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DEHYDROGENASE ENZYME ACTIVITY OF NORMAL, SALINE AND ALKALI SOILS UNDER DIFFERENT CROPPING SYSTEMS

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ABSTRACT

Dehydrogenase activitywas measured in normal soils having pH 7.0 to 8.5 and EC 0.9 to 2.9dS m^{-1}; alkali soil having pH 8.5 to 9.2 and EC 1.8dS $m^{-1}$and in saline soil having pH 7.7 to 7.8 and EC 4.3 to 7.0 dsm^{-1} under different cropping systems. Dehydrogenase activity in normal soil was 50% more under trees compared to rice-wheat cropping system. Whereas in saline soil it was more underbajra-wheat cropping system than under trees. In alkali soils dehydrogenase enzyme was maximum underjungleekikar, rice-wheat and followed by Eucalyptus. When dehydrogenase activity was compared for barren soil at all the sites, it was 30.05ìg TPF g^{-1} soil in the normal soil under Halfa grass, 1.44 to34.57ìg TPF g^{-1} soil in alkali soil and 0.00 to 80.18ìg TPF g^{-1} soil in saline soil. Average dehydrogenase was 40.56, 39.95 and 12.50 TPF g^{-1} soil for normal, saline and alkali soil, respectively. Dehydrogenase activity was almost same for saline and normal soils whereas, alkali soils showed minimum dehydrogenase enzyme activity.

Key words : Normal soil, Saline soil, Alkali soil, Cropping system, Dehydrogenase activity.

INTRODUCTION

Enzymatic activity of soils influenced by its physico-chemical characteristics and agricultural management practices. Dehydrogenase enzyme activity provides correlation between microbial population and biological activity (Skujins, 1973). Characteristics such as soil microbial biomass, soil enzymes and respiration respond quickly to changes in cop management practices and type of cultivation than physico-chemical properties of soil (McGill *et al*., 1986; Rao *et al*., 1990; Fromm *et al*., 1993; Chander *et al*., 1997). Permanent vegetation such as trees and grasses causes an increase in dehydrogenase activity as compared to annual crops (Rao and Gill, 1985). For highly deteriorated alkali soil, dehydrogenase activity was greater in rice-based cropping sequence than sorghum-based cropping sequence (Batra, 1998). Keeping this in mind the present study was undertaking to compare the dehydrogenase activity of normal, saline and alkali soils and correlate them with physico-chemical properties of soil with crops under different cropping systems.

MATERIALS AND METHODS

Soil samples were collected from three Tahsils of Muzaffarnagar distt. of Western U. P. Normal soils from Budhana Tehsil, saline soil from kairana Tehsil and alkali soil from Jansath Tehsil. Soil at Kairana is sandy loam, Typicnatrustalf at Budhana the soil is normal and at Jansath soil is typical alkaline and water logged generally classified as calciorthid. The soil samples were collected in January, 2007 under different agricultural management practices *i.e.* trees, grasses and annual crops. At Budhana and Kairana soil samples were also collected from typical

barren sites without any vegetation and salts were visible on the surface at the time of soil sample collection. At Jansath, one sample was from a fenced site which was infested with Halfa grass. Soil sampling was done from 0-0.15 m depth at five locations from each site and composited. For determination of dehydrogenase enzyme all the collected samples were grounded and sieved with less than 2mm without drying and kept in a refrigerator for further analysis. Dehydrogenase activity was assayed by the method of Casida *et al.* (1964) using 2, 3, 5 triphenyltetrazolium chloride as electron acceptor and expressing the results in µg TPF g^{-1} dry soil. The pH was determined in soil and water (1:2) and EC was determined in the saturated extract of soil. Organic carbon and available N of the soil were determined following the methods described by Piper (1966).

