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Evaluation of Microalgae Sludge as Biofertilizer for Growth of Maize Under Greenhouse Trials

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Abstract: The importance of microalgae is justified by its nutrition content especially the presence of carbohydrates, lipids and proteins which make it useful in a wide array of applications including biogas production. In the present study microalgae sludge was obtained as a by-product of biogas production by two formulations, one digested with cellulose degrading microorganisms (CD) and the other without CD and their potency when used as a bio-fertilizer compared with the other organic manures, namely, cattle manure and chicken manure as well as the mineral fertilizer NPK 2:6:1 (36). To this end, maize - a staple food in Lesotho, was used as a model. Different applications on acidic and neutral soils were evaluated given the widespread acidic soils in Lesotho. Microalgae sludge + CD increased maize growth in both acidic and neutral soil by more than 100% and about 15% respectively compared to the negative control. Microalgae sludge + CD also effected the maize biomass more than the negative control in both soils, suggesting the effectiveness of microalgae sludge + CD in improving growth of maize. Deeper research into microalgae sludge, especially the application rates and application methods on different crops still has to be studied and put into use.

Keywords: Microalgae sludge, Cellulose degrading microorganisms.

1. Introduction

In agriculture the major management goal is to increase and maintain soil quality with high biological activity and excellent crop yield. Farming practices which involve heavy application of chemical fertilizers may cause depletion of certain nutrients in the soil and certain other nutrients would generally accumulate in excess, resulting from nutrient imbalances which affect the soil productivity. In addition, excessive use of chemical fertilizers increase nitrate, nitrite, ammonium, phosphate and other reactive chemical species in the ground water and surface water bodies, which is a serious environmental and health hazard [1], adding to its high values costs. Heavy applications of chemical fertilizers also reduce soil fertility by changing the soil pH balance [2].

Their preference in agriculture over chemical fertilizers offers an economic and ecological benefit by improving soil health and fertility. When these bio-fertilizes are added to the soil, the contained microbes colonise the rhizosphere or interior of the plant, enhancing the plant's ability to absorb nutrients necessary for root development, promoting the uptake of nitrogen and water as well as production of hormones that stimulate the growth of the plant and its resistance to e.g. diseases, drought and soil salinity [3] and resistance to moisture stress [4].Several investigations have been carried out and showed that application of bio-fertilizers increase crop yield by 20-30%, replace chemical nitrogen and phosphorus by 25% in addition to stimulating growth [4]. It has been reported that microalgae sludge has more nitrogen content than most bio-fertilizers, it contains macronutrients, carbohydrates, proteins and vitamins implemented for improving growth and yield of crops [5]. Nitrogen in plant growth is required for synthesis of enzymes, proteins, chlorophyll, DNA and RNA. Bio-fertilizers add nutrients through natural processes of nitrogen fixation, solubilizing phosphorus and stimulating plant growth through synthesis of growth promoting substances [4]. A small dose application of a bio-fertilizer is sufficient to produce desirable results because each gram of a bio-fertilizer contains about 10 million viable cells of a specific strain [6].

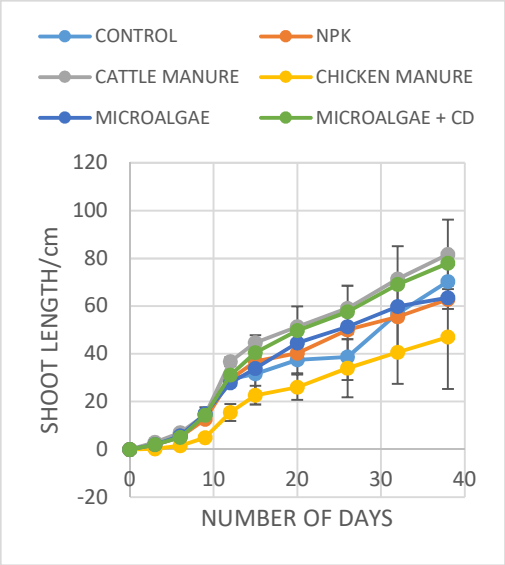

Figure 1. Effects of different fertilizers on maize growth in natural soil.

