The application of NPK compound fertilizer (15-15-6) on soil chemical properties and corn plant

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Abstract. Fertilization is a process to meet the amount of nutrient needs for plant to increase the production of plant yield. This means that the use of fertilizers and other inputs is important to have a high effectiveness in agricultural system. The purpose of this study was to determine the effect of inorganic fertilizer (NPK compound 15-15-6) on soil chemical properties and corn plant. The method used a Randomized Block Design (RBD) consisting of 10 treatment combinations (8 treatments of inorganic fertilizer doses (1/4, ½, ¾, 1, 11/4, 11/2, 13/4, and 2), 1 treatment dosage of NPK fertilizer recommendations and 1 control (without fertilizer). The results obtained were Application of inorganic fertilizer (15-15-6) give significant effects on N uptake, total N soil and yield of corn plant. All the treatments of inorganic fertilizer (15-15-6) can increase the parameter N uptake (9%-29.10%), N soil (4%-22%), weight of cover peel of cob (38%-90.82%), weight of cob (44%-85.33%), length of cob (10%-22%), and diameter of cob (17.08%-34.82%) compared with control. The application of inorganic fertilizers (15-15-6) at doses ¾, 1, 1 ¼ and 1¾ can significantly improve the yield of corn with the highest yield at NPK 1½ dose (15,850 kg/ha).

1. Introduction
Corn is one of the most important plants in the world, besides wheat and rice. In some countries such as Central or South America and several regions in Indonesia, corn is the main food. In Indonesia, the development of sweet corn cultivation is still limited to farmers who have large capital and apply intensive cultivation techniques. This condition is because in the cultivation of sweet corn requires high costs in terms of seed supply, maintenance and inputs in the cultivation process. Besides being a major commodity, in some countries, it is can also utilize in other fields such as animal husbandry and processing of products such as oil, flour and various derivative products into food industry products. If we see the potential of this commodity, the increase of production must be balanced with good handling of problems. This refers to the lack of farmers knowledge in the use of proper cultivation techniques, as well as marketing factors. In addition, to handling various problems in the field, the characteristics of plant growth of corn are important, which can grow well in moderate to tropical climates [1]. Nowadays, the demand for corn plants in Indonesia is getting higher. This can be seen in the availability of sweet corn on a small or large scale (restaurants, hotels and supermarkets).

In Indonesia, sweet corn plants can grow and produce optimally in the lowland to highland with an altitude of 800 m above sea level. The ideal rainfall for corn growth is 85-200 mm/month and temperatures of 230°C - 270°C. This plant needs full of sun and good irrigation. Sweet corn does not require special soil requirements, but loose, fertile and rich of humus will produce optimal production. Also, soils with acidic to neutral pH (pH 5.5 - 7.0) [2]. The yield of sweet corn in Indonesia per hectare
is still low, ranging from 7.5-10.5 t ha-1. This can occur due to improper selection of seeds, fertilization, irrigation, and improper soil management, as well as due to pests/diseases that attack the crops. The application of N, P, K fertilizer can be seen through the use of plants that are responsive to the provision of external inputs such as sweet corn (Zea mays Saccharata L.). The growth of this plant is greatly influenced by various environmental growth factors such as nutrient availability in the soil, availability of groundwater, and light intensity. These environmental factors will be able to influence the productivity of these crops, according to the statement of [2] which explains that the response of low productivity of these crops, according to the statements of [2] which explains that the response of low production in corn plantations is because of a large amount of nutrient competition that occurs. The purpose of this research was to determine the effect of inorganic fertilizer (NPK compound 15-15-6) on soil chemical properties and corn plant. It is also getting the benefits from inorganic fertilizers (15-15-6) in terms of production and economic analysis. Furthermore, this application can decrease the use of inorganic fertilizer with the use of organic fertilizers in the farming system.

