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Effect of organics and inorganics on soil enzyme activity

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Abstract
A field experiment was undertaken during *kharif* 2016 in order to study the "Effect of different organics and inorganics on soil enzyme activity". The activity of dehydrogenase, phosphatase and urease at peak growth stage and harvest as influenced by application of different organics and inorganics was estimated by following standard procedures. A highest Dehydrogenase (80.12 and 76.41µg TPF formed g^{-1} soil day^{-1}), Phosphatase (44.68 and 21.12 µg of PNP g^{-1} soil h^{-1}) and Urease (7.60 and 2.52 µg of NH_4-N formed g $soil^{-1}$) activities at peak growth and harvest stage, respectively were recorded in treatment which received 100 per cent RDF + poultry manure

Keywords: Maize, soil, organics, dehydrogenase, phosphatase and urease.

Introduction
Maize (*Zea mays* L.) is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions. Among the cereals grown in India, maize is gaining significant importance on account of its growing demand for diversified uses, especially as animal feed and industrial raw material apart from human consumption in different forms. Maize crop is grown in wide range of climatic conditions. In India, maize is grown in all the seasons *i.e.*, *kharif, Rabi* and summer.

Organic agriculture is gaining much importance and popularity in recent days with increasing health concern among the farmers and consumers. It helps to enhance and maintain soil organic carbon status for sustained crop yield. The biological condition of a soil can serve as a marker of the soil status and is closely linked to its natural fertility. The enzymes in soil originate from animal, plant and microbial sources. 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 due to increase in soil microbial activity. Available nitrogen, phosphorus, potassium and organic carbon content found to have a strong positive relationship with all the enzymes.

Materials and methods
A field experiment was conducted at main agricultural research station (MARS), Dharwad, Karnataka during *kharif,* 2016. The experiment was laid out in randomized complete block design with 13 treatments, replicated thrice. The treatments include, 100 per cent RDF+ FYM (T_1), 100 per cent RDF + Vermicompost (T_2), 100 per cent RDF + Poultry manure (T_3), 100 per cent RDF + Sheep manure (T_4), FYM alone (T_5), Vermicompost alone (T_6), Poultry manure alone (T_7), Sheep manure alone (T_8), 50 per cent RDF +FYM (T_9), 50 per cent RDF + Vermicompost (T_{10}), 50 per cent RDF + Poultry manure (T_{11}), 50 per cent RDF + Sheep manure (T_{12}) and RDF alone (T_{13}). The quantity of Farm yard manure (FYM), Vermicompost (VC), Poultry manure (PM) and Sheep manure (SM) required for each plot was calculated as per the treatment details and applied. Recommended dose of nitrogen, phosphorous and potassium were applied in the form of urea, diammonium phosphate (DAP) and muriate of potash (MOP), respectively at the time of sowing.

Soil samples were collected at peak growth and harvest stage 0-22.5 cm depth from each treatment and were analysed for activity of dhydrogenase, phosphatase and urease enzymes by following the procedures as described by Casida *et al*. (1964) [1], Evazi and bBatabai (1979) [2] and Tabatabai and Bremner (1972) [5], respectively.

Results and discussion
The data on the effect of organics and inorganics on the dehydrogenase, phosphatase and urease activity in soil at both peak growth and harvest stage of crop are presented in Table 1, 2 and 3, respectively.

Table 1: Effect of different organics and inorganics on soil dehydrogenase enzyme activity

