The effects of potassium, nitrogen and straw compost giving to increase organic material levels and k-exchangeable rice fields and rice growth

S Aminah1, H Hanum*2 and Sarifuddin2

1Master of Agrotechnology Faculty of Agriculture, Universitas Sumatera Utara, Padang Bulan, Medan – 20155 Indonesia
2 Department of Agriculture Faculty of Agriculture, Universitas Sumatera Utara, Padang Bulan, Medan – 20155 Indonesia

E-mail : *hamidah1@usu.ac.id

Abstract. Potassium and nitrogen fertilization accompanied by the application of rice straw compost is expected to improve the chemical properties of rice fields and the growth of rice plants. The purpose of this research is to find out the effect of potassium, nitrogen and straw compost fertilizer on increasing C-organic, organic matter and K-exchangeable soil and the growth of rice plants. This research was conducted in the rice field area of Cengkeh Turi village, Binjai City (± 32 m asl) from March-July 2018. This study used factorial randomized block design method with 3 Factors: Potassium (KCL): 0, 25, 50 and 75 kg ha\(^{-1}\); Nitrogen (Urea): dosage for farmers (250 kg ha\(^{-1}\)) and LCC recommendations (315 kg ha\(^{-1}\)); straw compost Treatment: without compost straw (0 t ha\(^{-1}\)) and straw compost (5 t ha\(^{-1}\)). The results showed that the application of potassium, nitrogen and straw compost had no significant effect on increasing levels of C-organic, organic matter and K-exchangeable paddy soil. However, there was an increase in nutrient status from very low to low. While there is a significant effect on plant height and number of tillers per clump at 2 weeks after planting and shoot dry weight of rice plants.

1. Introduction
Aside from decrease in land area, the decline in agricultural production could be due to the level of use of production factors (inputs) that have not been optimal by farmers. The paddy field used in the study is land with low nutrient conditions which can be seen from the low levels of N, P, K, pH and soil C-Organic. Giving fertilizer addition to the soil will add one or more soil nutrients and this will change the other nutrients balance [1] so as to get optimal production. However, on the other hand the high production costs due to fertilization make some farmers do not pay attention to the amount of fertilizer given which will have an impact on the quality of soil and production. Fertilization carried out should be balanced fertilization which is adjusted to the specific conditions of the location and the nutrient requirements of rice plants.

Other fertilization without considering the concept of nutrient balance can trigger soil degradation and reduce soil productivity. In addition, nutrient imbalances will have a negative effect on plants. Nitrogen nutrient imbalance causes considerable changes in the ratio of shoot and root plants so that
plants become stressed [2]. The size of the effect of N and K given to the soil and plants will be greatly influenced by the proportion of N and K applied [3].

To optimize the use of fertilizers, especially nitrogen fertilizer can be done by using a Leaf Colour Chart (LCC) that considers the needs of plants and target yields. N plant needs can be known by measuring the greenish level of the colour of rice leaves using LCC [4]. Fertilizer N which is based on the use of LCC can increase the efficiency of N fertilizer use by 10 - 53% compared to the recommended dose [5].

The application of balanced fertilizer is one way to improve fertilizer efficiency because in addition to N, P and K fertilizers, organic fertilizer is also given because it can increase the benefits of N, P and K fertilizers and soil fertility so that fertilization will be more efficient. Giving rice straw compost also affected rice yield, dry grain weight, present of filled grain per panicle, dry weight of straw per clump and number of productive tillers [6]. [7] And [8] a combination of KCl, dolomite and organic fertilizer can increase K nutrient uptake and significantly increase the dry grain weight of harvest. Organic materials are very good for improving physical properties, chemical properties and soil biological properties such as improving soil structure, increasing soil action exchange capacity, increasing the activity of soil biological life and increasing nutrient availability in the soil. Giving 10 t ha-1 rice straw compost significantly reduced the weight value of soil volume and improved soil permeability [9]. In addition, organic materials also contain organic acids which help release the elements that are bound to be easily absorbed by plants.

Based on the description above, this study was aimed to determine the effect of potassium, nitrogen and straw compost fertilizer on increasing C-organic, organic matter and K-exchangeable soil as well as the growth of lowland rice plants.

