Assessment on the Nutrient Status of Lowland Rice Soil Using Minus One Element Technique (MOET)

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Abstract

Laboratory soil analysis is one of the effective way of knowing the nutrient content of the soil. However, it is expensive and difficult to avail from the government facilities for free laboratory soil analysis. Minus one element technique (MOET) is a friendly and less expensive way of knowing the nutrient status of the soil. This study aimed to determine the nutrient status of the lowland soil in Central Luzon State University (CLSU) rice farm. Minus one element technique (MOET) was used through observation of growing rice (NSIC Rc216) variety planted in a container. The fertilizer formulations considered as the treatments included the following without nitrogen (-N), without phosphorus (-P), without potassium (-K), without sulfur (-S), without copper (-Cu), and without zinc (-Zn). Rice plants receiving complete nutrient elements served as the control. Results revealed that no visible deficiency symptoms in the growing rice except on minus nitrogen and minus sulfur treatments. This result suggested that the soil in CLSU rice farms still have sufficient nutrient elements except on nitrogen and sulfur. Plants in minus N element showed yellowing of the leaves starting at the older leaves and moves along to the middle leaves two weeks after planting. This treatment show less number of tillers and foliage as compared to the treatment receiving complete nutrients. Plants in minus sulfur appears a pale green to pale yellow leaves starting in the younger leaves. Thus, soil in CLSU rice farm needs Nitrogen and Sulfur nutrient elements and need to be addressed.

Keywords: Deficiency symptoms, minus one element technique (MOET), nutrient elements and productive soil

Research article

INTRODUCTION

Rice (*Oryza zativa* L.) is a staple food for nearly half of the world's population, most of which live in developing countries. It occupies one-third of the world's total area planted to cereals and provides 35-60 percent of the calories consumed by 2.7 billion people in Asia. According to Rescalsota, et. al, (2005), one of the major crop production problems that will affect rice yield is the deficiency of important soil nutrients needed by the plant for its growth and development. Moreover, (Sanchez et al. 1997; Shepherd and Soule, 1998) stated that, soil fertility depletion in smallholder farms is the fundamental cause of declining food production. An inadequate supply of one of these important nutrients can cause metabolic disorders in plants (Kirkby and Bergmann, 1992).

To have efficiently supply the needed amount of nutrients to the plants it is necessary to have our soil analyzed for chemical analysis. However, soil analyses are very expensive and farmers seldom have access to soil laboratories and other practical soil testing procedures that could accurately determine their soil nutrient status. Thus, PhilRice developed the Minus One Element Technique (MOET), this is a crop diagnostic tool that determines soil nutrient deficiency under lowland rice condition. Despite the application of appropriate rates of nitrogen (N), phosphorus (P), and potassium (K) fertilizers accompanied with new technologies and management strategies on rice production, yields of most rice farmers are still below the potential yield of improved and high yielding varieties. Multi-nutrient imbalance could be one of the reasons for the gaps in yield.

It is therefore imperative that farmers fully assess the nutritional status of their low-yielding farms. According to (Castillo and Mamaril, 2008) the minus-one element technique (MOET) of diagnosing nutrient limitations of lowland rice soils is one promising technique because it is farmer-friendly, simple, cheap, and sensitive as a good diagnostic tool. Moreover, the basic principle of MOET is based from the "law of the minimum" which states that the level of crop production can be no greater than that allowed by the most limiting of the essential plant growth factors. It is a biological technique wherein the plant itself extracts the elements from the soil and the amount they absorb from the soil is reflected by its relative growth. Thus, the test can show farmers the limiting nutrient(s) that needs to be applied. Results from MOET test are obtained faster; hence farmers can make the necessary adjustment and amelioration to their standing crop. The test is likewise more economical than the soil chemical analysis method.

This study was conducted to determine the nutrient deficiency symptoms of lowland rice (NSIC Rc216) variety grown in a container with soils from CLSU rice farm using minus one element technique.