2. Material and Methods
The study was conducted using the experimental method Randomized Block Design (RBD), which consists of 10 treatment combinations and consists of 8 treatments of inorganic fertilizers (15-15-6) consist of 1 recommended fertilizer dosage treatment and 1 control treatment (without fertilizer), (1/4, ½, ¾, 1, 1 ¼, 1 ½, 1 3/4, 2 dose of inorganic fertilizer). Each treatment was repeated 3 times so that the total experimental plot was 30 experimental plots. Standard of NPK fertilizer is the recommended dosage of inorganic fertilizer treatment for corn plants (300 kg Urea, 150 kg SP-36, and 50 kg KCl per hectare). The recommended dosage inorganic fertilizer is 250 kg / ha for 2 times the application. Analysis of soil chemical properties (pH, N, P, K in soil and sorption of N, P, K in plant) was conducted at the Laboratory of Soil Chemistry and Plant Nutrition. Also plant growth parameters (plant height, stem and number of leaves) were observed every two weeks from 7 DAP to vegetative maximum (± 49 DAP) and yield component: fresh weighted of cob per plant (g), weight peeled of cob per plant (g), diameter cob per plant, and length cob per plant (cm).

3. Result and Discussion
3.1 Plant Uptake
Based on the results, the average plant uptake (N, P and K) measured on indicator plants shows the varied impact between each treatment (Table.1).

| Treatments     | N Sorption (%) | P Sorption (%) | K Sorption (%) |
|----------------|----------------|----------------|----------------|
| Control        | 2.68 a         | 0.02 a         | 1.81 a         |
| NPK Standard   | 3.6 bc         | 0.02 a         | 1.88 a         |
| NPK 1/4 Doses  | 2.65 a         | 1.09 a         | 2.84 a         |
| NPK 1/2 Doses  | 2.96 ab        | 0.97 a         | 2.43 a         |
| NPK 3/4 Doses  | 2.63 a         | 1.04 a         | 2.62 a         |
| NPK 1 Doses    | 2.91 ab        | 0.90 a         | 2.34 a         |
| NPK 1 1/4 Doses| 3.46 c         | 1.08 a         | 2.46 a         |
| NPK 1 1/2 Doses| 3.03 abc       | 0.93 a         | 2.54 a         |
| NPK 1 3/4 Doses| 3.19 bc        | 1.00 a         | 2.53 a         |
| NPK 2 Doses    | 3.25 bc        | 1.32 a         | 2.73 a         |

Table.1 showed that for N uptake parameters give a significant effect but no for another uptake. For N parameter, the NPK 1/4 up to 2 doses inorganic fertilizers (15-15-6) showed N uptake per plant greater than the control treatment. In those doses, the application of inorganic fertilizer can substitute the use of
NPK recommendation with the result of sorption on plant corn. This is correlated with the application of inorganic fertilizer with fit formulation for corn plant, that can substitute 96.11% NPK recommendation. Plants grow better in soil with the availability of enough nutrients. The nitrogen is needed at the beginning of growth, starting from the initial growth until the seed filling period. This is stated in the literature of [4], that the element N continuously absorbed by the plant until it is nearing maturity. Most of the nitrogen is brought to the growing point, stems, leaves, and male flowers, then transferred to seeds. On the other side, parameters P and K did not give a different effect for all treatments compared to control. This is because of the characteristics of those nutrients. Plant growth and P uptake are strongly influenced by P fertilization. The response to P fertilization is due to the low availability of soil P, and changes in soil conditions [5].

3.2 Acidity and Content of N, P and K in Soil
The average of pH, N, P and K parameters from soil samples, give no significantly different (pH, K and P) compared to controls. But give significantly effect for nitrogen parameter, (Table 2).

| Treatments       | pH     | K₂O (HCl 25%) | P₂O₅ (HCl 25%) | N (%)  |
|------------------|--------|---------------|----------------|--------|
| Control          | 6.5 ab | 12.28 a       | 58.12 a        | 0.27 ab|
| NPK Standard     | 6.23 ab| 14.66 a       | 80.92 a        | 0.31 ab|
| NPK 1/4 Doses    | 6.19 ab| 17.59 a       | 51.84 a        | 0.27 ab|
| NPK 1/2 Doses    | 6.24 ab| 16.54 a       | 53.83 a        | 0.33 c |
| NPK 3/4 Doses    | 6.12 ab| 24.22 a       | 66.94 a        | 0.31 abc|
| NPK 1 Doses      | 6.25 ab| 11.72 a       | 55.42 a        | 0.30 abc|
| NPK 1 1/4 Doses  | 6.19 ab| 23.23 a       | 60.45 a        | 0.31 bc|
| NPK 1 1/2 Doses  | 6.61 b | 24.24 a       | 75.06 a        | 0.30 abc|
| NPK 1 3/4 Doses  | 6.29 a | 13.20 a       | 48.42 a        | 0.26 a |
| NPK 2 Doses      | 6.39 ab| 11.70 a       | 56.57 a        | 0.28 ab|

