

Effect of Cow Manure and KCl on Changes in Soil Properties and Growth of Nutmeg (*Myristica fragrans* Houtt) in Inceptisol Galela

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ABSTRACT

Nutmeg plant is one of the spice commodities that had been known from the ancient world. In an effort to revive the dignity of spice crops, nutmeg also promise encourage to be developed. This study aims to analyze the effect of cow manure and KCl to change soil properties and growth of nutmeg in inceptisol Galela in North Halmahera district -part of North Maluku province. The research was conducted on mixed cropping system, by using factorial experiment in randomized block design which consisted of two factors. The first factor was the manure application that consisted in three levels: without manure, 500 kg ha⁻¹ of manure, and 1000 kg ha⁻¹ of manure. The second factor was K fertilizer application, consisted of four levels: without KCl, 60 kg ha⁻¹ of KCl, 120 kg ha⁻¹ of KCl, and 180 kg ha⁻¹ of KCl. The results showed that the separately application of 500 kg ha⁻¹ of cow manure or 120 kg ha⁻¹ of KCl fertilizer are a suitable dosage to influence nutmeg grown in mixed garden.

Keywords: *Myristica fragrans* Houtt, cow manure, KCl, inceptisol, mixed garden

I. INTRODUCTION

The nutmeg (*Myristica fragrans* Houtt) is native plant from Indonesia and originated in Banda and Maluku [1,2,3] and has been known as a spice plant since the 18th century. The center of nutmeg production in Indonesia is located in Maluku Island, North Sulawesi, and Aceh^[2]. Up until now, Indonesia is the world's largest nutmeg producer (70-75%), besides other producer countries which are Grenade, India, Sri Lanka, and Malaysia [4].

Galela is an area located on North Halmahera districts and only a small part of the region in North Maluku Province. This area is gaining attention to developed plantation crops with a development pattern focused on the core plantations done by local people/farmers [5]. One of the plantations commodities that is developed in this region is nutmeg. As a whole nutmeg ranks third after coconut and clove plants^[6]. In view of the area and production data, the Galela region turned out to have considerable potential in producing nutmeg commodities [6,7], so the prospects for the development of nutmeg plants in this area are promising to be more developed.

The location of the study area is in the eastern of region Indonesia, which generally rain occur in short periods with relatively a small amount with a high intensity. In addition to having a flat, wavy, and mountainy landform, the research area also has different soil types, with its various Physico-chemical properties and different soil fertility^[7]. With the condition of such territory, the possibility of a decrease in nutrient status occurs quite high. Through a study of nutrient management measures such as compost

application, manure, the use of soil enhancing materials can be an attractive approach to improve the efficiency of nutrient use.

This study aims to determine the effect of cow manure and KCl on the growth of nutmeg (*Myristica fragrans* Houtt) and improvement of soil properties.

II. METHODS

The research was carried out in the village of Simau, Galela sub-district, on mixed garden land where coconut, nutmeg, banana, pineapple, mango, and soursop were planted. Geographically, situated between N 01° 50 '36.4" and E 127° 50' 06.3 ", with a place height of 26 m above sea level.

Materials needed for this study: nutmeg plants, manure, KCl fertilizer, and NPK compound fertilizer. The experiment used a Factorial Design in a Randomized Block Design, which consisted of 2 factors. The first factor is the provision of manure, which consists of 3 levels, namely: S₀ = without giving manure, S₁ = giving manure 500 kg ha⁻¹, and S₂ = giving manure 1000 kg ha⁻¹. The second factor is K fertilization, which consists of 4 levels, namely: K₀ = without KCl fertilization, K₁ = KCl fertilization 60 kg ha⁻¹, K₂ = KCl 120 kg ha⁻¹ fertilization, and K₃ = KCl fertilization 180 kg ha⁻¹.

Determination of sample plants in each block is determined randomly according to the design used. Land clearing is done by removing the weeds, especially those around the sample plants. Next, soil samples and leaf samples were taken on each block. The treatment of manure, KCL fertilizer and basic fertilizer (NPK) was

carried out in the first month of the study, named after the first sampling of both soil samples and leaf samples. KCl fertilizers and NPK fertilizers are given by 1/3 of the parts are spread around the plant, and 2/3 of the parts are broken down, while manure is spread evenly around the plant to the limit of the plant canopy.

