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The Influence of Organic Materials to Nitrogen Content of Leaf Tissue of Corn Planted in Coastal Sand Soil

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A greenhouse experiment was conducted to examine the effect of organic matter application on nitrogen content of corn leaf tissue grown in coastal sandy soil. The experiments were arranged in a complete randomized design using doses of organic matter (5, 10 and 15 tons ha^{-1}) treated to corn crops in three different doses of N-urea (115; 135 and 155 N kg ha^{-1}). The experimental results show that Doses of 10 and 15 tons of ha^{-1} of organic matter have an effect on nutrient nitrogen status in coastal sandy soil, organic matter (X) has a contribution of 99 percent to nitrogen content of corn leaf tissue (Y), with the equation $Y = 5{,}610 + 1{,}107X - 0{,}0462X^2$.

Keywords: Coastal Sandy Soil, N-Status, Nitrogen Content of Corn Leaf Tissues.

1. INTRODUCTION

Nitrogen is one of the elements of the three main nutrients of the plant namely nitrogen, phosphorus and potassium. In the soil, nitrogen is a volatile element, because its existence lies within the process of mineralization and immobilization. Inorganic nitrogen produced by the mineralization process will undergo the process of nitrification, denitrification and volatilization. Nitrification is the process of transforming ammonium ions into nitrate ions that are always in the soil solution. White and Reddy suggest that nitrification is the process of biological oxidation of the NH^{4+} ions to NO^{2-} and NO^{3-} which involve outotrophic bacteria.[1] Wolkowski adds that nitrification will occur if N-ammonium is introduced into warm-watered and sufficiently well-watered soil. Negatively charged nitrate ions are not bound by soil particles and will soon leach when there is water moving through the soil.[2]

Gehl suggest that nitrogen management efficiency is important to minimize agricultural contribution in causing NO^{3-} groundwater pollution.[3] Failure of sandy soil to provide soil solution causes the constraints of nutrient uptake of nitrogen, while in excess water conditions nitrate ions will carry out of the root zone, and the excess nitrogen which not absorbed by plants can be washed out of the root zone. Rapid permeability to very fast causelow efficiency in nitrogen fertilizing. Nakamura suggest that nitrogen fertilization in more frequencies (more than 3 times) is strongly recommended because it is proven to reduce in-efficiency fertilization, but with more frequencies can cause load labor costs.[4]

The utilization of coastal sandy soil associated with the application of nitrogen fertilizer is always faced with the problem of low fertilizer efficiency caused by (a) its soil's inability to provide water for the nitrogen absorption process by the plant and (b) the soil aeration condition that causes nitrification process of nitrogen fertilizer and loss Nitrogen through the nitrate leaching process.

Nitrogen management in the soil is an attempt to control the availability of nitrogen nutrients in soil solution in order to achieve nitrogen nutrient uptake efficiency and provide expected crop yields. Control of nutrient nitrogen status in soil solution can be done by inhibiting the process of N-ammonium to N-nitrate by applying organic matter with a C/N ratio more than 40, and reducing nitrate leaching.[5] Based on these matters, in order to increase its productivity, the southern coastal slope of Kulon Progo of Yogyakarta Special Region can be pursued through soil nitrogen management that is focused on nitrate conservation efforts in the soil. Control of nitrogen nutrient availability in soil solution and decrease of leaching rate of nitrate compound through gravity water movement can be done by adding organic material into the soil.

The strategy to improve marginal land productivity, especially coastal sandy soil is by adding nitrogen sources, organic fertilizers and other inorganic fertilizers. On the one hand organic matter is expected to create an organic colloidal complex and increase the soil's ability to hold water and increase the solubility of anorganic fertilizer. FAO in 2005 states that the addition of organic matter into the soil can increase the number of micro pores and macro pores even some types of certain organic materials can hold water twenty times its weight.[6]

On the basis of this, the provision of organic materials is expected to improve the weakness of its physical properties. The giving of organic matter is aimed at decreasing the rate of gravity water movement so as to decrease the nitrate leaching process

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and increase the ammonium ion fixation in the soil organic colloid complex which can finally delay the nitrification process.

2. MATERIALS AND METHODS

The main material of greenhouse experiment is sandy soil taken from coastal area of Kulon Progo, organic material with ratio of cow dung and rice straw = 1:1 and N-urea, SP-36 and KCl fertilizer and corn seed (*Zea mays* L.) Hybrid Bisi-16 which will be grown as indicator plant.

