EFFECTS OF APPLICATION OF COMPOST AND INORGANIC PONMICROBIAL ACTIVITIES,NITROGEN AND PHOSPHORUS MINERALIZATION IN AN ULTISOL

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DEDICATION

This project work is dedicated to the Almighty Allah, who is the most gracious, the most merciful, the only owner and the only ruling judge of the day of recompense.

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ABSTRACT

The aim of this study was to assess the effects of separate and combined applications of compost and inorganic P on soil microbial respiration and population, and on N and P mineralization in an UItisol with the view to developing a method for efficient co-application of organic and inorganic fertilizers.

The study, which was carried out in the Soil Microbiology Laboratory of the Department of Soil Science and Land Resources Management involved laboratory incubation over 16 weeks. Top soil (0-15 cm) of Iwo series (Ultisol) was collected from a fallow land at the Teaching and Research Farm (T&RF) of the Obafemi Awolowo University, Ile-Ife. The fraction less than 2 mm was used for the incubation study. The study consisted of 500 g of air-dried soil, 5 g kg^{-1} and 10 g kg^{-1} compost, $Na_2HPO_4.12H_2O$ as source of P at 60 kg ha^{-1} mixed with half or the whole soil mixed thoroughly with the half or the whole soil. There were four treatments (5 g kg^{-1}, 10 g kg^{-1}, 5 g kg^{-1} + inorganic P at 60 kg ha^{-1} and 10 g kg^{-1} + inorganic P at 60 kg ha^{-1}, and the control). The treatments were replicated thrice and then arranged in a Completely Randomized Design (CRD). Carbon dioxide evolution, N and P mineralization were determined fortnightly for a period of 16 weeks. Microbial populations were determined at the end of the 8th and 16th weeks. The experiment was repeated in soil culture in the screenhouse using maize (*Zea mays* L.) as the test crop. There were two consecutive 8-week plantings. Maize agronomic parameters and soil chemical properties were determined at the end of each planting. The data collected were subjected to analysis of variance (ANOVA) and the means separated using Duncan's New Multiple Range Test (DNMRT) at 95% level of probability. Correlation analysis was also carried out using SAS 2000 package.

The mean amount of CO_2 evolved from the P-enriched compost applied to half the bulk soil (C_1P_1h) was significantly ($p \leq 0.05$) lower than in the remaining treatments. On the other hand, the treatment that had the higher rate of compost (C_2P_1h) had the highest amount of CO_2 evolution. The mean available P in the control (C_0P_0) was significantly ($P \leq 0.05$) lower than in the remaining treatments. There was no significant ($p \leq 0.05$) difference between the available P contents at both rates of compost addition whether applied to the whole bulk or half portion of the bulk soil. The populations of heterotrophic bacteria (THB), actinomycetes (THA) and fungi (THF) at the end of the 8^{th} week of incubation were generally higher than at the end of 16^{th} week. The mean microbial populations showed the following trend: THB > THA > THF. Increase in the application of compost increased plant height, dry matter yield, soil pH, available and tissue P while there was no significant difference in the concentrations of exchangeable cations.

It was concluded that inorganic P and compost applied separately to either side of the plant enhanced N and P mineralization and maize agronomic parameters.

CHAPTER ONE

INTRODUCTION

In the developing countries including Nigeria the increasing price of chemical fertilizers coupled with the growing concerns of sustaining soil productivity has led to renewed interest in the use of organic manures as fertility-restoring input (Sankaram, 1996). Apart from this, organic manure has been known to break the fixation of Phosphorus (P) caused by some ions in the soil thereby making P which is deficient in most soils (because of its mobility) more available in the soil.

Phosphorus is an essential nutrient required for plant growth and development and is intimately involvedin a wide range of physiological and biochemical processes. However, large areas of soil used for agriculture across the world aredeficient in plant-available forms of phosphate which can limit agricultural production (Runge - Metzger, 1995).Phosphorus-based fertilizers are, therefore, used routinely in agricultural systems to overcome deficiency of soil phosphorus.Some 17.5 million tonnes of P is processed annually from world reserves of rock phosphates of which approximately 85% is used in the production of fertilizers (Cordell *et al.,*2009).However,reserves of rock phosphate are finite with an estimated depletion of quality sources expected to occur within the next 50-80 years (Isherwood, 2000).

