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Seasonal Changes in Available Phosphorus and Different Enzyme Activities in Arid Soil

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Abstract Available P and phosphatases and dehydrogenase activities associated with Arid soil were assessed over a 12 month period under crops, grass, trees and fallow land. There were considerable seasonal fluctuations. Generally, maximum enzyme activities as well as available P status were observed during the rainy season in all the soils, while the activities of dehydrogenase and phosphatases and the amount of available P were at minimum during summer months. The soils under crops and trees had significantly higher activities of dehydrogenase and phosphatases and available P than those observed under grass and fallow. Surface soil (0-15 cm) had significantly higher available P and enzyme activities compared to sub-surface soil (15-30 cm). The results indicated that enzyme activities and available P status in the soil are dependent upon vegetation, temperature and moisture.

Key words Arid soil, Phosphatase, Dehydrogenase, Seasonal Change, Available P, Cropping pattern

Studies on different enzyme activities in soil are important as these indicate the potential of soil to carry out the biochemical processes which are important to maintain soil fertility. Generally enzymes accumulated in soil have biological significance as these participate in the decomposition of organic matter and mobilization of various elements, thus playing an important role in the plant nutrition (Kiss *et al.* 1975). Dehydrogenase activity in soils provides correlative information on the biological activity and microbial population ; phosphatase activity is said to be directly related to the level of organic P in the soil (Skujins 1976). Seasonal variations in the enzymatic activities of soil reported in a number of studies (Dormaar *et al.* 1984) are biologically important because they change the quantity and quality of substrates upon which they act and are responsible for altering the rate of various soil processes. Dormaar *et al.* (1984) observed high potential activities of dehydrogenase, phosphatases and urease during winter months and low activities during summer in mixed prairie of Canada. The paper presents the comparative account of seasonal changes in the available P, phosphatases and dehydrogenase activities of arid soils under different land use patterns.

Materials and Methods

Soil samples were collected on the 7th day of every month at two depths (0-15 and 15-30 cm) from different sites of the CR farm, CAZRI, Jodhpur, under crops, grass (*Cenchrus ciliaris*), trees (*Prosopis cineraria*) and in fallow land with the help of soil auger. All the soil samples were sieved through a 1 mm sieve, and representative samples of each were obtained by mixing layers collected from 10 different sites. The samples were immediately transfered to a refrigerator until further analysis. The CR farm soil is a Camborthid with 8.1 pH, 0.18 dS m^{-1} electrical conductivity, 0.23% organic carbon, 0.031% total N, 0.027% total P and 50 ppm as organic P. The climate is arid and annual precipitation averages about 360 mm. Dehydrogenase and phosphatase activities were determined on the fresh moist soil within 24 to 48 h respectively after its collection from fields to avoid changes in these activities. Available P was determined by the molybdenum blue method after ex–

