The effect of fertilizing residues on growth and yield of sweet corn

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Abstract. The application of organic and inorganic fertilizers is an effort to meet the needs of plant nutrients. Fertilization that has been done in the previous planting season is very possible to provide fertilizer residues that can be used for the next planting season (Second Planting Season). The purpose of this study is to determine the effect of organic and inorganic fertilizer residues that have been applied to the planting of shallots in the first planting season to the growth and yield of sweet corn in the second planting season. The study was conducted from November 2018 to January 2019 on farmer land located in Kotarindau Village, Dolo District, Sigi Regency, Central Sulawesi. The study used a non Factorial Randomized Block Design (RBD) with 4 residual treatments from the fertilizing dose in the previous planting season (treatment packages A, B, C, and D). To determine the effect of fertilizing residues on the growth and yield of sweet corn was carried out by analysis of variance. If the results of variance were significantly different, then to compare between treatments was done with Duncans New Multiple Range Test (DNMRT) at 5% level. The results showed that the application of organic and inorganic fertilizers in the first planting season was proven to be able to meet the needs of plant nutrients in the second planting season for each fertilizer treatment given in first planting season. Package A fertilizer residue gives the highest result on the growth and yield components and is not significantly different from the other three fertilizer package residues.

1. Introduction

Sweet corn is one of the preferred commodities because it has a sweeter taste than other types of corn and has a faster harvest age. However, sweet corn production from year to year has decreased. Sweet corn production in 2012 was 19,377,030 tons, in 2013 it was 18,506,287 tons, in 2014 it was 19,033.00 tons, and in 2015 it was 19,610,000 tons [1]. The decline in the level of production can be influenced by several factors, including a decrease in the level of soil fertility, the application of cultivation technology recommendations have not been applied appropriately, and the reduction in the land area resulting from the conversion of food crops to other uses. One effort to increase production levels is through the use of balanced and location-specific fertilizers, both organic and inorganic.

Fertilizer is one of the important factors in crop cultivation which aims to increase crop yields, but it must be accompanied by proper fertilizer management in order to obtain the expected crop yields and increase soil fertility [2, 3, 4]. The effect of fertilizer application also has a long-term effect on soil conditions. According to [5], a combination of NPK can increase crop yields, and also improve soil nutrients and soil fertility status for the long term. In other words, the fertilizer that given in the previous planting season is very possible to provide fertilizer residues that can be utilized for the next planting season. The effect of NPK fertilizer residues can have a positive impact as described by [6]
which states that the application of inorganic fertilizers such as NPK since the 1950s has an important role in increasing crop yields. On the other hand, excessive application of inorganic fertilizers can have a negative impact on the quality of soil properties, both physical, chemical and biological soil properties. But unlike the case with the effects of organic fertilizer application, its function can improve soil quality and its impact are felt in the long term. [7] showed that the application of manure by 2 tons/ha increased corn production by 6% in the first season, whereas in the second season by 40% in the treatment without and with organic fertilizer. Increased production between seasons has reached six times. This shows that the effect of organic fertilizer application is generally seen especially in the second planting season (residue). The purpose of this study is to determine the effect of fertilizer residues on the growth and yield of sweet corn in the second planting season.

2. Materials and Methods

2.1. Study Area

The study was conducted from November 2018 to January 2019. The location was carried out in the Farmers’ Land of Kotarindau Village, Dolo District, Sigi Regency, Central Sulawesi. The materials used are sweet corn seeds, herbicides, fungicides and insecticides, while the tools used are analytical scales, hoes, machetes, wood, ropes, buckets, hand sprayers, stationery, and cameras.