2. Material and Methods
This research was carried out in the paddy fields of Cengkeh Turi, North Binjai Sub district, Binjai City with altitude of ± 32 meters above sea level. Soil analysis was carried out by the Research and Technology Laboratory of the Faculty of Agriculture Universitas Sumatera Utara. This research was carried out from March 2018 to July 2018.

The materials used in this study were Inpari Sidenuk variety rice seeds, Nitrogen in the form of Urea fertilizer (45% N), Potassium in the form of KCL fertilizer (100% K), Phosphate in the form of TSP fertilizer ration, hoe, meter, trace sample, leaf colour chart, scale, camera and stationery.

This study used factorial randomized block design method with 3 Factors namely Potassium (KCL) with 0 kg ha-1, 25 kg ha-1, 50 kg/ ha and 75 kg ha-1; dosage of Nitrogen (Urea) dosage for farmers (250 kg ha-1) and LCC recommendations (315 kg ha-1); Compost Straw consists of without compost straw (0 t ha-1) and straw compost (5 t ha-1). The area of the research plot is 2 x 2 m, the spacing is 20 x 20 cm and the distance between the plots of each sample is 20 cm.

Seeding and application of rice straw compost were carried out 3 weeks before planting. Fertilizer application consists of TSP (phosphate) fertilizer with an equivalent dose in all treatments, 50 kg ha-1 given after planting. KCL fertilizer according to the treatment dose in 2 stages of application wich is after planting and the productive tillering phase. Dosage for farmers for urea are given 3 stages: 7-10. 21 and 42 days after planting. Urea fertilization LCC recommendations are carried out from 0, 25 and 35 days after planting. Urea dosage of LCC recommendation after observation was obtained on two scales: 2-3 urea 125kg/ ha and 3-4 urea scale 100kg ha-1 with 90kg ha-1 urea base fertilizer so that the total urea given was 315kg ha-1. Soil sampling was taken 2 times after 3 weeks of incubation (during planting) and at the end of the vegetative period (7 weeks after planting).

Data were analysed by Variance Analysis for each parameter measured and further test using Duncan's Multiple Range Test level of 5%.

3. Result and Discussion
The application of various combinations of potassium. Nitrogen and straw compost fertilization on C-Organic Levels (%), Organic Materials (%) and soil K-exchangeable (cmol/kg) did not show
significantly different effects. In the C-O rganic parameter (%) the data showed the condition of nutrient status included in the criteria of low (L) and very low (VL) with the highest data indicated by 2 different treatments on No Straw Compost + dosage for farmers (250 kg ha⁻¹ Nitrogen) + 0 kg ha⁻¹ Potassium and Straw Compost + LCC recommendation (315 kg ha⁻¹) + 25 kg ha⁻¹ Potassium amounting to 1.161%. But in the Organic Material parameter (%) all treatments are only included in one criterion, namely medium (M) and K-exchangeable (cmol/kg) in the low criteria (L).

**Table1. C- Organic (%), organic materials (%) and K-exchangeable (cmol/kg) on various Potassium. Nitrogen and compost straw Combination**