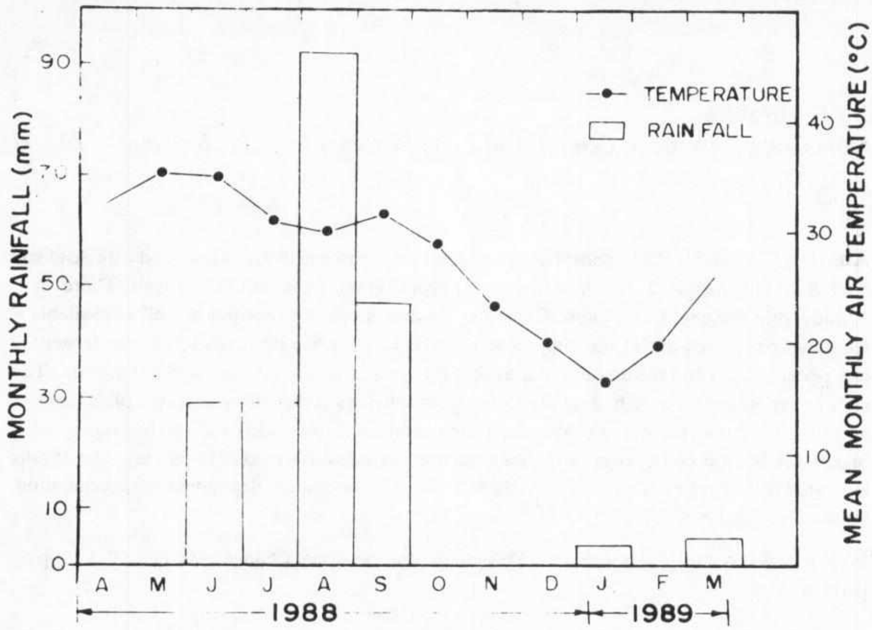

Fig 1 Average monthly air temperature and rainfall for the year 1988-89

tracting with 0.5 M $NaHCO_3$. For the assay of both acid and alkaline phosphateses the procedure of Tabatabai and Bremner (1969) was followed using acatate buffer (pH 5.4) and borax-NaOH buffer (pH 9.4) respectively with p-nitrophenyl phosphate as substrate at 35°C. Dehydrogenase activity was assayed by a method modified by Casida *et al.* (1964). The amount of enzyme present has been computed on oven dry basis.

Results and Discussion

The data on monthly rainfall and mean monthly air temperature during the sampling period indicated that the maximum rainfall received was in the month of August (Fig. 1). There was no precipitation during the months of April, May, October, November, December and February. The minimum mean monthly temperature was observed in January and the maximum during the month of May.

Dehydrogenase activity was maximum in the month of August and least in the month of May–June (Fig. 2). The maximum activity was observed under crops followed by tree lands. Fallow land shows less deviation in activity in different seasons. Sub- surface layers (15-30 cm) had about 22.3 to 35.9% less activity compared to surface layers (0-15 cm). The maximum differences among these layers were observed under crop land.

As dehydrogenase activity reflects the activity of microorganisms in the soil (Lenhard 1956), the higher dehydrogenase activity during the rainy season may be due to optimum moisture and temperature for the growth of micro-organisms at that time, (Rao & Venkateswarlu 1983). They also observed significantly higher population of different microorganisms during July–August. In many desert soils, higher temperatures and soil drying during summer months bring down the microbial population to very low levels (Sasson 1972) resulting in low dehydrogenase activities. In winter low dehydrogenase activity might be due to the fact that the microorganisms remain in a state of biochemical inactivity (Milosevic 1958). In general, the soil beneath crops and trees had slight-

