
S × I	0.50	NS
M × S × I	0.87	NS

M: Main plot (Farming practices)	S: Sub plot (Row spacings)	I: Sub sub plot (Intercropping systems)
M_1: Recommended package of practices (RPP)	S_1: PRP - Paired row planting (60-180-60 cm × 60 cm)	I_1: Sugarcane + Onion – Turmeric (Sc + O - T)
M_2: Organic farming (OF)	S_2: WRP - Wide row planting (240 cm × 60 cm)	I_2: Sugarcane + Onion + Cowpea + Coriander + Green Chilli (Sc + O + Cp + Co + GC)
M_3: Natural farming (ZBNF)		I_3: Sole sugarcane

farming practices and intercropping systems at both stages of sugarcane (Table 1 and 2). Among the farming practices, organic farming (M_2) recorded significantly higher phosphatase activity (568.0 and 454.1 µg pNP g^{-1} soil hr^{-1}) at 180 DAP and at harvest, respectively than RPP and natural farming. While, RPP recorded lower phosphatase activity at both stages. The maximum phosphatase activity in soil under organic farming practice when compared to inorganic nutrient management practice was due to incorporation of organic manures in the form of FYM, vermicompost, enriched pressmud and bio-fertilizers (phosphate solubilizing bacteria - PSB) and liquid organic manure like *jeevamrutha* and *panchagavvya* that increase decomposition process there by increase the microbial activity. The higher phosphatase activity was recorded (Meena *et al*. 2014) with 100 % substitution of RDN with concentrate organic manure. Sriramachandrasekharan and Ravichandran (2011) reported that addition of organic substances to the

Table 2. Soil enzyme activities at harvest of seasonal sugarcane as influenced by different farming practices, spacings and intercropping systems.

Treatments		Soil enzyme activity							
		Dehydrogenase (µg TPF formed g^{-1} soil day^{-1}				Phosphatase (µg pNP g^{-1} of soil hr^{-1})			
		RPP	OF	NF	Mean S	RPP	OF	NF	Mean S
S: Row spacings (cm)		M × S		M × S					
S_1: 60-180-60 cm × 60 cm		24.19	28.39	25.41	26.00	390.7	458.1	418.1	422.3
S_2: 240 cm × 60 cm		24.15	26.98	24.79	25.30	415.7	450.1	422.9	429.5
I: Intercropping systems		M × I		Mean I		M × I		Mean I	
I_1: Sc + O - T		25.55	29.33	26.85	27.24	422.0	500.7	445.4	456.0
I_2: Sc + O + Cp + Co + GC		23.67	26.67	24.69	25.01	414.2	438.8	430.2	427.7
I_3: Sole sugarcane		23.30	27.06	23.76	24.70	373.4	422.7	385.9	394.0
		M × S × I		S × I		M × S × I		S × I	
S_1: 60-180-60 cm	I_1	25.62	28.67	27.21	27.17	393.5	504.2	442.2	446.6
× 60 cm (PRP)	I_2	23.59	28.67	24.83	25.70	405.1	457.1	430.5	430.9
	I_3	23.37	27.84	24.19	25.13	373.6	413.0	381.7	389.5
S2: 240 cm ×	I_1	25.48	29.99	26.48	27.32	450.6	497.2	448.6	465.5
60 cm (WRP)	I_2	23.75	24.66	24.55	24.32	423.3	420.5	429.9	424.6
	I_3	23.22	26.28	23.32	24.27	373.2	432.4	390.1	398.6
M: Farming practices		24.17	27.69	25.10		403.2	454.1	420.5	
Source of variations		SEm ±		CD (p=0.05)		SEm ±		CD (p=0.05)	
M - Farming practices		0.24		0.95		5.34		21.0	
S - Spacings		0.21		NS		5.38		NS	
I - Intercropping systems		0.49		1.43		6.78		19.8	
M × S		0.37		NS		9.32		NS	
M × I		0.85		NS		11.75		NS	
S × I		0.69		NS		9.59		NS	
M × S × I		1.20		NS		16.62		NS	

Table 2. Continued.