Greenhouse experiments were arranged in a completely factorial randomized design (Factorial Completely Randomizd Design). The first factor was organic material, consisting of three treatment levels of 5 t ha^{-1} organic matter (*b*1), 10 t ha^{-1} (*b*2) and 15 t ha^{-1} (*b*3). The second factor was nitrogen fertilizer (N), consisting of three treatment levels of 115 kg N ha^{-1} (*n*1), 135 kg N ha^{-1} (*n*2) and 155 kg N ha^{-1} (*n*3). Each treatment combination was replicated for three times.

The soil samples were taken compositely at 30 cm depth, from the location of the alluvial plains of the southern coast of Kulon Progo, Yogyakarta Special Region. The soil samples from the field were mixed evenly and dried for 7–10 days. After the drying period was complete, all the soil samples were filtered with a 2 mm diameter strainer, then weighed 15.18 kg of absolute dry soil sample (equivalent to 15.204 kg of air dried sample). This procedures was replicated until gain 27 soil samples, then soil samples fertilized with organic material (5; 10 and 15 tons ha^{-1}) and put into polybags with 20 cm diameter and 30 cm high. The soil samples that have been put into the polybags are located in greenhouse, randomized completely, and incubated for one week under field capacity conditions.[7]

After the incubation period of the soil sample was completed, into each polybag was applicated treatments of N-urea fertilizer (115; 135 and 155 kg ha^{-1}), phosphorus fertilizer (SP-36) and potassium fertilizer (KCl). In each of the treated polybags, two BISI-16 corn seeds were grown and watering up to the field capacity. After the corn seeds grow and the age of one week, from each polibag done the removal of corn seeds with worse growth, and left the other plant with better growth. The revoked plants are returned to the soil. At the time the plant enters the maximum vegetative growth (60 days after planting) the N-total content of leaf tissues was measured.

The average result of measurement of plant growth response variable, N content of leaf tissue, was analized of variety (Analysis of Variance) and to differentiate the average effect of different treatment significantly performed Duncan Multiple Test with 5% significance. While to get model of relationship between dose of organic material with N leaf tissue content and conducted regression analysis was done.

3. RESULTS AND DISCUSSION

The content of nitrogen in the leaves tissues of corn were determined when the plant entered maximum vegetative growth (60 days after planting). The nutrient concentrations of N of corn ranged from 8.2–28.1 g N kg^{-1}, whereas the nitrogen content in most plants ranged from 7 to 36 g kg^{-1}.[8] The result of variance analysis shows that there is no interaction between organic material and nitrogen fertilizer to content of N-leaf tissues. The dosage of organic matter has a significant effect on the content of N-leaf tissue and nitrogen dose has not significant effect, as presented in Table I.

Table I. The content of N-leaf tissues (g N kg^{-1}).

Dose of organic matter (ton ha^{-1})	Dose of N (kg ha^{-1}) 115 (*n*1)	135 (*n*2)	155 (*n*3)	Average
5 (*b*1)	10,65	9,47	9,87	9,99b
10 (*b*2)	11,40	11,57	13,21	12,06a
15 (*b*3)	11,01	12,33	12,11	11,82a
Average	11,02A	11,13A	11,73A	(–)

Note: The mean in rows and columns followed by the same letter shows no significant difference based on Duncan Multiple Range Test 5%.

Table I shows that the application of organic materials of 10 and 15 t ha^{-1} (*b*2 and *b*3) results content of N-leaf tissues greater than the dosage of organic material 5 t ha^{-1} (*b*1). Results of laboratory analysis showed that the organic materials used in this study contained nitrogen of 1.34%. Therefore an increase in the dose of organic material up to 10 t ha^{-1} can provide nitrogen nutrients and increase the N content in leaf tissue. Fertilizer application using slow release N-fertilizers (organic matter) may increase N uptake by corn crops. This is thought to be related to the ability of organic materials in providing water so as to support the process of N uptake by plants.

The table above also shows that during the vegetative growth of the plant, organic matter is more involved in the process of supplying nitrogen. In this case Hansen et al. who stated that the application of manure can provide nitrogen for corn.[9] Sanchez et al. also argue that the nitrogen-mediated mineralization of microorganisms in the N-organic transformation process into NH^{4+}, is the largest contributor to the availability of nitrogen for the uptake process of N by crops.[10] However, the dosage of organic matter of 10 and 15 t ha^{-1} was not significantly different in the content of N-leaf tissue. It is suspected that up to a certain dose, an increase in the dosage of organic matter does not necessarily guarantee an increase in N uptake, but plants absorb nutrients according to their needs.

