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THE INFLUENCE OF *AZOTOBACTER* INOCULATION ON THE AVAILABILITY OF PHOSPHORUS IN SOIL

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ABSTRACT

The influence of the two species of *Azotobacter (A. chroococcum* and *A. macrocytogenes)*, phosphorus, organic matter, and their combinations was examined on available P under laboratory conditions. In all the treatments available P increased upto 20 days and then decreased by the end of 30 days. The release of available P was more on bacterial inoculation with organic matter and or phosphorus than with inoculation alone, and was more with *A. chroococcum* than with *A. macrocytogenes.*

The availability of phosphorus in soil is influenced by a number of factors. The major sources of P in soil are in organic combinations (Cosgrove, 1967). The release of P from organic fraction is a microbial phenomen on (Eid *et al.*, 1951). There are reports about the influence of soil microorganisms in bringing about certain changes in soil micro-environment which facilitate the release of plant available P (Taha *et al.*, 1969; Ali, 1985). Alexander (1974) reported that species of *Aspergillus, Penicillium, Rhiozopus, Bacillus* and *Cunninghamella*, released P from organic combinations. The mineralized P when fixed by soil components mainly becomes unavailable to plants. The attempts have been made to minimize this fixation but very little information is available with respect to the efficiency of microorganisms influencing P availability to crops.

There is a little but growing interest in microbial mediated P availability to crops (Estermann and McLaren, 1961; Ali, 1983; Molla *et al.*, 1984) and certain soil microbes such as *Bacillus, Proteus, Serratia, Pseudomonas* etc. are reported to promote the solubility of insoluble P into available form. The present study was undertaken to investigate whether the inoculation with *Azotobacter* species alone or in combination with conventional energy sources can modify the P availability pool.

MATERIAL AND METHODS

The soil sample was collected (0-15 cm) from a cultivated, non calcareous, Mirpur series, Dhaka. The chemical properties of soil sample are shown in Table 1.

The identification of *Azotobacter* species was done by the method of Norris and Chapman (1968). A liquid medium was prepared according to Clark and enriched with glucose and phosphorus at the rate 10 and 1g/l, respectively. The media were inoculated with respective pure isolate from the culture tube aseptically, and were shaken in a receprocating

TABLE 1

Chemical properties of the soil sample examined

Soil series	pH	Organic matter (%)	CEC meq/100 g soil	Available N (meq/100 g soil)	Available P (meq/100 g soil)	Available K (meq/100 g soil)	USDA Soil taxonomy
Mirpur	5.8	0.72	5.5	9.0	0.6	130	Fluvaquentic Haplaquept

shaker at room temperature (28-30°C) until the suspensions attained an optical density of 1 as measured colorimetrically at 600 mm by a Colemen Junior II Spectrophotometer.

The sample was processed and treated with three levels of triple superphosphate (TSP) (0, 85 and 170 kg P_2O_5/ha), two levels of decomposed cowdung (0 and 1000 kg/ha) as organic matter and two species of *Azotobacter* (1 ml/300 g soil) in all possible combinations with a basal dose of 55 kg K_2O/ha. The treated soil samples (300 g per container) were allowed to equilibriate at 30°C for two days at field moisture capacity before incubation. The experiment was arranged in a completely randomized block design with two replications. Soil samples were analyzed for available P at the end of 0, 10, 20 and 30 days of incubation.

RESULTS AND DISCUSSION

The changes in available P as influenced by incculation with *Azotobacter* spp., organic matter and/or phosphorus are shown in Figs. 1-4. In general, in all treatments the trend is more or less similar. The availability increased upto 20 days and thereafter it decreased by the end of 30 days in soil treated with bacteria (Fig. 1). At the 10-day run, the level of available P remained almost

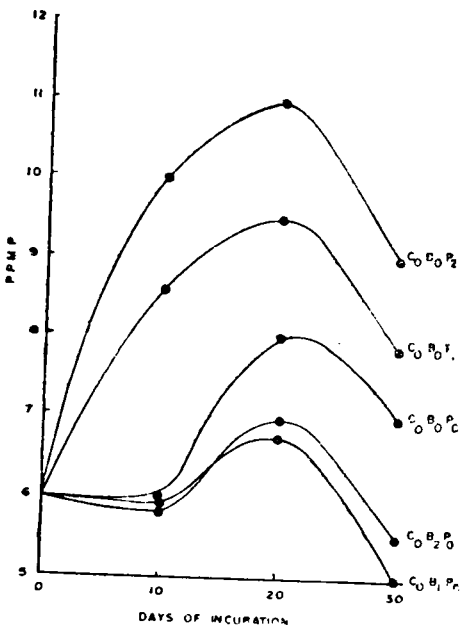

Fig. 1. Availability of phosphorus as influenced by bacteria and phosphorus.
Legends : B_0, B_1, B_2 (no inoculum, *A. chroococcum*, *A. macrocytogenes* (C_0, C_1 (O, 10000 kg organic matter/ha); P_0, P_1, P_2 (0, 85, 170 kg P_2O_5/ha).