Soil samples were analyzed in the Laboratory of Soil Department, Agriculture Faculty, Gadjah Mada University involving physical and chemical soil properties. The physical properties that were analyzed include texture using Pipet method, bulk density/BD using ring method, particle density/PD using Pycnometer [8], and porosity. The chemical properties analyzed, including pH H₂O using pH meter (1:2,5), N-Total using method Kjeldahl, P-Available using Olsen Method, K available through ammonium acetate extract 1 M pH 7, Cation Exchange Capacity (CEC) through ammonium acetate extract 1 M pH 7 [9]. Nutrient levels of plant tissue observed included N Total, P Total and K Total with the destruction analysis method wet. For plant parameters observed, it included: plant height (cm), stem circumference at breast height (cm), leaf wet weight (g), leaf dry weight (g), and dry weight (g).

To find out whether or not there is a treatment effect, a variety analysis is performed with the F test, whereas to compare between the values of the average treatment Duncan's multiple distance test (DMRT) is carried out at the level of $\alpha = 5\%$.

III. RESULTS AND DISCUSSION

A. Characteristics of Soil, Manure and Artificial Fertilizers

The results of the preliminary analysis of soil characteristics used are presented in Table 1. The manure used in this study was composted cow manure with a composition of total N nutrient content of 0.79% (very low), organic C 30.54% (sufficient), P₂O₅ is 0.34% (sufficient) and K₂O is 0.19% (very low) [10,11]. Artificial fertilizers used as treatments were K fertilizer, KCl fertilizer with 60% K₂O content, considering that the available K content in the research soil was very low at 4.68 cmol⁽⁺⁾ kg⁻¹. In addition, NPK compound fertilizer is also used as a basic fertilizer, with the composition N: P: K = 23: 8: 5.

Table 1. Characteristics of Soil Properties in depth soil 20 cm in Simau Village, Galela District, North Halmahera Regency.

| Soil Properties | Value | Unit | Rewards |
|-----------------------|-------|--------------------------|------------|
| Clay | 17 | % | } Loam |
| Silt | 32 | % | |
| Sand | 51 | % | |
| Bulk Density (BD) | 0,87 | g cm ⁻³ | - |
| Particle Density (PD) | 2,20 | g cm ⁻³ | - |
| Porosity (n) | 61 | % | - |
| N Total | 0,32 | % | Sufficient |
| P available | 38 | mg g ⁻¹ | very high |
| K available | 4,68 | cmol(+) kg ⁻¹ | very low |
| CEC | 23,6 | cmol(+) kg ⁻¹ | sufficient |

Source: Analysis Laboratory of Soil Department, Agriculture Faculty, Gadjah Mada University (2016). Rewards according to ISRI (2009).

B. Effect of Giving Cow Manure and KCl Fertilizer on Soil Properties and Plant Growth

Table 2 showed that the results of different tests on the average effect of giving cow manure and KCl fertilizer to the parameters of soil pH, it appears that the administration of cow manure and KCl fertilizers tends to reduce soil pH. The decrease in soil pH in the treatment of cow manure is possible because cow manure contains a lot of organic acids, so if given in high doses it will release organic acids in the soil as a result the soil pH tends to decrease, although the decrease is not too significant sour. While the decrease in soil pH in the KCl fertilizer application, it is possible because KCl fertilizer has a physiological reaction that is weak and somewhat hygroscopic, so giving too much will tend to reduce the pH of the soil. The fertilizers that have acidic physiological reactions tend to be lower in soil pH [12].

Table 2. The Effect of Giving Cow Manure and KCl Fertilizer on the Average pH of Inceptisol

| KCl (kg ha ⁻¹) | Cow manure (kg ha ⁻¹) | | | |
|----------------------------|-----------------------------------|-------|-------|---------|
| | 0 | 500 | 1000 | Average |
| 0 | 6,6 | 6,8 | 6,5 | 6,7 a |
| 60 | 6,6 | 6,4 | 6,3 | 6,4 b |
| 120 | 6,2 | 6,2 | 5,9 | 6,1 c |
| 180 | 6,4 | 6,4 | 6,1 | 6,3 b |
| Average | 6,5 p | 6,5 p | 6,2 q | 49(-) |

Note: (-) indicates no interaction; the average followed by the same row or column shows no significant difference based on the Duncan's multiple distance test (DMRT) is 5% significance level

Table 3. The Effect of Giving Cow Manure and KCl Fertilizer on the Average available K of Inceptisol

| KCl (kg ha ⁻¹) | Cow manure (kg ha ⁻¹) | | | |
|----------------------------|-----------------------------------|--------|--------|----------|
| | 0 | 500 | 1000 | Average |
| 0 | 1,88 | 1,69 | 1,83 | 1,80 b |
| 60 | 1,22 | 1,71 | 1,52 | 1,48 b |
| 120 | 1,68 | 3,03 | 1,77 | 2,16 b |
| 180 | 3,69 | 2,38 | 2,63 | 2,90 a |
| Average | 2,12 p | 2,20 p | 1,94 p | 2,09 (-) |

Note: (-) indicates no interaction; the average followed by the same row or column shows no significant difference based on the Duncan's multiple distance test (DMRT) is 5% significance level

Table 3. showed, that it appears that the increasing supply of KCl fertilizer, the availability of available K is also increasing. It also appears that although the treatment of cow manure by variance analysis did not have a significant effect on available K, the average yield gave a varied available K average. The highest available K is obtained in the treatment of 500 kg ha⁻¹, but the addition of the next dose is likely to decrease the available K.