| Dosage of Straw Compost | Dosage of Nitrogen | Dosage of Potassium | C- Organic (%) | Organic Materials (%) | K-exchangeable (cmol/kg) |
|-------------------------|--------------------|---------------------|----------------|-----------------------|-------------------------|
| Without Straw Compost  | 0 kg ha⁻¹Potassium | 0.829VL             | 1.429M         | 0.129L                |
| (250 kg ha⁻¹ Nitrogen) | 25 kg ha⁻¹Potassium| 1.057L              | 1.822M         | 0.119L                |
|                         | 50 kg ha⁻¹Potassium| 1.161L              | 2.001M         | 0.129L                |
|                         | 75 kg ha⁻¹Potassium| 1.368L              | 2.358M         | 0.139L                |
| LCC recommendations     | 0 kg ha⁻¹Potassium | 0.953VL             | 1.643M         | 0.126L                |
| (315 kg ha⁻¹ Nitrogen)  | 25 kg ha⁻¹Potassium| 1.161L              | 2.001M         | 0.119L                |
|                         | 50 kg ha⁻¹Potassium| 1.285L              | 2.215M         | 0.119L                |
|                         | 75 kg ha⁻¹Potassium| 0.725L              | 1.250M         | 0.139L                |
| Straw Compost (5t ha⁻¹) | 0 kg ha⁻¹Potassium | 1.223L              | 2.108M         | 0.114L                |
| (250 kg ha⁻¹ Nitrogen)  | 25 kg ha⁻¹Potassium| 1.306L              | 2.251M         | 0.119L                |
|                         | 50 kg ha⁻¹Potassium| 1.326L              | 2.287M         | 0.119L                |
|                         | 75 kg ha⁻¹Potassium| 1.492L              | 2.572M         | 0.139L                |
| LCC recommendations     | 0 kg ha⁻¹Potassium | 0.995VL             | 1.715M         | 0.119L                |
| (315 kg ha⁻¹ Nitrogen)  | 25 kg ha⁻¹Potassium| 1.098L              | 1.894M         | 0.143L                |
|                         | 50 kg ha⁻¹Potassium| 1.243L              | 2.144M         | 0.159L                |
|                         | 75 kg ha⁻¹Potassium| 0.995VL             | 1.715M         | 0.130L                |

Note: VL = Very Low. L = Low. M = Medium, Source: Soil Research Center (1983) [10]

From the treatment of Straw Compost + dosage for farmers (250 kg ha⁻¹) + 0 kg ha⁻¹ Potassium showed an increase in C-Organic levels from 0.829% to 1.222% and soil organic matter 1.429% to 2.108% almost 2 times the treatment of without Straw Compost + dosage for farmers (250 kg ha⁻¹) + 0 kg ha⁻¹ Potassium (Table 1). It means that the action of adding straw compost can increase the levels of C-organic and soil organic matter due to the high organic C content in straw compost. Straw treatment can affect C-organic, N-total, P-available and K-exchangeable in soil [11].

The results of the levels of C-organic nutrients (%) and organic matter (%) indicated that the lands in Indonesia still clearly continue to require input of organic matter. Most of Indonesia's agricultural land is classified as low. 73% of Indonesia’s agricultural land has a low organic matter content, 23% is medium and only 4% has high status [12]. The increase in the content of organic matter in the soil cannot be achieved in a short time. But if each times the entire waste is returned to the soil. Gradually there will be an increase in soil organic matter content. The action of adding organic matter if carried out continuously will increase soil organic matter content to an optimal level.

Level of K-exchangeable can be exchanged with straw compost treatment also shows better results than without being given compost. Level of K-exchangeable Straw Compost treatment + LCC recommendation (315 kg ha⁻¹) + 50kg ha⁻¹ Potassium is higher than all treatment combinations. The application of potassium fertilizer coupled with straw compost can saturate the adsorption complex so that the equilibrium is reached with K in the soil solution. The amount of potassium that can be adsorbed by the soil depends on the level of saturation [13]. The adsorbed potassium is mostly found in an equilibrium state with potassium in the soil solution which is the main source for plants.
The straw compost treatment showed a different effect on the height of rice plants of 2 weeks after planting. The results of the research have shown that the administration of straw compost gives higher yields compared to potassium fertilization without accompanied by straw compost (Table 2).

Table 2. Effects of straw compost on rice crop height (cm) 2 weeks after planting

| Dosage of Potassium | Without Straw Compost | Straw Compost | Average |
|---------------------|-----------------------|---------------|---------|
| 0 kg ha⁻¹ Potassium  | 30.00                 | 35.42         | 32.71   |
| 25 kg ha⁻¹ Potassium | 30.75                 | 34.68         | 32.72   |
| 50 kg ha⁻¹ Potassium | 34.28                 | 35.82         | 35.05   |
| 75 kg ha⁻¹ Potassium | 33.18                 | 36.12         | 34.65   |
| Average             | 32.05ᵃ                | 35.51ᵇ        |         |

Note: Numbers followed by unequal letters in the same row show significantly different levels of 5% based on Duncan's Multiple Range Test.