Brady states that one condition must be considered in nitrogen fertilization is to seek matching point between the availability dosage and the need of nutrients.[11] On this basis, it is assumed that the of organic matter of 10 t ha^{-1} has been able to meet the needs of plant nitrogen, and the excess nitrogen supply by the process of mineralization of organic material of 15 t ha^{-1} can be leached.

The table also showed that the application of three nitrogen doses of 115 kg N ha^{-1} (*n*1), 135 kg N ha^{-1} (*n*2) and 135 kg N ha^{-1} (*n*3) yielded content of N-leaf tissue was not significantly different. The same effect of these three doses is thought to be caused by the nitrate leaching process because of the nitrogen nutrients from inorganic fertilizers whose mobility in the soil is closely related to the movement of water, especially on sandy soils. Wolkwoski et al. suggest that nitrate leaching occurs more quickly in sandy soils than in fine textured soils.[2]

The result of determination of N-leaf tissue content is the accumulative uptake along the corn plant through the vegetative growth process, and the above data also informs that organic matter has more role in providing nutrient nitrogen, this is in accordance with the slower nature of organic matter in releasing its nutrient than in-organic N-fertilizer. While on the other hand nitrogen fertilizer which is an-organic fertilizer that is fast

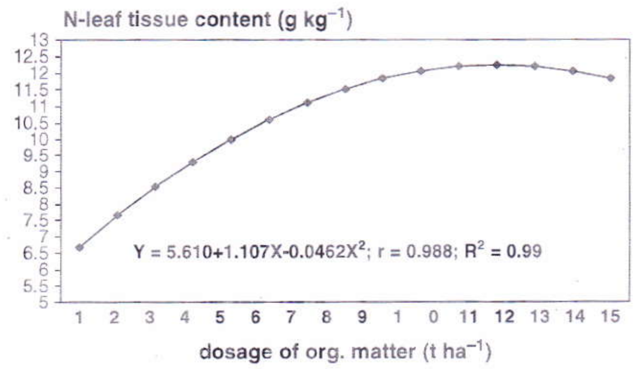

Fig. 1. N leaf tissue content vesus dosage of org mater curve.

in removing the nutrient content and tend to provide nutrients after the basic fertilizer or fertilizer was applied. In line with statement of Sutoro that at the time of the appearance of male flowers, corn plants have absorbed as much as 50% of all N nutrients required, and in this greenhouse experiment, the appearance of the male flower candidate occurred at the time the corn plants were 60 days old.[12] It is suspected the provision of nutrient needs nitrogen During the period of vegetative growth is more determined by the role of organic matter in maintaining the condition of water content and the provision of nitrogen nutrients as illustrated in Figure 1.

The relationship between the dosage of organic matter and the N content of the leaf tissue is represented by the quadratic equation $Y = 5.610 + 1.107X - 0.0462X^2$. The determination coefficient (R^2) of 0.99 indicates that organic matter contributes 99 percent to the content of N-leaf tissue. The role of organic matter in the supply of nitrogen lies in the ability of the organic material to reduce the gravitational water rate which can reduce nitrate leaching rate, increase the soil capacity in water holding and the supply of nitrogen through the mineralization process. The research results of Susilawati et al. show that organic compounds have a good effect in controlling the loss of N-urea so as to improve the efficiency of its utilization.[13] Feichtinger et al. state that the process of decomposition of organic matter in the soil and nutrient mineralization process of this material can be available to plants.[14] The results showed that the utilization of 10 tons of organic waste and 20 kg N ha^{-1} resulted in slow nitrogen decomposing greater than 3 tons of organic waste and 40 kg N ha^{-1}. This shows the role of organic matter in maintaining the nitrogen status in the soil.

4. CONCLUSION

The application of organic matter on coastal sandy soil have an effect on nitrogen status and efficiency of N-urea fertilizing. Dosages of 10 and 15 tons of ha^{-1} application of organic matter have an effect on nutrient nitrogen status in coastal sandy soil, organic matter (X) has a contribution of 99 percent ($R^2 = 0.99$) to nitrogen content of corn leaf tissue (Y), with the equation $Y = 5.610 + 1.107X - 0.0462X^2$.

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