At the age of 1 and 6 months after treatment, administration of cow manure (S) had a significant effect on the total N content of nutmeg plant tissue (*Myristica fragrans* Houtt), but the treatment of KCl fertilizer and its interactions did not have a significant effect. Table 4 showed that it appears

that along with the increase in cow manure administration, the total N content of the tissue also tends to increase.

Table 4. Average Difference Test Effect of Cow Cattle Fertilizer on N Content of Total Nutmeg Plant Tissue (*Myristica fragrans* Houtt) at Age 1 and 6 months after Treatment

| Cow manure (kg ha ⁻¹) | Average N Content of Total Nutmeg Plant Tissue After Treatment at Age | |
|-----------------------------------|---|--------------------|
| | 1 Month | 6 Month |
| 0 | 1,56 ^a | 1,37 ^b |
| 500 | 1,55 ^a | 1,44 ^{ab} |
| 1000 | 1,75 ^p | 1,55 ^a |

Note: The numbers followed by the same letter show no significant difference in the Duncan's multiple distance test (DMRT) at 5% significance level

Table 5. The Effect of Giving Cow Manure and KCl Fertilizer on the Average P Total Nutmeg Plant Tissue (*Myristica fragrans* Houtt) at Age 1 and 6 months after Treatment

| KCl (kg ha ⁻¹) | Average P Total Nutmeg Plant Tissue After Treatment at Age | |
|----------------------------|--|--------------------|
| | 1 Month | 6 Month |
| 0 | 0,18 ^p | 0,15 ^{ab} |
| 60 | 0,16 ^p | 0,13 ^b |
| 120 | 0,19 ^p | 0,15 ^{ab} |
| 180 | 0,18 ^p | 0,20 ^a |

Note: The numbers followed by the same letter show no significant difference in the Duncan's multiple distance test (DMRT) at 5% significance level

P total tissue, the treatment that gives effect is the treatment of KCl fertilizer. The effect is seen at the age of 6 months after the treatment, while at the age of 1 month does not give a real influence. Table 5 showed that it appears that the higher the KCl fertilizer content the total P tissue tends to increase.

Table 6. Average Difference Test Effect of Cow Cattle Fertilizer and KCL Fertilizer on Nutmeg Plant Height (*Myristica fragrans* Houtt)

| KCl (kg ha ⁻¹) | Cow manure (kg ha ⁻¹) | | | |
|----------------------------|-----------------------------------|-----------------------|------------------------|------------|
| | 0 | 500 | 1000 | Average |
| 0 | 276,33 ^a | 159,00 ^{cd} | 213,33 ^{abcd} | 216,22 |
| 60 | 206,33 ^{abcd} | 218,00 ^{abc} | 215,33 ^{abcd} | 213,22 |
| 120 | 172,00 ^{bcd} | 175,33 ^{bcd} | 186,00 ^{abcd} | 177,78 |
| 180 | 125,33 ^d | 261,33 ^{ab} | 193,33 ^{abcd} | 193,33 |
| Average | 195,00 | 203,42 | 202,00 | 200,14 (+) |

Note: (+) there is interaction; the average followed by the same row or column shows no significant difference based on the Duncan's multiple distance test (DMRT) is 5% significance level

Table 6 showed that it appears that the treatment of KCl 60 kg ha⁻¹ in combination with all treatments given by manure provides a fairly high average value of all other treatments. The highest plant height was achieved in a combination of treatments without fertilizing cow manure and without fertilizing KCl fertilizer, followed by a combination of fertilizing 500 kg ha⁻¹ cow manure with fertilizer KCl 180 kg ha⁻¹. The high value of plant height in an untreated combination is due to the taking of sample plants in this

combination mostly taken on plants whose initial growth did indeed have better growth than other sample plants