Compost straw affected the growth of rice plants significantly because the nutrients contained in straw were quite large, which is 0.5-0.8% N, 0.07-0.12% P₂O₅, 1.2-1.7% K₂O and 4-7% Si [14]. Nitrogen is an essential element of amino acids. Nucleic acids. Nucleotides and chlorophyll. Nitrogen serves to encourage plant growth quickly (increase plant height and number of tillers). Increase the size of leaf area. Number of grains per panicle. Percentage of grain content and protein content of grain. The addition of organic fertilizers allegedly contributing mainly N nutrients needed by plants is also able to improve the efficiency of N and K nutrients inorganic fertilizers (50%) caused by improvements in soil chemical properties. especially CEC, so that plant growth becomes better than without organic fertilizer [15].

The application of straw compost also showed a significant effect on the number of tillers per clump of rice plants on 2 weeks after planting. The results showed that giving straw compost showed higher values than straw compost without potassium fertilizer.

Table 3. Effects of straw compost on number of tillers per clump (stem/clump) of rice crops 2 weeks after planting

| Treatments         | Without Straw Compost | Straw Compost | Average |
|--------------------|-----------------------|---------------|---------|
| 0 kg ha⁻¹ Potassium| 7.33                  | 7.33          | 7.33    |
| 25 kg ha⁻¹ Potassium| 5.50                  | 7.00          | 6.25    |
| 50 kg ha⁻¹ Potassium| 6.00                  | 7.83          | 6.92    |
| 75 kg ha⁻¹ Potassium| 6.83                  | 6.83          | 6.83    |
| Average            | 6.42ᵃ                 | 7.25ᵇ         |         |

Note: Numbers followed by unequal letters in the same row show significantly different levels of 5% based on Duncan's Multiple Range Test.

The highest number of tillers per rice-growing hill was found in treatments applied with straw compost (Table 3). This shows that straw compost can support the growth and formation of the number of tillers of rice plants. The role of straw compost on production. Can increase the formation of tillers so that it becomes higher in number of panicles / clumps and 1000 seed weight [16]. The use of rice straw compost had a significant effect on the number of tillers compared to without straw compost [17].

The application of straw compost also showed a significant effect on the dry weight of the shoot of rice plants. The results of shoot dry weight were higher in the interaction between potassium fertilizer and straw compost compared with no straw compost.
Table 4. Effects of straw compost on shoot dry weight of rice plant (gram)

| Treatment            | Without Straw Compost | Straw Compost | Average |
|----------------------|------------------------|---------------|---------|
| 0 kg ha⁻¹ Potassium  | 16.96                  | 19.22         | 18.09   |
| 25 kg ha⁻¹ Potassium | 15.88                  | 19.95         | 17.91   |
| 50 kg ha⁻¹ Potassium | 16.97                  | 19.50         | 18.24   |
| 75 kg ha⁻¹ Potassium | 19.06                  | 21.21         | 20.14   |
| Average              | 17.22ᵇ                 | 19.97ᵃ        |         |

Note: Numbers followed by unequal letters in the same or row show significantly different levels of 5% based on Duncan’s Multiple Range Test.

The application of rice straw compost to the yield of the dry weight of the rice plant shoot showed a significant effect. The dry weight of the shoot with the application of rice straw compost was 19.97 grams while without the application of straw compost the average dry weight of the shoot was 17.22 grams (Table 4). This states that rice straw compost can be a source of nutrition for rice plants. The combination of straw compost and chicken manure can increase the dry weight of plant shoots on ultisol soil [18]. Domination of kaolinite in ultisol soils does not contribute to the cation exchange capacity of the soil and only depends on the content of organic matter so that soil improvement can be done by providing organic matter [19].

4. Conclusions

Application of potassium fertilizer, nitrogen and straw compost had no significant effect on increasing levels of C-organic, organic matter and K-exchangeable (cmol/kg) in paddy soils. But there was an increase in nutrient status from very low (VL) to low (L). While there is a significant effect on plant height and number of tillers per clump at 2 weeks after planting and shoot dry weight of rice plants. Application of straw compost improves the growth of rice plants.