The need to use renewable forms of energy and reduce costs of fertilizing crops has revived the use of organic fertilizers worldwide. Compost plays a vital role in binding the soil and providing plant nitrogen supply (Korsaeth*et al.,* 2002). The addition of manure compost at reasonable rate enhance the plant growth, soil physical properties and also increases available soil level (Ahmad *et al.,* 2008;Zafar*et al*., 2011).

Hence, it is obvious that sustainable crop production could be achieved in depleted soils if both organic (plant and animal sources combined) and inorganic nutrient sources are properly integrated. Further, immobilization of soil P in inorganic and organic forms unavailable for crop uptake also necessitates P amendments as fertilizer or animal manure to achieve desired crop yield goals. Although P is not directly toxic, its continued application to agricultural land and subsequent movement to surface waters in runoff can accelerate eutrophication. This can impair water use for industry, recreation, drinking and fisheries due to the increased growth of undesirable algae and aquatic weeds. Although nitrogen (N) and carbon (C) are also associated with accelerated eutrophication, most attention has focused on P, due to the difficulty in controlling the exchange of N and C between the atmosphere and a water body and fixation of atmosphere N by some blue-green algae. Thus, P is often the limiting element and its control is of prime importance in reducing the accelerated eutrophication of surface waters.

However, P deficiency is widespread in the soils of the tropics. In general, low available P in soils is a problem throughout the tropical Africa and many of the soils in the humid zone of West Africa are naturally low in P. The problem is more severe on acid soils as the applied P is converted to unavailable forms as a result of fixation by Iron (Fe) and Al hydroxides (Warren, 1992). Like nitrogen, P occurs in soils in organic and inorganic forms. The organic fraction is found in humic substances and other organic materials. The inorganic fraction occurs in numerous combinations with Fe, Al, Ca and other elements resulting in the formation of compounds that are only slightly soluble in water. The organic soil P is important especially in the tropics because as noted by Udo(1986), it may readily undergo mineralization to release available P for the plant. In contrast, the inorganic P forms may be fixed and made unavailable to plants. However, low soil N and P availabilities are problems limiting agricultural production

in Nigeria. While N is lost by leaching, P becomes unavailable due to adsorption-precipitation reactions and immobilization. It is unclear how N and P availabilities are affected when P is compounded with organic manure; Hence, this study.

Early research works on soils from Kenya (Friend and Birch, 1960) and Southern Nigeria (Adepetu and Corey, 1976) revealed a strong and direct relationship between total soil organic P and plant available P. But for crops to optimize the benefits of applying organic and inorganic nutrients together, it is necessary to determine the effect of rates and method of application on microbial mineralization of organic nutrients. While nutrients will be mineralized by microorganisms from the organic component, high microbial activity might be detrimental to plant growth in terms of nutrient immobilization (Olayinka and Ailenubhi, 2000; Olayinka, 2001).

To supplement soil native fertility for crop production, man has always been dependent on inorganic and/or organic manures (Cooke, 1980). Inorganic or chemical fertilizers are highly concentrated salts, not bulky, easy to apply with high degree of precision and release their nutrient content quickly to the soil. On the other hand, organic manures are wastes and residues from plants and animals which supply nutrients to plants. Although, they are bulky, not easy to apply and slowly release their nutrient contents, their application improves soil structure and consequently increase the water holding capacity, aeration and drainage (Mc Vickar and Walker, 1978; Cooke, 1980).The objectives of the study are to

i. evaluate the effects of separate and combined applications of compost and inorganic phosphorus to the soil on microbial respiration and populations and
ii. assess the effects of the treatments on the mineralization of nitrogen and phosphorus.