The study used a Randomized Block Design (RBD) with 4 (four) residual treatments of fertilizer doses in the previous planting season namely Package A (manure as much as 2 t/ha, plant spacing 10 cm x 10 cm, base fertilizer as much as 500 kg/ha Phonska, 200 kg/ha SP36, and 100 kg/ha KCl, the first supplementary fertilizer as much as 400 kg/ha NPK Mutiara, and 200 kg/ha ZA, and the second supplementary fertilizer dose as much as 400 kg/ha NPK Grower); Package B (manure as much as 3 t/ha, plant spacing 8 cm x 10 cm, base fertilizer as much as 400 kg/ha Phonska, 150 kg/ha SP36, and 100 kg/ha KCl, the first supplementary fertilizer as much as 300 kg/ha NPK Mutiara and 150 kg/ha ZA, and the second supplementary fertilizer dose as much as 300 kg/ha NPK Grower); Paket C (manure as much as 4 t/ha, plant spacing 10 cm x 15 cm, base fertilizer as much as 300 kg/ha Phonska, 100 kg/ha SP36, and 50 kg/ha KCl, the first supplementary fertilizer as much as 200 kg/ha NPK Mutiara and 100 kg/ha ZA, and the second supplementary fertilizer dose as much as 200 kg/ha NPK Grower); dan Paket D (manure as much as 1 t/ha, plant spacing 15 cm x 15 cm, base fertilizer as much as 250 kg/ha Phonska and 50 kg/ha SP36, the supplementary fertilizer as much as 150 kg/ha NPK Mutiara and 50 kg/ha ZA). Each treatment was repeated 5 (five) times so that the total treatment units were 20.

2.2. Research Implementation

Stages of the implementation of activities including (1) land preparation, (2) planting, (3) plant maintenance including watering, weeding, and controlling pests and diseases, (4) harvesting, and (5) data collection and analysis.

2.3. Data Collection and Analysis

The data observed included components of growth and yield of sweet corn plants, namely (1) plant height, (2) number of leaves (strands); 3) the height of the cob; (4) weight of cob with cornhusk; (5) weight of cob without cornhusk; (6) the length of the cob; (7) the diameter of a cob; and (8) number of lines. The observations were made at harvest time. To find out the effect of fertilizer residue on the growth and yield of sweet corn plants was done by the analysis of variance. If the results of the variance were significantly different, then to compare the average treatment was done with Duncans New Multiple Range Test (DNMRT) at 5% level.
3. Result And Discussion

3.1. Soil Research Conditions
The soil condition of this research location is important to be known as a determining factor for the growth of sweet corn plants, so it is necessary to do a soil analysis to find out some important elements of fertilizer residue in the second planting season. This soil analysis is carried out at harvest time in the first planting season. The results of soil analysis are presented in Table 1.

Table 1. The results of analysis of soil residue fertilization in first planting season

| Parameter       | Value | Criteria       |
|-----------------|-------|----------------|
| pH (H2O)        | 7.91  | Rather Alkaline|
| C-Organic (%)   | 1.75  | Low            |
| N-Total (%)     | 0.25  | Medium         |
| C/N             | 7     | Low            |
| K-Total (mg/100g) | 51    | Very high      |
| P-Total (mg/100g) | 72    | Very high      |

Table 1 shows that fertilizing residues in the previous planting season still contained nutrients needed by plants for the second planting season. This can be seen from the results of soil analysis, namely the acidity of the soil (pH) is rather alkaline, low of C-organic content, levels of N-total in the medium so that C/N is low, P-total and K-total are very high.

3.2. The Growth Components of Sweet Corn
Analysis of variance showed that fertilizer residue from the first planting season had a significant effect on plant height and height of cob, but not significantly affect the number of sweet corn plant leaves. Average plant height (cm), number of leaves (strands) and height of cob (cm) of sweet corn plants from fertilizing residues are presented in Table 2.