Treatments	Dehydrogenase (µg TPF formed g soil^{-1} day^{-1})			
	At peak growth		At harvest	
	Soil depth (cm)			
	0 - 22.5	% increase/ decrease over control	0 - 22.5	% increase/ decrease over control
T_1: 100 % RDF + FYM	75.51^{a-c}	32.45	70.81^{a-c}	30.86
T_2: 100 % RDF + VC	76.42^{ab}	34.05	73.12^{ab}	35.13
T_3: 100 % RDF + PM	80.12^{a}	40.54	76.41^{a}	41.21
T_4: 100 % RDF + SM	76.72^{ab}	34.57	73.92^{ab}	36.61
T_5: FYM alone	68.21^{c}	19.65	54.62^{d}	0.94
T_6: VC alone	69.42^{bc}	21.77	56.34^{d}	4.12
T_7: PM alone	70.91^{bc}	24.38	58.21^{d}	7.58
T_8: SM alone	69.52^{bc}	21.94	57.11^{d}	5.54
T_9: 50 % RDF + FYM	70.81^{bc}	24.21	64.73^{c}	19.63
T_{10}: 50 % RDF + VC	72.32^{bc}	26.85	65.71^{c}	21.44
T_{11}: 50 % RDF + PM	73.42^{a-c}	28.78	69.60^{bc}	28.63
T_{12}: 50 % RDF + SM	73.21^{a-c}	28.42	66.80^{c}	23.45
T_{13}: 100 % RDF (control)	57.01^{d}	0	54.11^{d}	0
LSD	6.82		5.70	

Note: Initial value of dehydrogenase activity = 70.12 (µg TPF formed g^{-1} soil day^{-1})
Means followed by same latter (s) within a column are not significantly different (DMRT P = 0.05)

Table 2: Effect of different organics and inorganics on soil phosphatase enzyme activity

Treatments	Phosphatase (µg of P-NP hydrolyzed g soil^{-1} hr^{-1})			
	At peak growth		At harvest	
	Soil depth (cm)			
	0 - 22.5	% increase/ decrease over control	0 - 22.5	% increase/ decrease over control
T_1: 100 % RDF + FYM	37.76^{cd}	21.41	30.01^{c}	22.89
T_2: 100 % RDF + VC	37.61^{cd}	20.93	32.22^{b}	31.94
T_3: 100 % RDF + PM	44.68^{a}	43.67	35.61^{a}	45.82
T_4: 100 % RDF + SM	41.57^{ab}	33.67	33.11^{b}	35.59
T_5: FYM alone	28.00^{g}	-9.97	21.12^{h}	-13.51
T_6: VC alone	29.63^{g}	-4.73	22.71^{gh}	-7.00
T_7: PM alone	31.00^{e-g}	-0.32	24.71^{e-g}	1.19
T_8: SM alone	29.98^{fg}	-3.60	23.01^{gh}	-5.77
T_9: 50 % RDF + FYM	31.00^{e-g}	-0.32	24.41^{fg}	-0.04
T_{10}: 50 % RDF + VC	33.26^{ef}	6.95	25.71^{ef}	5.28
T_{11}: 50 % RDF + PM	38.81^{bc}	24.79	28.32^{cd}	15.97
T_{12}: 50 % RDF + SM	34.40^{de}	10.61	26.52^{de}	8.60
T_{13}: 100 % RDF (control)	31.10^{e-g}	0	24.42^{fg}	0
LSD	3.22		1.86	

Note: Initial value of phosphatase activity = 20.15 (µg of P-NP hydrolyzed g soil^{-1} hr^{-1})
Meas followed by same latter (s) within a column are not significantly different (DMRT P = 0.05)

Dehydrogenase activity (µg TPF formed g^{-1} soil day^{-1})

Dehydrogenase activity in soil at peak growth stage ranged from 57.01 to 80.12 µg TPF formed g^{-1} soil day^{-1}, while at harvest stage it ranged from 54.11 to76.41 µg TPF formed g^{-1} soil day^{-1}. The highest dehydrogenase activity at peak growth stage (80.12 µg TPF formed g^{-1} soil day^{-1}) and harvest (76.41 µg TPF formed g^{-1} soil day^{-1}) was observed in the treatment which received 100 % RDF + poultry manure (T_3) followed by other INM treatments except T_{10} and T_{11}. The lowest dehydrogenase activity (57.01 and 54.11µg TPF formed g^{-1} soil day^{-1} at peak growth and harvest stages, respectively) was observed in T_{13} treatment (RDF alone). Application of poultry manure with 100 per cent RDF (T_3) recorded 40.54 per cent increase in dehydrogenase activity over application of RDF alone (T_{13}). All the INM treatments showed increased dehydrogense activity than treatments with organics alone (Fig. 1 and 2). The increased activity in INM treatments could be attributed to the readily available forms of nutrients in fertilizers which help in faster proliferation of microbial population.