RESULTS AND DISCUSSION

Normal soil : at experimental farm, Shamli, the initial soil pH in 1996 was higher than 8.7 where the different treatments were imposed *viz*: 1. Rice-wheat cropping with 50% G.R. application (10 years), 2. Tree plantation like jungleekikar, babul and Eucalyptus, junglisaru and 3. A fenced area as an original soil to grow grasses naturally (table 1). At the time of sampling, pH varied from 7.2 to 8.0 under all crop management practices. The average dehydrogenase activity was about 2 and 2.5 times greater than under tree canopie as compared with rice-wheat system which might be because rice cultivation results in the shift for microflorafrom aerobic to anaerobic ones which in turn determine the dehydrogenase activity.Babul and Eucalyptus showed almost similar dehydrogenase activity but the lowest DHA was observed under Halfa grass. This may indicate some allelopathic effect of junglisaru leaves because organic carbon content under jungliusaru canopy was at par with other trees canopies and needs to be investigated further.

Organic C was higher under tree canopies than under rice-wheat. Organic C build-up under different crops was in the order: jungle kikar> babul >junglisaru> Eucalyptus > rice-wheat. Available N was greater under grasses, which may be due to asymbiotic N fixed by grasses that might have accumulated at the site itself because there was no removal of N through crop harvest. A slight build-up of available N was observed under jungleekikar (may be because of higher N concentration in the leaves), whereas it was depleted under all crops. Under Eucalyptus the available N was depleted most which may be because of non- nitrogen fixing nature of Eucalyptus.

Saline soil : In saline soil the pH was almost similar under all the treatments, whereas EC was 6.5dS m^{-1} in the barren soil, 7.0dS m^{-1} under seep weed, 6.5 to 7.0dS m^{-1} under tree canopies and from 4.3 to 6.7dS m^{-1} under Pearl millet- wheat cropping. In barren soil, no dehydrogenase activity was observed. Average dehydrogenase activity was 6 and 10 times greater under canopy and Pearl millet-wheat canopies, respectively, compared with that under seep weed (table 2). Amongst the trees, babulshowed highest DHA followed by Eucalyptus DHA (34.67) and jungleekikar DHA (12.36), may be because of its better growth performance under saline conditions. Under Eucalyptus, where the EC was lowest, DHA was half, while it was half under jungleekikar. The results thus showed that DHA also influenced by the type of crops besides salinity.

The higher DHA under pearl millet-wheat may be because of higher root/ shoot ratio (0.5) for pearl millet crop (Andrews and Kumar, 1992) that might have caused greater amount of carbon input and rootexudates to the soil. Further, under pearl millet-wheat rotation, biological activity was more in the treatments where the plots were irrigated with canal water (EC 6.0 to 12.0 dS m^{-1}). Garcia and Hernandez (1996) reported that dehydrogenase activity was negatively affected when 0.1 M solution of NaCl or Na_2SO_4 was introduced into the soil, which reflects the inhibition of microbial respiration at this concentration. However, the increased concentrations of salts do not necessarily lead to inhibition of enzymes. This may be due to the type of salt which dominated at that time as in his study dehydrogenase activity increased at higher concentration of salts when Na_2SO_4 was used, possibly because of adaptation of microorganisms to the saline environment. Similar to dehydrogenase activity, the average organic C and available N were greater under pear millet-wheat followed by tree canopies and saline soil with crop. The higher fertility status under pearl millet-wheat may be due to continuous fertilizer application to the crop.

Alkali soils : The overall low dehydrogenase activity was observed in alkali soil compared with normal and saline soil (table 3). Batra and Manna (1997) have reported low dehydrogenase activity and microbial biomass in alkali soils dominated by CO_3^{2-} and HCO_3^-) compared to saline soils (dominated by Cl^- and SO_4^{2-}), which may be ascribed to very low OC status of the former. The average DHA was greater under tree canopies and under rice-wheat / Karnal grass canopies, respectively compared with barren alkali soil (table 3). Junglee kikar showed maximum DHA followed by Eucalyptus, junglisaru and babul. The reduceddehydrogenase activity in sodic soil was either due to direct toxic effects of CO_3^-

Table 1 : Dehydrogenase activity and some chemical properties of normal soil of Budhana area of Muzaffarnagar Distt under agricultural management practices (0- 0.15 m depth).