Treatments		Soil enzyme activity			
		Urease (NH_4-N g^{-1} of soil day^{-1})			
		RPP	OF	NF	Mean S
S: Row spacings (cm)			M × S		
S_1: 60-180-60 cm × 60 cm		18.09	17.00	15.62	16.90
S_2: 240 cm × 60 cm		18.71	17.36	16.18	17.42
I: Intercropping systems			M × I		Mean I
I_1: Sc + O - T		19.37	17.37	16.63	17.79
I_2: Sc + O + Cp + Co + GC		18.08	17.08	16.09	17.08
I_3: Sole sugarcane		17.75	17.10	14.99	16.61
			M × S × I		S × I
S_1: 60-180-60 cm ×	I_1	19.27	17.21	16.89	17.79
60 cm (PRP)	I_2	17.79	16.54	15.87	16.73
	I_3	17.21	17.25	14.10	16.19
S_2: 240 cm ×	I_1	19.46	17.52	16.37	17.78
60 cm (WRP)	I_2	18.37	17.62	16.32	17.44
	I_3	18.29	16.95	15.87	17.04
M: Farming practices		18.40	17.18	15.90	
Source of variations			SEm ±		CD (p=0.05)
M - Farming practices			0.31		1.20
S - Spacings			0.46		NS
I - Intercropping systems			0.49		NS
M × S			0.79		NS
M × I			0.85		NS
S × I			0.70		NS
M × S × I			1.21		NS

M: Main plot (Farming practices)
M_1: Recommended package of practices (RPP)
M_2: Organic farming (OF)
M_3: Natural farming (ZBNF)

S: Sub plot (Row spacings)
S_1: PRP - Paired row planting (60-180-60 cm × 60 cm)
S_2: WRP - Wide row planting (240 cm × 60 cm)

I: Sub sub plot (Intercropping systems)
I_1: Sugarcane + Onion – Turmeric (Sc + O - T)
I_2: Sugarcane + Onion + Cowpea + Coriander + Green Chilli (Sc + O + Cp + Co + GC)
I_3: Sole sugarcane

soil served as a carbon source that enhanced microbial biomass and phosphatase activity, showing that these enzymes are of microbiological origin (Bohem *et al*. 2005). Greater enzyme activity is usually associated with greater microorganism activity. It is possible that phosphatase activity was dependent on the presence of fungi since Casida (1959) has reported that fungi produce enzyme capable of dephosphorylating organic phosphorus compounds found in soil.

Intercropping had significant effect on phosphatase activity at harvesting stage wherein, sugarcane + onion – turmeric (I_1) recorded significantly greater phosphatase activity (456.0 µg pNP g^{-1} soil hr^{-1}) over other intercropping and sole cropping systems. While, I_3 (sole sugarcane) recorded lower phosphatase activity at both stages of sugarcane. The higher phosphatase activity might be due to higher microbial population and organic substrate available for soil enzymes. Plant roots stimulate enzyme activity because of their positive effect on microbial activity and production of exudates rich in substrates acted on by enzymes. In addition to this, micro climate of intercropping of turmeric with sugarcane enhanced phosphatase activity in soil.

Urease activity in sugarcane rhizosphere

Urease (Urea amidohydrolase) is one of the most important enzymes that play a key role in nitrogen cycle (Tabatabai 1994, Srinivasa Rao *et al*. 2017, Kuscu 2019). Urease activity is directly related to

type of vegetation and quality of incorporated organic materials and with fluctuation in nutrient levels due to associated changes in population of urolytic microbes in the soil. Urease is a hydrolase enzyme responsible for hydrolytic conversion of substrate, urea into CO_2 and NH_3. Urease enzyme assay is important in understanding mineralization of N element and its response to the application of organic fertilizers. Land use system, tillage and soil management systems particularly its relations up to the agriculture practices has led to extensive research investigation in the last 3 decades.

Urease has an important role in the occurrence of accessibility of N for plant growth in N cycle and in the widespread usage of urea as a fertilizer (Burak Koçak 2020). In the present study, urease activity was influenced significantly by different farming practices at both the growth stages of sugarcane (Tables 1 and 2). Among the farming practices, RPP recorded significantly higher urease activity (23.18 and 18.40 NH_4-N g^{-1} of soil day^{-1}) than organic and natural farming at 180 DAP and at harvest, respectively. Whereas, lower urease activity recorded in natural farming. Higher urease activity under RPP might be due to nitrogen substrate from application of chemical fertilizer urea than organic and natural farming. Urease activity was positively correlated with protease activity and soil nitrogen (Burak Koçak 2020).

CONCLUSION

It can be concluded that soil dehydrogenase and phosphatase enzymes are catalysts that maintain decomposition of organic matter and nutrient cycling in soils in organic sugarcane production. Urease enzyme is the most important enzymes in soil that determine the fate of urea in soil. Organic farming practices and intercropping system, sugarcane + onion – turmeric recorded higher dehydrogenase and phosphatise enzymes activity. Whereas, recommended package of practices recorded higher urease activity in sugarcane rhizosphere.

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