unchanged. During this period of incubation, the bacteria possibly depleted the released P. It is reported that bacteria thrive well if there is preponderance of easily available P in soil medium (Alexander, 1974). Between the two types of bacteria, *A. chroococcum* utilized the available P more than *A. macrocytogenes*. Only the soil treated with TSP gave remarkable increase in available P with no lag phase resulting in the maximum accumulation at 20-day run (Fig. 1). The combined effect of inocula and P enhanced its availability at all stages of incubation (Fig. 2). It also appeared that inocula might have lowered the level of mineralized P owing to immobilization.

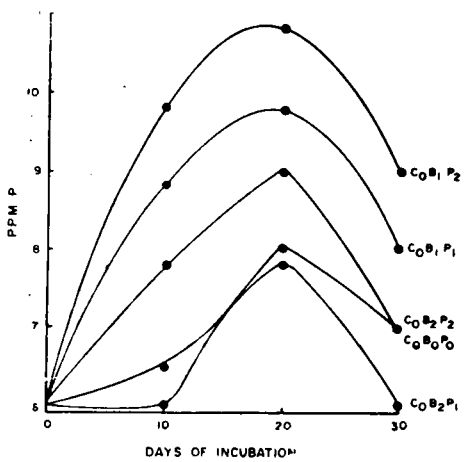

Fig. 2. Availability of phosphorus as influenced by bacteria × phosphorus. For legends see Fig. 1.

Azotobacter spp. appeared to be relatively ineffective in increasing the availability of P in the presence of organic matter (Fig. 3). The amount of available P released by inocula in association with organic matter was rather lower by 2 ppm in comparison with increasing doses of P at all stages of incubation. P availability was appreciably influenced when

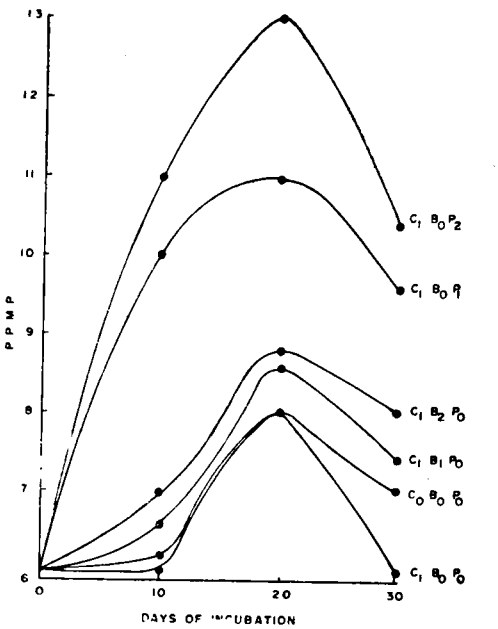

Fig. 3. Availability of phosphorus as influenced by organic matter, organic matter × phosphorus, and organic matter × bacteria. For legends see Fig. 1.

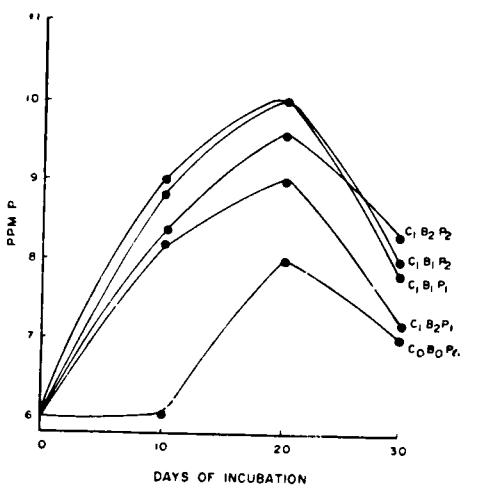

Fig. 4. Availability of phosphorus as influenced by organic matter × bacteria × phosphorus. For legends see Fig. 1.

organic matter, inocula and P were applied together (Fig. 4). When organic matter and bacteria were added together to the soil, P was utilized by bacteria as before but not to the same extent, for some of P gets bound with humified organic matter at the prevailing temperature. Finally, the bound P together with organic matter P was released comparatively earlier by the bacteria thereby increasing the content of P in the total pool of availability.

The findings of the present investigation suggest that *Azotobacter* spp. alone are ineffective in increasing P availability. However, their efficiency can be improved markedly when provided with energy sources.

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