Table 2. The average of plant height (cm), number of leaves (strands) and height of cobs (cm) of sweet corn plants from fertilization residues in the second planting season in Kotarindau Village, Dolo District, Sigi Regency, 2018

| Treatments | Plant Height (cm) | Number of Leaves (strands) | Height of cobs (cm) |
|------------|-------------------|-----------------------------|---------------------|
| Package A  | 173.50 a          | 11.25 a                     | 80.00 ab            |
| Package B  | 158.50 b          | 11.25 a                     | 76.50 ab            |
| Package C  | 171.50 a          | 11.25 a                     | 84.25 a             |
| Package D  | 169.00 ab         | 11.00 a                     | 70.00 b             |

Note: The number followed by the same letter in the same column is not significantly different according to the DNMRT test at 5%

Table 2 shows that the highest sweet corn plant is 173.50 cm found in Package A fertilizer residue treatment and not significantly different with Package C and D fertilizer residue treatment, but significantly different with Package B fertilizer residue treatment. This is influenced by the number of plant populations found in Package B in the previous planting season which is higher than other package treatments, so that the competence in nutrient absorption is higher, which causes the high use of nutrients in the soil. The high plant population can be reflected in the spacing used, which is 8x10 cm, where the spacing has a higher density compared to other treatments. The height of sweet corn plant obtained was 173.50 cm, this almost reached the plant height in the description of sweet corn plant, which is 175-200 cm. his is influenced by organic and inorganic fertilizers that given in the first planting season where the residue is not sufficient for nutrient needs for plant growth in the second planting season. Plant growth will increase if the available nutrients are sufficient. One of the nutrient...
elements that play a role in the growth of plant height is the nutrient N which in Table 1 shows the total N-content in the soil is in medium level. The level of N nutrient content influences the process of cell division that affects the increase of plant height. Nitrogen plays a role in accelerating overall plant growth, including stems and leaves [8].

In the number of leaves parameters (Table 2), the results of analysis of variance showed that there were no significant differences shown by each treatment package of fertilizer residues. This is due to the number of leaves obtained is the maximum number of leaves in the maximum vegetative phase of sweet corn plants. According to the results of research by [9] about the response of the growth of sweet corn to the application of KCl and chicken manure, that the average number of leaves obtained at the age of 56 days after planting is around 10-11 strands.

While on the height of cob parameters (Table 2), the treatment of package C fertilizer residue gives the highest yield, which is an average of 84.25 cm and is not significantly different from the treatment of package A and Package B fertilizer residue, but it is significantly different from the treatment of Package D fertilizer residue. This is influenced by the dose of organic and inorganic fertilizers that given in the previous planting season is higher than other treatments, so that the availability of organic matter in the soil is higher to support plant growth. However, the results of the height of cob that obtained in the treatment of the package are in accordance with the description of sweet corn plants that are around 80 cm. This shows that the fertilizer residue can still be utilized and has an effective effect on the growth of sweet corn plants in the second planting season.

In general, there is an effect of fertilizer residue which is can be utilized to support the growth of sweet corn in the second planting season. This is indicated by the average on the growth component not significantly different from the growth of sweet corn in general. [10] As the results obtained by [10] about the results of the growth of sweet corn with the treatment of organic fertilizer types, where the average height of plants obtained ranged from 139 cm - 188 cm, the number of leaves ranged from 9 strands - 11 strands. Organic and inorganic fertilizers that applied to the soil play a role in improving soil quality. The intended soil quality is divided into the physical quality of the soil (structure, porosity, water binding capacity, and increased erosion resistance), soil chemical properties (improving soil pH, increasing soil C-Organic content, and increasing soil CEC), and soil biological quality (activity and population of soil microbiology). In sandy soils, organic matter can change soil structure from loose structure to crumb, thereby increasing the stability of soil aggregates, and increasing the class of soil structure from fine to medium or coarse to medium soil structure [11].

3.3. The Yield Component of Sweet Corn

Variance analysis results showed that the fertilizing residue in the first planting season significantly affects to the weight of cob with cornhusk, the weight of cob without cornhusk, and diameter of the cob, but no significantly different on the length of the cob. The average weight of cob with cornhusk, the weight of cob without cornhusk, the length of the cob, and the diameter of cob from the fertilizer residue treatment is presented in Table 3.