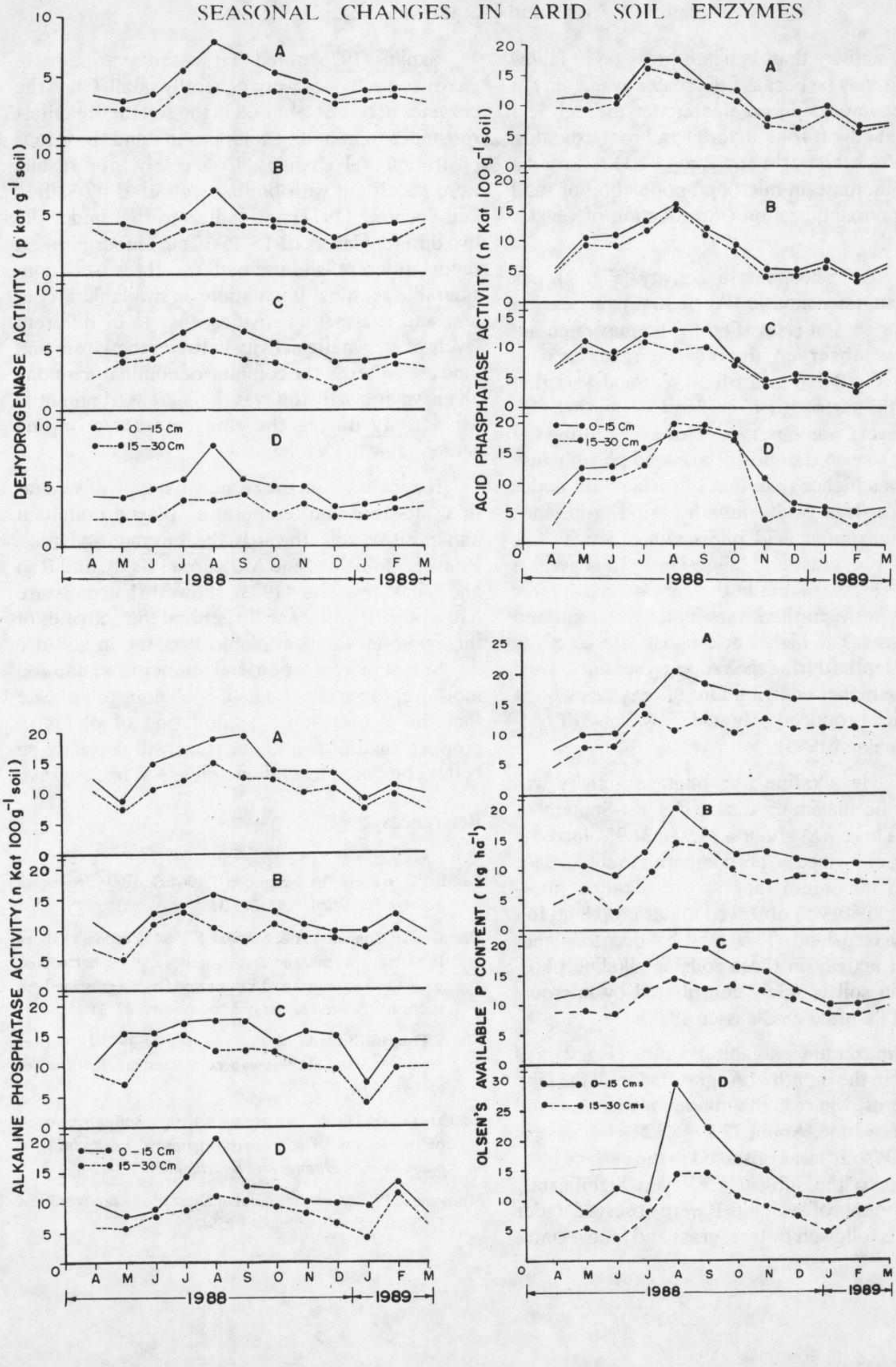

Fig 2 Changes in available P and enzymic activities in Aridisols under different landuse pattern. (A-Tree, B-Grass, C-Fallow, and D-Crop)

ly higher activity than beneath grass or in fallow land. This may be because of greater availability of easily decomposable organic matter through leaf fall, sloughed–off root material and root exudates. Earlier Venkateswarlu and Rao (1981) reported a 200 fold increase in microbial population of sand dunes upon stabilization (introduction of vegetation).

The acid phosphatase activity (Fig. 2) was lower in summer months (April-June) and least in the winter season (Nov.-Feb.). The maximum activity was observed during the rainy season (August- Oct.) No consistent seasonal variation between the surface (0-15 cm) and sub-surface (15-30 cm) layers was observed. However, during the cropping season the sub-surface acid phosphatase activity was higher than that of surface soil under crop lands. In a twelve month period crop lands showed maximum acid phosphatase activity followed by tree, grass and fallow lands. In general, a 10.1 to 13.8% variation in the enzyme activity was observed between the layers under different land use patterns. The higher acid phosphatase activity in lower depths during the cropping season may be due to the higher contributions of enzyme by plant roots which produced only acid phosphatse (Tarafdar & Claassen 1988).

Similarly alkaline phosphatase activity was found to be maximum during August-September (Fig. 2). There was about a 21.9 to 31.9% increase in activity in surface layers compared to sub surface soil. The maximum increase in alkaline phosphatase activity was observed under crop land followed by tree land. This may be due to higher microbial activity in these soils as alkaline phosphatase in soil is solely contributed by microorganisms (Tarafdar & Claassen 1988).

The maximum available P status (Fig. 2) was observed in the month of August under all the land use patterns, whereas the minimum was observed during May-June. About 22.7 to 41.5% increase in available P status was observed in the surface layer compared to the sub-surface layer. Significantly higher amounts of available P were observed under crop lands followed by tree, grass and fallow lands.

Skujins (1976) noted that seasonal variations in enzymatic activities were generally small. Once the enzymes become stabilised in the soil they manifest resistance to humidity, temperature and to various environmental changes. Conversely, our results were consistent with findings reported by Salfeld and Sochting (1977) and indicated that under the two different layers (0-15, 15-30 cm) superimposed onto 4 different land use patterns, there were considerable seasonal fluctuations in available P content and enzymatic activities. Inspite of different levels of enzymatic activity between the layers and land use patterns, the common denominator among all enzymatic activities was the increased potential for activity during the rainy months/cropping season (July to October).

It appears from the results that type of vegetation, moisture and temperature played dominant and positive role towards the enzyme activities. Ramirez–Martines and Mc Laren (1966), and Rao and Venkateswarlu (1983) showed that moisture had a positive influence. In general the activities of these enzymes and available P status in soil are dependent on vegetation, soil temperature and soil moisture. From the results it is obvious to indicate that the P nutrition/P assimilation of plants in cropped field of soil under trees will certainly be better compared to a fallow soil or soil under grass.

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