In general, the pH in the soil is a neutral condition. In this condition, all the nutrients are available for the plant, including macro and microelements. But, in this case, the additional inorganic fertilization is not enough to increase the P and K in the soil. This parameter has the same path with sorption on the corn plant. When the availability of P and K in soil is low, the sorption will low too. However, for nitrogen parameter, the availability of N in the soil was increased when NPK fertilizer applied. Because, the addition of nutrients through application inorganic fertilizer is more easily available than P and K. NPK fertilizer contains around 15% of nitrogen, which is available when the process of mineralization occurs [6]. On the other side, the application of organic fertilizer as basic fertilizer in this treatment also can supply (C, N, P, K, S, and other compounds). These compounds consist of other nutrients such as carbohydrates, proteins, amino acids, fats, waxes, and organic acids with small atomic weights [7].

3.3 Average of Yield Parameters
The effect of treatments on the weight of cover peel of cob, the weight of cob, length of cob and diameter of cob as a component of corn yield give significant effects for all parameters. In general, the average of all treatments gives significant results compared to controls (Table 3). The increased crop yields (weight of cob, length of cob and diameter of the cob) are closely related to the amount of photosynthetic that is allocated to the cob. In some studies including, [11] it was stated that fertilizer application could increase the yield of corn. This is in line with the photosynthetic process that produced, were influenced by the amount of energy absorbed by the leaves based on the leaf area [8].
For the weight of cover peel of cob, the dose of inorganic ¼ up to 2 doses give differences with control (38%-90.82%). This treatment is also can substitution the application of NPK recommendation in treatments NPK 1 ½ and NPK 1 ¾. For the weight of cob, all the treatments give a significant effect on control (44%-85.33%) with the higher weigh of cob was 194.60 g (NPK 1 ½ dose). Also, for a length of cob, the treatments NPK ½ up to 2 doses give significant effect (10%-22%) from control. The diameter of cob also gave a significant effect on NPK ¼ up to 2 doses (17.07%-34.82%) from control, with the highest diameter of cob is NPK 1 ½ dose. For every ton of seed yield, corn plant requires 27.4 kg N; 4.8 kg P; and 18.4 kg K [9], so that proper nutrient management is needed to make plant growth optimally. The needs of nutrients, light and water can make the results of photosynthesis process will be formed properly. The resulting photosyntheate will be transferred and stored in the seeds. This is caused by the elements absorbed by plants will be used for protein formation and fat, which will be stored in the seeds [10]. The average yield of corn can be seen at Fig.1 below.
3.4 Plant Growth Parameter

3.4.1 Plant High
The plant height is one of the parameters of corn plant growth that observed at 14, 28, 42 and 56 DAP or the maximum vegetative phase (40-50 DAP), see in Figure 2 below. In general, plant growth looks relatively the same high for all treatments of NPK (15-15-6). The highest plant high was resulted by recommendation NPK for corn plant, but not different with NPK 1 ½ dose.

![Figure 2. Graphic Plant High of Corn](image)

Stated that plant needs nutrients such as N, P and K as essential nutrients which play an important role in plant growth, especially for the vegetative phase [11]. Thus, plant growth is generally influenced by the intake of nutrients obtained by these plants. Furthermore, this parameter is influenced by the supply of nitrogen, which can help the increase of plant high [12]. In [13] stated that the availability of adequate and balanced nutrients would affect the metabolic processes in plant tissues. This is referred to as the metabolic process of formation and recast of nutrients also organic compounds in plants.