Table 3 shows that package A fertilizer residue produces the highest weight of cob with cornhusk and weight of cob without cornhusk, namely 454.82 g and 319.78 g and not significantly different from the treatment of Package B and Package D fertilizer residues. The results of the weight of cob that is 319.78 g have not yet reached the description of the sweet corn plant that is 475 g. This is caused by fertilizer residue in the second planting season which has not been able to increase the yield of sweet corn. The availability of more nutrients and tend to be excessive will also reduce the availability of other nutrients and cause nutrient conditions in the soil are not balanced. According to [12], excessive addition of nutrients through fertilization can be toxic, even causing the availability of nutrients Zn, Fe, and Cu to be reduced and make difficult the absorption of Mn, so plant growth will be inhibited. inhibition of plant growth will have an impact on crop yields, in this case, the weight of cob with
cornhusk and weight of cob without cornhusk. Another thing that can also affect the weight of cob beside the cornhusk is the length of the cob.

Table 3. The average weight of cob with cornhusk (g), weight of cob without cornhusk (g), length of the cob (cm), and diameter of the cob (mm) of sweet corn from fertilizer residues treatment in second planting season at Kotarindau Village, Dolo District, Sigi Regency 2018

| Treatments  | Weight of Cob With Cornhusk (g) | Weight of Cob Without Cornhusk (g) | Length of the Cob (cm) | The diameter of the Cob (mm) |
|-------------|---------------------------------|-----------------------------------|------------------------|-----------------------------|
| Package A   | 454.82 a                         | 319.78 a                          | 23.00 a                | 51.79 a                     |
| Package B   | 415.06 ab                        | 259.96 ab                         | 22.63 a                | 49.60 ab                    |
| Package C   | 398.61 b                         | 245.72 b                          | 23.00 a                | 45.82 ab                    |
| Package D   | 433.95 ab                        | 298.34 ab                         | 22.38 a                | 49.60 ab                    |

Note: The number followed by the same letter in the same column is not significantly different according to the DNMRT test at 5%

The weight of cob with cornhusk and weight of cob without cornhusk illustrates the amount of photosynthetic results that are transplanted to cobs [9], where the weight of the cob is directly proportional to the amount of photosynthate that translocated. Nutrients which play a role in the formation of chlorophyll are nitrogen nutrients (N). In the parameters of cob length (Table 3), it shows no significant effect on fertilizer residue treatment packages. The longest cob length is 23.0 cm. The average length of cob obtained from the research of (2018)[13] also ranged from 19-24 cm on 6 varieties of sweet corn tested. Factors that affect the length of cob and diameter of cob are derived from genetic factors, but the ability of plants to bring out their genetic character is greatly influenced by the agro-climate conditions [14].

In general, fertilizing residues from the previous planting season are effective in supporting growth and yield of plants in the second planting season, especially organic fertilizer and P nutrients which are slow release. Based on the results of [15], the interaction of residues from P nutrients and organic matter that derived from the previous planting season (dose of phosphorus 100 kg/ha and organic fertilizer 15 tons/ha) can increase the yield of green bean. So that the residue from the application of organic and P fertilizer is still effective in supporting plant growth and yield in the second planting season. According to [16], from the application of P fertilizer empirically it is known that less than 10% is absorbed by plants while the rest (90%) is fixed by clay minerals, iron oxides (hematite and gutit) and Al oxides (gibsite and buhmit), so there is a piling up of P. The use of organic fertilizers can increase the efficiency of absorption of P nutrients and other nutrients. This is influenced by the content of citric acids, oxalates, humic, fulfit, etc. which can increase the solubility of phosphate (P) in the soil.

4. Conclusion
Organic and inorganic fertilizer residues that applied in the first planting season are very effective in supporting the growth and yield of sweet corn plants in the second planting season. The results of the soil analysis showed that the residue from fertilizer application in the previous planting season could still be utilized by sweet corn for the second planting season, where the N nutrient content is in the medium category, while the P and K nutrient content is in the very high category. The treatment of package A fertilizer residue gives the highest result on growth component (plant height 173.35 cm, number of leaves 11.25 strands) and yield component (weight of cob with cornhusk 454.82 g, weight of cob without cornhusk 319.78 g, length of the cob 23 cm and the diameter of the cob 51.79 mm) and not significantly different from other fertilizer packages residues treatment.
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