MATERIAL and METHOD

The first step in doing the MOET is to buy the kit from PhilRice, Maligaya, Munoz, Nueva, Ecija, Philippines. Aside from the fertilizer formulation, the kit also contained seven plastic bags and the instruction booklet. The fertilizer formulations served as the treatments for the study. These formulations are complete fertilizer, minus nitrogen (N), minus phosphorous (P), minus potassium (K), minus sulfur (S), minus zinc (Zn), minus copper (Cu). The soil samples collected from the CLSU rice production area in Sawmill farm, Munoz, Nueva Ecija. Organic debris that was not well decomposed was removed leaving uniform soil samples. Soil samples were submerged in water for one week to soften and pulverize the soil medium.

The soil samples were placed in plastic container (25cm wide x 35cm long) with 10 kg wet soil thoroughly mixed with the fertilizer formulation. A 20 day old seedlings (NSIC Rc216) rice variety was transplanted at 2 seedlings per pot. The rice plants were taken cared and the water supply was maintained in the pots until the experiment was terminated. The vegetative parts of rice plants were cut, weighed and placed in the oven 70 ^{0}C until constant weight was attained. Agronomic and dry matter yield (%) were gathered such as; plant height (cm) and number of tillers per pot were recorded weekly starting 14 days from transplanting until the experiment was terminated at 50 days after planting. The growth of the plants in the pots under minus certain elements such as (-P, -K, -S, -Cu and –Zn) was compared to that of plants receiving the complete nutrient formulation. Observations on plant growth patterns and the occurrence of deficiency symptoms were noted until the experiment was terminated.

RESULTS and DISCUSSION

To determine the basis for the deficiency of specific elements in the lowland soil, agronomic data from the rice plants receiving complete elements was multiplied to 80% as shown in Table 1. If the value from the agronomic data is below than the amount computed (80%) of the value from the plants receiving complete elements, it means that the element is deficient. Plants in minus N and minus S elements exhibited nutrient deficiency symptoms which include few number of tillers, yellowing of the leaves, thinner stems and lower fresh and dry weights of biomass as compared to plants receiving complete nutrients. These results suggested that the soil tested still had sufficient amount of some nutrient elements except on the nitrogen and sulfur.

Table 1. Growth parameters (49 DAP) of NSIC Rc216 rice variety under the minus one element technique (MOET).

Treatment	Final Number of tillers plant^{-1}	Final Plant height (cm)	Biomass fresh weight (g)	Biomass dry weight (g)	Moisture content (%)	Dry matter yield (%)
Complete	28	60.22	76.45	18.75	75.47	24
-N	10	60.24	23.90	5.60	76.57	23
-P	25	65.51	73.00	17.05	76.64	23
-K	23	65.50	49.00	16.80	77.96	22
-S	13	61.65	30.55	6.55	78.56	21
-Cu	26	64.52	61.15	15.90	77.27	23
-Zn	26	61.00	63.80	15.00	76.49	24
80% value from the complete elements	28 x 0.80 = **22.48**	60.22 x 0.80 = **48.16**	76.45 x 0.80 = **61.16 g**	18.75 x 0.80 = **15.0 g**		24 x 0.80 =**19.0**

On the other hand, red numbers in Table 1 signify the deficiency of nutrient elements in the said parameters. Nitrogen and Sulfur are the 2 elements that are insufficient thus, it reduces the number of tillers per plant and the weight of fresh and dry biomass. However, the dry matter yield produced by the plants applied with minus elements (N, -P, -K, -S, -Cu and –Zn) showed a comparable weights (g) to the plants applied with complete fertilizer.