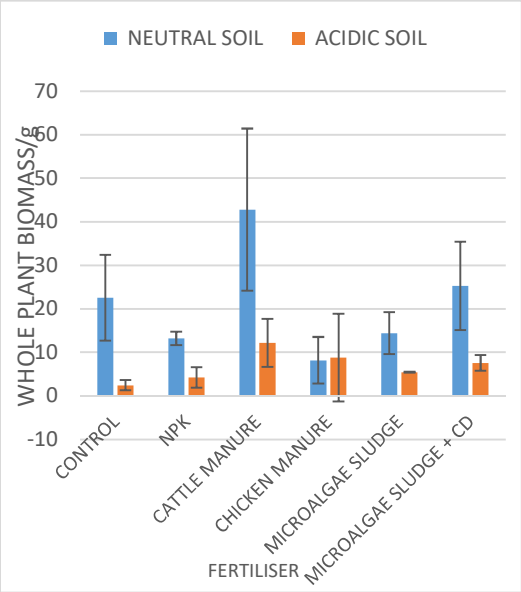

Figure 2. Effects of different fertilizers on the wet biomass of uprooted maize plants.

Use of microalgae sludge as bio-fertilizer provides all required organic and inorganic nutrients for the plant to grow. Besides, it is free of pathogenic microorganisms and contains more than 70% of organic compounds as it has been reported from laboratory experiments [7].

2. Material and Methods

Sampling:

Sewage water microalgae was collected in 10 5L plastic bottles from the sewage water pond at the National University of Lesotho (NUL). Half of the bottles containing microalgae were each inoculated with 1ml of cellulose degrading microorganisms and then incubated for 10 days to allow biogas production. Acidic and neutral soil were collected from Ha-Mafefooane and NUL respectively. The soil was sterelised at 121°C and 15lb for 30minutes. About 2kg of the soil was then added into 18 4L plastic pots separately. Subsequently, fresh chicken manure and cattle manure were collected in plastic bags from NUL farm. The manures were ground separately for particle uniformity. The manures were then mix evenly with the soil, each in triplicates for the different soil pH, at a rate of 133g/2kg of soil together with commercial NPK 6:2:1 (36) fertilizer separately. Three pots for each soil type were not treated with fertilizer to serve as negative control.

Greenhouse experimentation:

The pots containing treated soil were kept in a greenhouse for 24hours. Pure breed viable maize seeds were sown in all the pots and allowed to grow. The pots were watered according to the water requirements of the sol. Weeding was done whenever necessary to eliminate competition between the maize and other plants. The maize shoot growth was measured every 3 days for 3 weeks. At the end of the experiment, the shoot and roots biomass was determined..

3. Results and Discussion

Maize plant development:

The five fertilizers applied separately in neutral and acidic soil showed a significant different in effecting the growth of maize. But generally all the fertilizers showed a better performance in neutral soil as compared to acidic soil. Cattle manure exhibited the highest growth development of maize shoot followed by microalgae sludge digested with cellulose degrading microorganism (CD) and thirdly, microalgae sludge without treatment. Compared to all other fertilizers, chicken showed the slowest growth development of the maize shoot with very pale looking shoots. Chicken manure increased the pH values in all the soils. The results in Figure 1 showed that chicken manure exhibited lowest growth as compared to other fertilizer treatments. This could be unexpected since chicken manure contains potentially useful amounts of N and large proportions of P and K as compared to cattle manure. This could be attributed to the increase in pH; this is an unbearably high pH for maize to tolerate. Maize grows optimally at pH 6.0-7.2 [8]. Attributes this increase in pH to presence of calcium in chicken manure. It is the high pH and the water lodging effect which make this nutrients unavailable for

plant uptake, however, large proportions of N can also be lost as ammonia gas, leaving the manure insufficient of N; nutrient responsible for growth of plants since it's essential for cell division.

Maize plant biomass

Soil treated with cattle manure produced the greatest plant biomass followed by microalgae treated with cellulose degraders (Figure 2). These results were more observable in neutral soil more than in acidic soil. This results suggest that the neutral soil was sufficient of the necessary nutrients required for maize growth in addition to the known pH suitable for maize growth (pH 6.94). The correct pH ensures that nutrients are available to crops as well as the good soil structure, which enhances root development.

4. Conclusions

Result of the study revealed that microalgae sludge pre-treated with cellulose degrading microorganisms improve maize growth. The improved performance is also similar to that achieved with cattle manure fertilization. The study further showed that chicken manure and NPK do not give the best growth of maize. It is therefore in the best interest of agricultural production and its improvement to replace chicken manure, NPK and other chemical fertilizer with the use of microalgae sludge digested with cellulose degraders. Application of 150tonnes/ha of microalgae sludge + CD was capable of increasing growth of maize by more than 100% in acidic soil and by about 5% in neutral soil over the negative controls. More research into microalgae sludge, especially the application rates and application methods on different crops is needed.

5. References

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