Crop	Year of planting	pH (1.2)	EC (dS m^{-1})	DHA (µg TPF g^{-1} soil)	Organic C (%)	Available N (kg ha^{-1})
Rice-wheat	2007	7.5	2.1	25.19	0.50	75.0
Jungleekikar	1996	7.4	2.0	50.02	0.66	74.0
Babul	1996	7.7	2.9	60.03	0.78	78.0
Eucalyptus	1996	7.8	1.5	58.09	0.62	71.0
Junglisaru	2000	7.2	0.9	30.05	0.62	74.0
Halfa grass	1994	8.0	1.6	20.01	0.61	78.0

Table 2: Dehydrogenase activity and some chemical properties of saline soil at Kairana area of M. Nagar district under different agricultural managementpractices (0- 0.05 m depth).

Crop	Year of planting	pH (1.2)	EC (dS m^{-1})	DHA (µg TPF g^{-1} soil)	Organic C (%)	Available N (kg ha^{-1})
Barren soil	2202	7.8	6.5	0.00	0.35	45.5
Seep weed	2002	7.0	7.0	8.42	0.32	48.0
Jungleekikar	1996	7.7	6.7	12.36	0.33	55.3
Babul	1996	7.7	6.5	75.10	0.36	76.0
Eucalyptus	1996	7.8	6.8	34.67	0.32	48.0
Pearl millet-wheat 1	2005	7.7	6.4	80.18	0.48	68.0
Pearl millet-wheat 2	2005	7.7	6.7	60.12	0.50	95.0
Pearl millet-wheat 3	2007	7.7	4.3	48.80	0.60	85.0

Table 3: Dehydrogenase activity and some chemical properties of alkali soil at Jansath area of M. Nagar district under different agricultural management practices (0-0.05 m depth)

Crop	Year of planting	pH (1.2)	EC (dS m^{-1})	DHA (µg TPF g^{-1} soil)	Organic C (%)	Available N (kg ha^{-1})
Barren soil	2002	9.2	8.0	6.70	0.20	21.0
Barren soil	2002	9.0	8.0	1.44	0.20	26.0
Jungleekikar	1996	8.9	3.7	34.57	0.30	54.0
Babul	1996	8.9	2.9	3.07	0.24	8.0
Junglisaru	2000	8.9	3.7	6.25	0.30	40.0
Eucalyptus	1996	8.8	3.8	14.85	0.30	40.0
Rice-wheat (50% G.R)	2007	8.5	1.8	22.50	0.36	63.0

Table 4 : The overall soil health of normal, saline and alkali soils at the time of sampling.

Crop	pH (1.2)	EC (dS m^{-1})	DHA (µg TPF g^{-1} soil)	Organic C (%)	Available N (kg ha^{-1})
Normal soil	8.0	2.2	40.12	0.63	76.2
Saline soil	7.7	7.2	36.19	0.43	65.4
Alkali soil	9.7	4.0	13.14	0.34	44.3

and HCO_3^- ions/environmental stresses upon plant themselves, leading in turn to decreased inputs of plant derived substrates (*e.g.* roots, roorexudates) and consequently to smaller soil microbial activities (Chander *et al*., 1997). The increase in OC was 50% more under trees as well as rice-wheat / grass canopies compared with barren soil. The build-up of available N was also observed under crops compared with barren sits.

The overall soil health at the time of sampling is shown in table 4. The pH was highest in alkali soil, whereas EC was maximum in saline soils. Dehydrogenase activity, total organic C and available N followed the trends *viz*. normal soil > saline soil > alkali soil.

The results thus indicate that dehydrogenase activity as well as fertility status of alkali soil was less as compared to saline as well as normal soils. In normal soil, both microbial and chemical amelioration was greater under trees than annual crops, whereas in saline and alkali soils the improvement in soil health was higher by growing annual crops than tree cultivation. Contrary to this, Rao and Gill (1985) have reported that permanent vegetation such as grasses and trees increase dehydrogenase activity more than annual crops in present study this was true for normal soil only but not for saline and alkali soils. The continuous cultivation of annual crops might have improved the aeration status of salt affected soils that further leads to greater nutrient transformation through microbes.

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