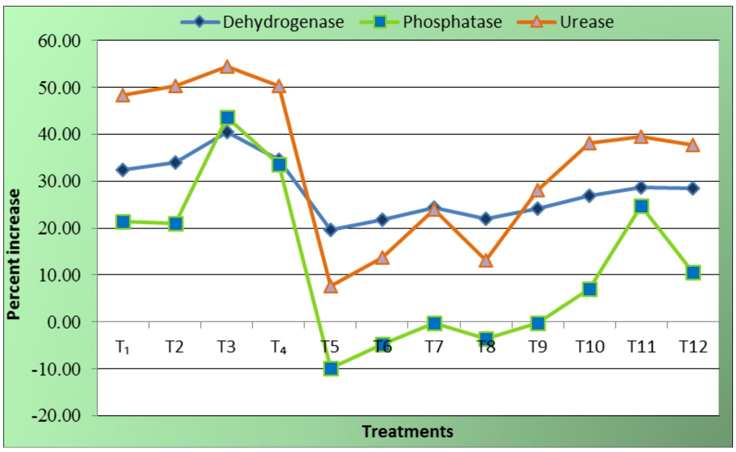

Fig 1: Per cent increase in enzyme activity in soil over control at peak growth stage

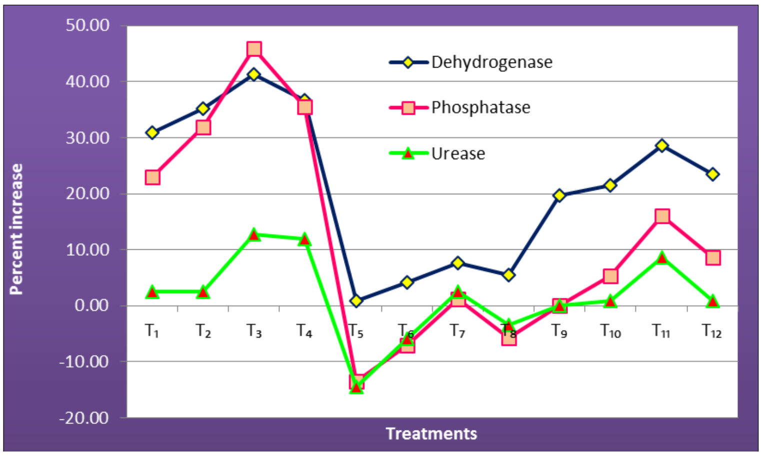

Fig 2: Per cent increase in enzyme activity in soil over control at harvest stage

Phosphatase activity (µg of PNP g^{-1} soil h^{-1})

Phosphatase activity of soil ranged from 28.00 to 44.68 and 21.12 to 35.61 µg of PNP g^{-1} soil h^{-1} at peak growth and harvest stage, respectively. Significantly highest phosphatase activity (44.68 µg of PNP g^{-1} soil h^{-1}) was recorded in treatment receiving 100 per cent RDF + poultry manure (T_3) which was 43.67 % more than control (T_{13}) followed by 100 per cent RDF + sheep manure (T_4) which was on par with it. The INM treatments receiving 100 per cent RDF and organic sources accounted for significantly higher phosphatase activity than treatments with organics alone which is attributable to the increased availability of nutrients from fertiliser source for proliferation of microbes. Lowest soil phosphatase activity (28.00 and 21.12 µg of PNP g^{-1} soil h^{-1} at peak growth and harvest stage, respectively) was observed in T_5 treatment which received FYM alone. All the treatments with organics alone showed a decrease in phosphatase activity compared to its activity in control (RDF alone) (Fig. 1 and 2). The non-availability of phosphorous source for microbial growth might have affected the activity as the P in organic sources gets released slowly.