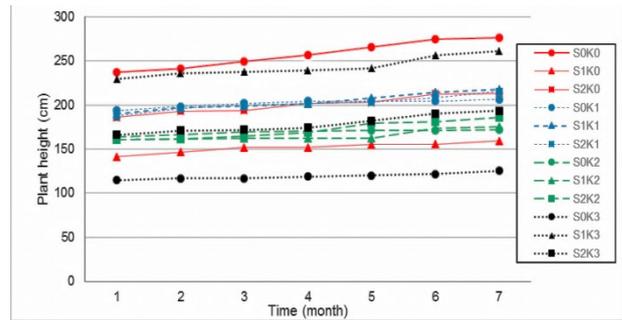


Figure 1. The Effect of Giving Cow Cattle Fertilizer and KCl on Nutmeg Plant Height (*Myristica fragrans* Houtt)

Figure 1 showed that is a graph of the growth of plant height at each observation, it can be seen that with the combination of treatment the administration of cow manure and KCl fertilizer plant height continues to increase every month of observation. This situation indicates that cow manure and KCl fertilizer can be absorbed by plants, if associated with the age of the plants used for this study, the age of the plant is still very young, namely 3 years so that it quickly responds to each given fertilizer, which in turn is high plants also experience an increase in each observation. It can be seen in the picture above that the plant height varies in each treatment, this condition is because even though the age of the plants used is the same but in growth has different growth there is fertile and some are very thin at first, random sampling, so that there are plants that indeed at the beginning of their growth have growth that is already good in the field such as plant samples without fertilization (control) but the growth appears to be quite good, which is why the combination of these treatments is higher than other treatments even without fertilizer.

In general, the effect of giving 500 kg ha⁻¹ cow manure had the best influence on the average value of soil properties and plant growth parameters, while the nutrient content of the increased plant tissue was obtained by the treatment of 1000 kg ha⁻¹ fertilizer. Cow manure is one form of organic fertilizer that has the ability to improve soil physical properties and provide nutrients. Manure is one form of organic fertilizer that has the ability to improve the physical properties of soil, including improving soil aggregation, aeration and percolation and stimulating the formation of more crumbly and easily processed soil structures. Provision of cow manure as soil conditioner will have a positive influence on improving soil properties, both physical, chemical and biological properties of the soil. The physically organic matter will affect the color of the soil to dark brown, stimulate granulation, improve soil structure and increase the power of the soil to hold water and nutrients [13]. Chemically biomass acts as a decomposed part of the mineralization process and difficult compounds decompose through the humification process will produce soil humus which

mainly plays a colloidal role, increasing soil CEC 30 times greater than inorganic colloidal, resulting in increase and availability and efficiency of other nutrient fertilization. While in biology, biomass is a source of energy and nutrients for soil biological bodies, especially heterotrophic. Microorganisms such as *Pseudomonas* and *Bacillus* will increase in population if biomass is administered.

The single treatment of KCl fertilizer showed that the increase in KCl fertilizer application actually lowered the soil pH, but the C and P levels were more increased, whereas in plant height the increase in KCl fertilizer had a fluctuating effect. Based on the average value of each parameter observed, it appears that KCl fertilizer with a dose of 120 kg ha⁻¹ gives the best results for most parameters observed, such as BD, PD, porosity, pH, p available, CEC, N total network, leaf wet weight and leaf dry weight. Increasing the administration of KCl fertilizer at higher doses tends to increase available K, total P and K total plant tissue, and plant height. K uptake is influenced by genetic characteristics and plant growth stages^[14]. In this study nutmeg plants used are young nutmeg plants that are only 3 years old in the field, at the age of plants such as this nutrient absorption process takes place quite high, with the provision of KCl fertilizer is quite high, the content of potassium in plant tissues also tends more increase. The best K uptake was found in healthy plants and sufficient K fertilizer was available^[16]. Potassium is taken by plants as K⁺ ions, and is very high in plant bodies, but is not assimilated in organic compounds^[15]. This condition indicates that the treatment of KCl K₂ fertilizer is a single dose of fertilizer suitable for mixed garden nutmeg cultivation. In line with the results of [2] for nutmeg plants the recommended dosage of KCl fertilization is 120 kg ha⁻¹, given twice in stages.

IV. CONCLUSION

In a single way the administration of cow manure only had a significant effect on soil pH, total N tissue and plant height, giving 500 kg ha⁻¹ cow manure gave the best influence on the average value of soil properties and plant growth parameters, while on nutrient content on the increased plant tissue obtained in the treatment of giving 1000 kg ha⁻¹ fertilizer. Giving KCl fertilizer with a dose of 120 kg ha⁻¹ gave the best results for most parameters observed, such as BD, PD, porosity, pH, available p, CEC, total N tissue, leaf wet weight and leaf dry weight. Increasing the administration of KCl fertilizer at higher doses tends to increase available K, total P and K total plant tissue, and plant height.

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