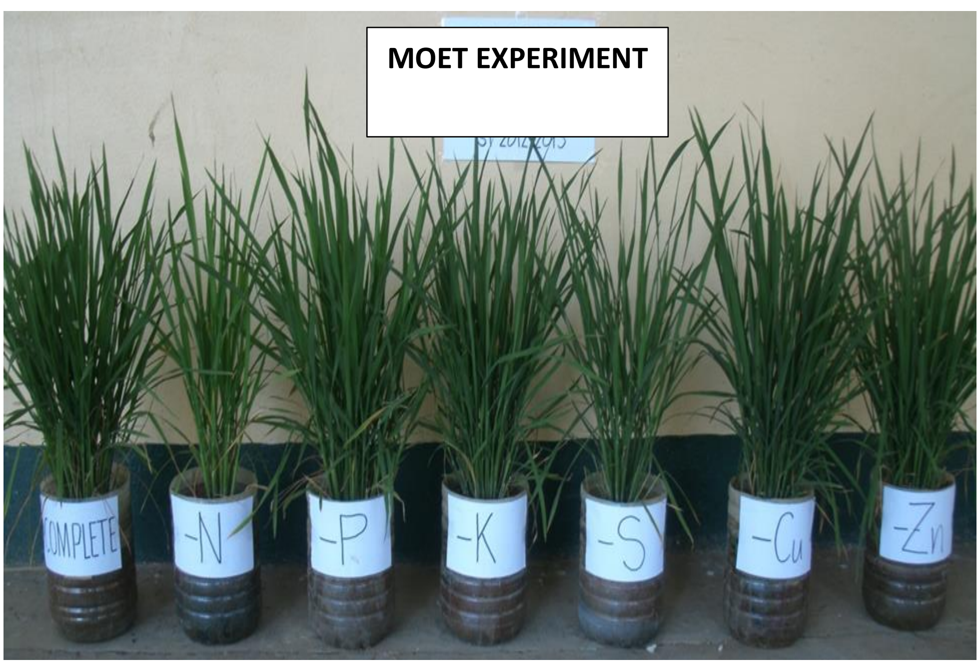

Figure 1. Fertilizer formulations used in the study

Visual Description of Deficiency Symptoms Observed in the Rice Plants

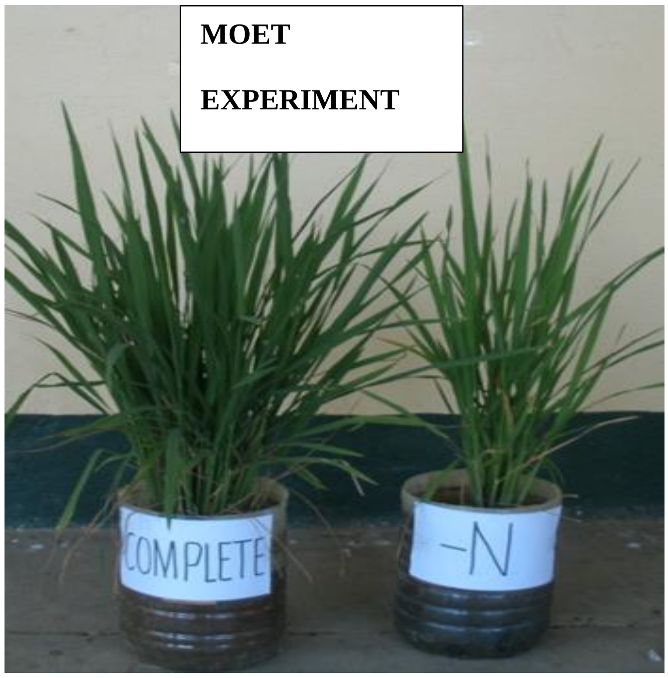

Figure 2. Observation comparing the complete (check) and the – N element

Nitrogen deficiency symptoms usually affect starting in older leaves and to younger leaves as severe deficiency progresses. The symptom is very evident in the plant shoots which exhibited by stunted growth and generally smaller leaf sizes as compared to the plants receiving complete nutrient elements. In this study, the minus N element showed a yellowing of the leaves starting at the older leaves and moves along to the middle leaves two weeks after planting. These treatments showed less number of tillers and thin foliage as compared to the treatment receiving complete nutrients. The deficiency symptoms revealed by the rice plant signals that the soil in sawmill rice production area is now deficient in this particular elements (N and S). Thus, the soil can`t be able to supply nutrients needed by the rice plant.

Figure 3. Observation comparing the complete (check) and the - P

The general symptoms of rice that deficient in phosphorus, the leaves are dark green with erect leaves. There was also an interveinal spotting of drying up of basal leaves, localized yellowing of older leaves with interveinal chlorosis. Also, there was intense brown coloration of the tips or edges of the plant leaves and reduced leaf area as compared to the treatment receiving the complete nutrients. However, in this study, the above deficiency symptoms did not occur significantly, only a very slight drying of the older leaves along the tips and edges of greener and erect young leaves. This result suggested that the soil tested in Sawmill area revealed that the P element sill sufficient for rice growth and development.