Urease activity (NH_4-N formed g^{-1} soil)

Soil urease activity varied from 4.92 to 7.60 and 1.20 to 2.52 µg of NH_4-N formed g^{-1} soil at peak growth stage and harvest, respectively. At both the crop stages significantly highest urease activity in soil was recorded in treatment receiving 100 per cent RDF + poultry manure (T_3) followed by other treatments with 100 per cent RDF + organics (T_1, T_2 and T_3) were on par with it. The treatments with 100 per cent RDF and organic sources accounted for nearly 50 per cent increase in urease activity over control (Fig 1 and 2)). The availability of carbon source from organics and nitrogen from fertiliser was responsible for such increase in urease activity. At peak growth stage significantly lower urease activity was recorded in organic alone (T_5 to T_8) and RDF alone (T_{13}) treatments. At harvest the urease activity in all the treatments except organics alone was on par.

In general, the activity of the three enzymes studied was Significantly higher in treatments which received 100 per cent RDF + organics followed by 50 per cent RDF + organics. This is attributable to sufficient supply of energy source i.e. carbon from the organics and readily available nutrients from inorganic fertilizers. Further, application of organic matter provides proper aeration, moisture content and nutrients which results in proliferation of microorganisms. Singaram and Kamala kumari (2000) reported enhanced levels of soil enzyme activity due to addition of FYM. Usha rani *et al*. (2014) [6] observed significantly improved dehydrogenase and phosphatase activity in soil which received vermicompost along with 100 per cent N fertiliser. Similar results were also recorded by Srinivas *et al*. (2000) [4] and Reddy and Reddy (2012) [3]. The lowest activity of the three enzymes was recorded in RDF alone treatment (T_{13}) which could be attributed to the lack of sufficient substrate *i.e.*, organic carbon required for microbial proliferation. The enzymes activity at harvest was lower than at peak growth stage which could be due to lower moisture in soil affecting microbial activity.

Table 3: Effect of different organics and inorganics on soil urease enzyme activity

Treatments	Urease (µg of NH_4-N formed g $soil^{-1}$)			
	At peak growth		At harvest	
	Soil depth (cm)			
	0 - 22.5	% increase/ decrease over control	0 - 22.5	% increase/ decrease over control
T_1: 100 % RDF + FYM	7.30^{ab}	48.37	2.20^{a}	2.56
T_2: 100 % RDF + VC	7.40^{ab}	50.41	2.30^{a}	2.56
T_3: 100 % RDF + PM	7.60^{a}	54.47	2.52^{a}	12.82
T_4: 100 % RDF + SM	7.40^{ab}	50.41	2.41^{a}	11.97
T_5: FYM alone	5.30^{f}	7.72	1.21^{d}	-14.53
T_6: VC alone	5.60^{ef}	13.82	1.40^{cd}	-5.98
T_7: PM alone	6.10^{de}	23.98	1.70^{bc}	2.56
T_8: SM alone	5.57^{ef}	13.21	1.50^{cd}	-3.42
T_9: 50 % RDF + FYM	6.30^{cd}	28.05	2.03^{ab}	0.00
T_{10}: 50 % RDF + VC	6.80^{bcd}	38.21	2.12^{ab}	0.85
T_{11}: 50 % RDF + PM	6.86^{bc}	39.43	2.33^{a}	8.55
T_{12}: 50 % RDF + SM	6.78^{b-d}	37.80	2.20^{a}	0.85
T_{13}: 100 % RDF (control)	4.92^{f}	0	2.03^{ab}	0
LSD	0.65		0.44	

Conclusions

The microbial proliferation depends upon the soil organic carbon status as well as on the availability of nutrient elements. The results of the present study clearly indicated the benefits of use of both organics and inorganics in enhancing the activity of all the three enzymes which in turn can enhance nutrient availability to plants through faster mineralization processes.

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