3.4.2 The Average Number of Leaves
Parameter number of leaves for 14 DAP, 28 DAP, 42 DAP and 56 DAP, was observed (Figure 3) below. In this this parameter, path of number of leaves has the same for every age of the plant.
NPK recommendation for corn plant gives the highest amount of leaf than NPK (15-15-6). [14] state that NPK fertilizer can affect the number of leaves, the number of lateral shoots, the number of flowers and their size. According to [15], plant growth speed is influenced by the synchronization between nutrient availability and plant requirements. The length of the plant stems will affect the number of stems on which the leaves are released. So, if the plant has a long stem size, a number of leaves of the plant will high related to the process of plant assimilation.

4. Conclusions

The application of inorganic fertilizer (15-15-6) give significant effects on N uptake, total N soil and yield of corn plant (weight of cover peel of cob, weight of cob, length of cob and diameter of cob). All the treatments can increase the parameter N uptake (9%–29.10%), N soil (4%–22%), weight of cover peel of cob (38%–90.82%), weight of cob (44%–85.33%), length of cob (10%–22%), and diameter of cob (17.08%–34.82%). The application of inorganic fertilizers (15-15-6) at doses ¾, 1, 1 ¼ and 1¾ can significantly improve the yield of corn with the highest yield at NPK 1½ dose (37.280 kg/ha).

References

[1] Mayadewi, N.N.A. 2007. Effect of Manure Type and Spacing on the Growth of Weeds and Sweet Corn Results. Agritrop. 26 (4): 153 - 159 (2007). Faculty of Agriculture, Udayana University. ISSN: 0215 8620.
[2] Tim Karya Tani Mandiri. 2010. Guidelines for Growing Corn. CV Nuansa Aulia. Bandung.
[3] Purnomo, J. 2005. Response of maize plant varieties to low irradiation. Agrosains. 7 (1): 86-93.
[4] Syafruddin, Faesal and M Akil. 2007. Nutrient Management in Corn Plants. Cereals Plant Research. Maros, South Sulawesi. balisereal.litbang.deptan.go.id. (Accessed Oct 08, 2019).
[5] Indriani, N.P., Mansyur., Susilawati, I., Khairan, L. 2006. The Efect Of Organic Matter, Mycorrhizae, And Rock Phosphate On Production And Phosphor Absorbtion Of Tropical Kudzu (Pueraria Phaseoloides Benth). Journal of Livestock. Desember 2006, Vol. 6 No. 2, 158 – 162.
[6] Kaya, E. The Effect Of Straw Compost and NPK Fertilizers on Available N Soil, Absorption N, Growth, and Results of Rice Rice (Oryza Sativa L). Agrologia. Vol. 2, No. 1, April 2013, Hal. 43-50.
[7] Simpson, K., 1986. Fertilizers and Manures. Longman Inc. New York.
[8] Salisbury, F.B. & C.W. Ross. 1992. Plant Physiology. 4th. Ed.Wadsworth Publishing Company Bellmount, California. 681 p.
[9] Cooke, G. W. 1985. Fertilizing for maximum yield. Granada Publishing Lmt. London. p. 75-87.
[10] Sutedjo, M. M. and Kartasapoetra. 1990. Growing Corn. Spreaders. Jakarta. 59 p.
[11] Zubachtiroidin, M. S. P. and Subandi. 2007. Regional Production and Potential for Corn Development. In Sumarno, et.al. (Editor). Corn: Production and Development Techniques: 464-473. Food Crop Research and Development Center, Agricultural Research and Development Agency.
[12] Darmawan, J. and J. Baharsyah. 1993. Fundamentals of Plant Physiology. Bogor Agricultural Institute. Bogor. 88 p.
[13] Javid, Q.A., Abbasi, N.A., Saleem, N., Hafis, I.A., and Mughal, A.L. 2005. Effect of NPK Fertilizer on Performance of Zinnia (Zinnia elegans) Wirlyging Shade. International Journal of Agriculture and Biology Vol. 7 No. 3, 471-473.
[14] Lakitan, B. 2004. Fundamentals of Plant Physiology. Raja Grafindo Persada. Jakarta.
[15] Sintia, M. 2011. Effects of Several Doses of Rice Straw Compost and Nitrogen Fertilizer on Growth and Yield of Sweet Corn (Zea mays saccharata Sturt.). Food Crop Journal. 1-7 pp.