Figure 4. Observation comparing the complete (check) and the – K

The appearance of potassium deficiency symptoms occur mainly on the older leaves and the general symptoms exhibited by rice leaves include brown necrotic lesions or spots which developed within the chlorotic zones of the leaves, severe yellow chlorosis in the interveinal zones and in extreme cases the leaves will turn whitish or completely lost its green coloration . However, in this study the visible deficiency symptoms did not appear, this result suggests that the potassium content in the area tested was still sufficient.

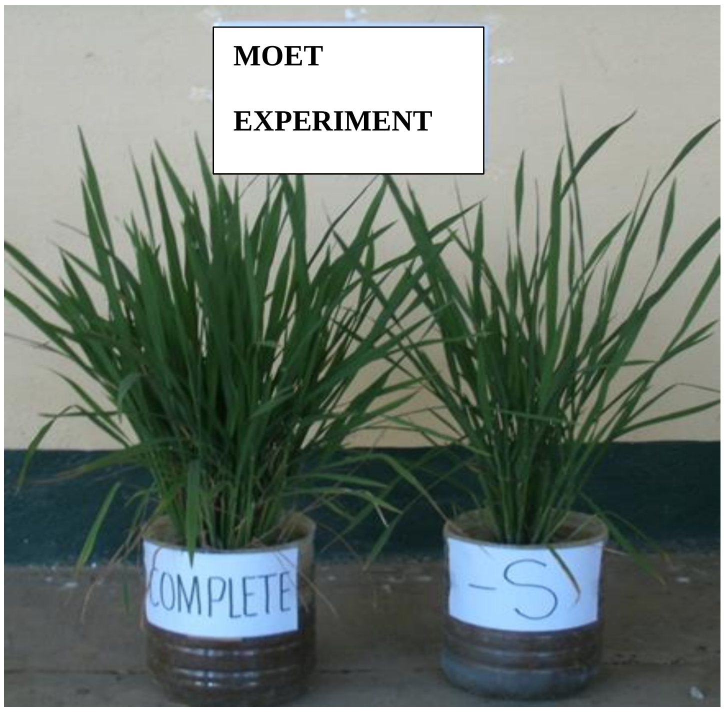

Figure 5. Observation comparing the complete (check) and the – S

The general description of the sulfur deficiency symptoms is comparable to the nitrogen deficient soil. It appears a uniform pale green to yellow leaf but the difference is sulfur deficiency starts in the new leaves whereas nitrogen deficiency starts in the older leaves. In this study, treatment minus sulfur appears yellow leaves with less number of tillers with thinner leaves.

