Journal of Water and Soil
Vol. 31, No. 2, May.-Jun. 2017, p. 597-608

نشریه آب و خاک (علوم و صنایع کشاورزی)
جلد ۳۱، شماره ۲، خرداد – تیر ۱۳۹۶، ص. ۶۰۸-۵۹۷

Effects of *Aspergillus Niger* and Green Manure on Soil Phosphorus Solubility in the Incubation Conditions

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Received: 01-06-2016
Accepted: 17-11-2016

Introduction: Phosphor (P) is the second nutrient element after nitrogen mostly required by plant. P is the main component of nucleic acid, phospholipid, ATP and some coenzymes. The effectiveness of phosphate fertilizer application is only about 15% - 20% and 10 – 25%, based on the different references.Rock phosphate (RP) as a source of P is not expensive, but its availability of P is low. Solubility of RP can be increased by phosphate solubilizing microorganisms. Increasing RP solubility by microorganisms is due to the lowering of pH and/or organic acid excretion. Fungi have been reported to possess greater ability to solubilize insoluble phosphates than bacteria. Among the fungal genera with the phosphate solubilization ability, there are *Aspergillus* and *Penicillium*. *Aspergillus Niger* convert insoluble phosphates into soluble forms through the processes of acidification, production of organic acids, production of acid and alkaline phosphatases, and the release of H^+ .These organic acids can either dissolve phosphates as a result of anion exchange or can chelate Ca, Fe or Al ions associated with the phosphates. The aim of this study was to investigate the effect of *Aspergillus Niger* and green manure on soil P solubility in the incubation conditions.

Materials and Methods: To investigate the effect of *Aspergillus Niger* and green manure on soil phosphorus availability, an experiment in a completely randomized design with three replications was conducted. The treatments were applied over a period of 70 days and were repeated at 3 incubations. The treatments were included C: control (50 g soil), As: *Aspergillus Niger* (50 ml/ kg), A: Green manure (1% weight of the soil), S: Sucrose (1 g/kg soil), P: Rock phosphate (150 kg/ha), As + A: *Aspergillus niger* + Green manure, As + S: *Aspergillus Niger* + Sucrose, As+P: Aspergillus niger + Rock phosphate, As + S + P: Aspergillus niger + Sucrose+ Rock phosphate , and As + A + P *Aspergillus niger*+ Green manure +Rock phosphate . Soils were air-dried and crushed to pass through a 2-mm sieve. Treatments were then applied to 50 g of soil and the treated samples were moistened to the field capacity (FC). The moisture of containers was kept near FC soil moisture content throughout the experiment by periodically weighing and replenishing evaporated water. At intervals of 7, 21, 35, 51 and 70 days, the samples were taken and after air drying, pH, EC, available soil phosphorus by Olsen method and soluble phosphorus were measured. The statistical analysis of all data obtained from the experiments was performed using the MSTAT-C software. The mean comparison was performed using Least Significant Difference (LSD) test at 5% level and drawing graphs using Excel software.

Results and Discussion: The results showed that all treatments had a significant effect on the measured parameters at 1% probability level. The effect of treatments and incubation Times on soil pH showed that all treatments were able to reduce soil pH. The greatest decrease was observed in *Aspergillus Niger* + Green manure (As + A) treatment that could reduce the pH by 0.59 unit. Usually, green manure decreases soil pH through decomposition and release carbon dioxide and organic acids. *Aspergillus Niger* also reduces pH and thus increases the solubility of soil phosphorus through the production of the metabolites and organic acids and microbial respiration. The effects of the treatments and incubation time on soil electrical conductivity showed that all treatments were able to increase soil electrical conductivity. Most of this increase was related to *Aspergillus Niger*+ Rock phosphate+ Green manure (As +P+ A) treatment .This increase was probably due to inorganic compounds found in green manure. The effects of the treatments and incubation time on soil available phosphorus and solube phosphorus showed that all treatments were able to increase them. Most of the soluble and available phosphorus amounts were observed in As +P+ A treatment and the amounts of increase resulting from this treatment for soluble and available phosphorus were 0/28 mg/l and 10/79 mg/kg, respectively. However, the green manure treatments and aspergillus alone increased soil soluble phosphorus, but with treatment of *Aspergillus Niger* (As) in green manure (A) observed that the amount of phosphorus in the soil solution was further enhanced. Organic acids resulting from the decomposition of organic matter by adsorption

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onto calcium phosphate surfaces and occupy the active sites such as nuclei for the formation of these deposits, prevent the growth of new crystals. These organic acids, in addition to the creation of the complex with calcium cations, reduce the activity.

Conclusions: The results of this study showed that use of phosphate solubilizing microorganisms and organic matter led to the significant decrease in pH and increase in electrical conductivity, dissolved phosphorus and available phosphorus in soil.. However, to obtain more accurate results, it is better to do a pot experiment as well.

Keywords: Green Manure, Organic acids, Phosphate solubilizing fungi, Soil phosphorus