References
[1] Silalahi F, Saragih Y, Marpaung A, Hutabarat R, Karsina and Purba S R 2004 Fertilization of NPK in Fruit Plants (Medan, Indonesia: Fruit Research Institute Fruit Plant Experiment Garden
[2] Varga P, Sardi K, and Beres I 2002 Effect of N imbalances on shoot and root growth of corn and velvet leaf Proc of the 7th Hungarian congress on plant physiology Hungary
[3] Pahlavi R W, Guritno B and Suminarti N E 2016 Effect of Combination of Proportion of Nitrogen and Potassium Fertilization on Growth. Yield and Quality of Sweet Potato Plant (Ipomea batatas (L.) Lamb) Varieties of Cilembu in Lowland J. Crop Production 4 1 pp 16-22
[4] Fairhurst T, Witt C, Buresh R and Dobermann A 2007 Panduan Pengelolaan Nutrisi Beras [Rice Practical Nutrient Management Guide] Translated by A Widjono I R R I (Jakarta)
[5] Wahid A S 2003 Increased Efficiency of Nitrogen Fertilizers on Rice Fields with Leaf Color Chart Method J. Agricultural Research and Development 22 4
[6] Mulyana, Darta, Sakhidin and A Iqbal 2011 Effect of Bokashi Dosage on Growth and Yield of Three Rice Varieties J. Agrin 15 1
[7] Nursyamsi D, Widowati L R, Setyorini D and Adiningh J S 2000 Effect of tillage interrupted irrigation and fertilization on the productivity of new paddy fields in Inceptisols and Muearbalerti Ultisols and Workshop J. Land and Climate 18 pp 33-42
[8] Abdullah S and Azwir K 2011 Effectiveness of potassium and/or organic matter on the growth and yield of rice in potassium-deficient rice fields in Kasang. Padang Pariaman Regency National Seminar on Agricultural Land Resources (Bogor) pp 305-14
[9] Junaedi H 2008 Utilization of Rice and Lime Compost to Improve Soil Permeability and Soybean Season Cropping Results Proc National Seminar on Sci and Technology 2 pp 89–94
[10] Soil Research Center 1983 Type A Reference Type. Type And Types Of Land In Indonesia For Requirements For Surveys And Mapping Regional Transmigration Land (Bogor, Indonesia :
[11] Ansari H, Jamilah and Mukhlis 2014 The effect of fertilizer and rice straw doses on the content of soil nutrients and the production of rice in the SRI planting system (System of Rice Intensification) Online J. Agroecotechnology 23 pp 1048-55
[12] Las I and Tim 2008 Land and climate resources support sustainable rice self-sufficiency. Memiograph (Bogor, Indonesia: SDLP Research and Development Center)
[13] Tan K H 1991 Basics of Soil Chemistry Translator D H Goenadi (Yogyakarta, Indonesia: Gadjah Mada University Press)
[14] Dobermann, A and T Fairhurst 2002 Rice Nutrient Disorder and Nutrient management Potash dan Phosphate Institute (PPI) (Canada: Photah and Phosphate Institute) pp 32-37
[15] Sitepu R, Anas I and Djuniwati S 2017 Utilization of Straw as an Increase Growth and Production of Rice Organic Fertilizer (Oryza sativa) Land and Soil Bulletin 11 pp 100-8
[16] Iskandar S 2003 Effect of Compost on Rice Production J. Agrotropic 82 pp 6-10
[17] Dyanti A P 2015 Pemanfaatan kompos jerami untuk meningkatkan pertumbuhan dan produksi padi sawah (Oryza Sativa L.) Di Desa Pematang Setrak, Sumatera Utara [Utilization of compost straw to increase growth and production of paddy rice (Oryza sativa L.) In Pematang Setrak Village North Sumatra] [Disertation] (Tanjung Pati, Indonesia: Politeknik Pertanian Negeri Payah Kumbuh)
[18] Barus N, Damanik M M B and Supriadi 2013 Availability of nitrogen due to giving various types of compost to three types of soil and its effects on the growth of corn (Zea mays L.). Online J. Agroecotechnology 13
[19] Munir M 1995 Indonesia's main land (Jakarta, Indonesia: Pustaka Jaya)