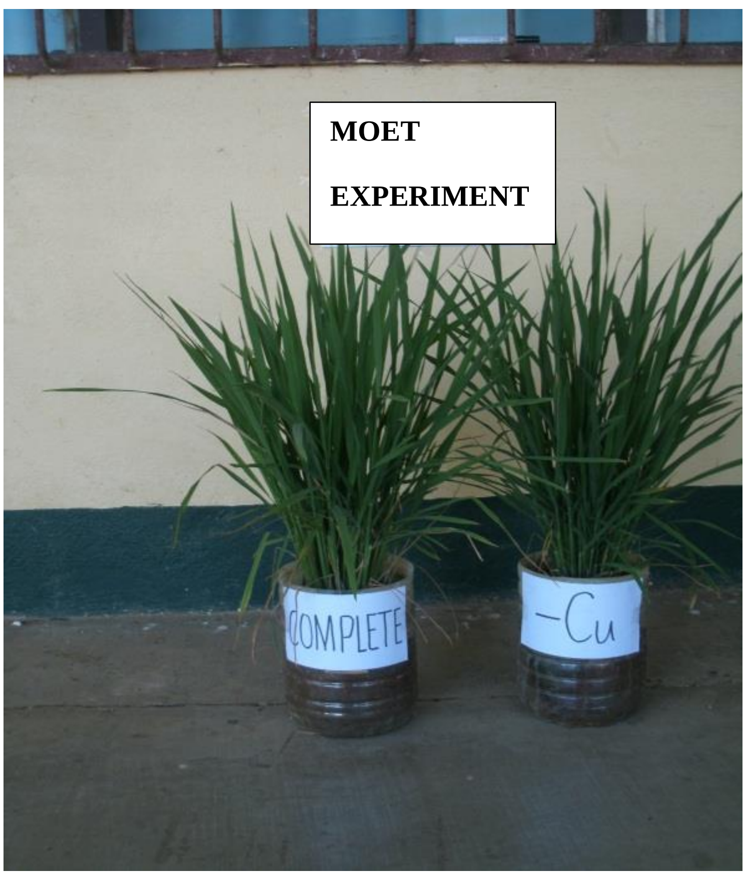

Figure 6. Observation comparing the complete (check) and the - Cu

The appearance of potassium deficiency symptoms occur mainly on the older leaves and the general symptoms exhibited by rice leaves include marginal chlorosis of young leaves sometimes necrotic tips (if severe), twig dieback, sometimes necrotic and brown spots over leaf surface thus, reduces the growth and yields. However, in this study a slight yellowing of leaves observed at the late stage (3 weeks after planting) thus, reduces its fresh and dry biomass production.

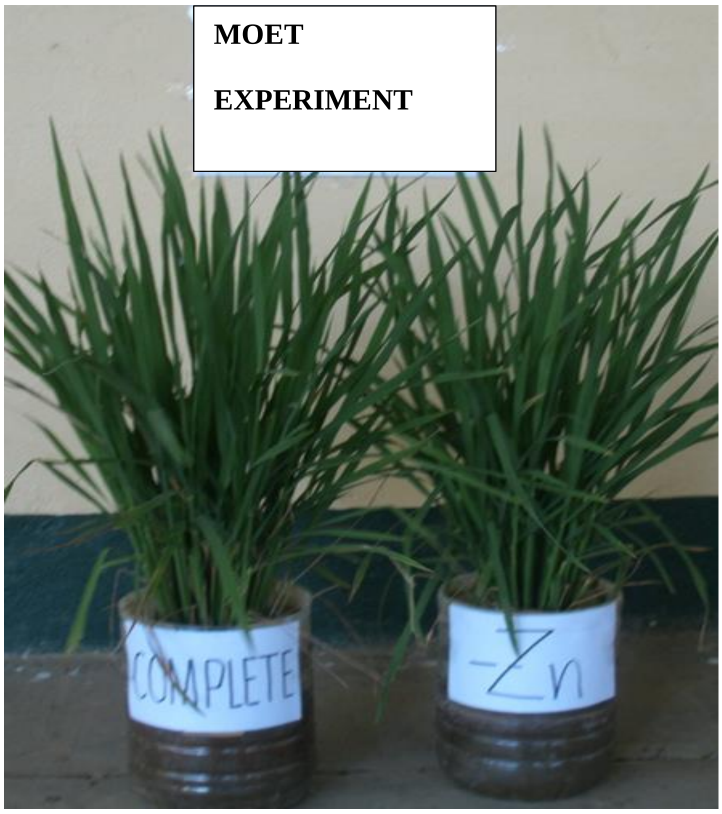

Figure 7. Observation comparing the complete (check) and the –Zn

The general symptoms of zinc deficiency were also chlorosis and necrosis of the younger leaves. As zinc stimulates the production of auxin, a characteristics symptom that the plant becomes dense with small leaves and short distance internodes. However, these deficiency symptoms did not appear in our experiment. The actual appearance shown is comparable to the treatment receiving complete nutrients. This result suggested that the soil tested still have sufficient amount of zinc element.

CONCLUSION

MOET is a farmer`s friendly technology in assessing the nutrient status of the soil as manifested in the growth of the plant, it is very practical, easy to follow and less expensive. Likewise, identification of visible symptoms of nutrient deficiency can be a useful tool to guide farmers and researchers in managing rice plant for optimum production. Moreover, soil in the rice farm of CLSU revealed that it has still enough amounts of secondary macronutrient elements except on nitrogen and sulfur.

RECOMMENDATION

Before planting the field, assessment of the nutritional status of the soil should be done through a practical and low cost process the minus one element technique (MOET). For more accurate results, at least 2 replications will be recommended in this technique. Also studies on the different level of N and S will be conducted in this area.

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