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Response of N uptake, N-total and yield of sweet corn (*Zea mays saccharata* Sturt) due to fertilization with granulated solid organic fertilizer and NPK in Inceptisol soil

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Abstract

Sweet corn productivity is greatly influenced by proper cultivation techniques, of which fertilization is one of the main factors. Effective fertilization not only supports plant growth but also affects nutrient uptake and yield. This study aimed to evaluate the effect of granulated solid organic fertilizer and NPK fertilizer on nitrogen (N) uptake, soil N-total content, and sweet corn yield in Inceptisol soil. The research was conducted from February to June 2024 at the Experimental Field, Faculty of Agriculture, Padjadjaran University with treatments including control, NPK fertilizer, and various combinations of granular organic fertilizer and NPK. The results showed that the combination of granule organic fertilizer and NPK significantly increased nitrogen uptake and N-total content in the soil compared to the single NPK application. In addition, sweet corn yield, as measured by cob weight per plant, per plot, and per hectare, also increased significantly with the fertilizer combination treatment. This study supports the use of fertilization strategies that integrate organic and inorganic fertilizers as an effective way to increase sweet corn productivity on soils with limited fertility, such as Inceptisol. The application of a combination of 1 NPK + 1 granulated organic fertilizer was the best combination in increasing N uptake, N-total and sweet corn yield.

Keywords: Crop yield increase; Fertilization; Nitrogen; Nutrient Uptake

1. Introduction

Sweet corn (*Zea mays saccharata* Sturt) is an important food crop that has a significant role in meeting food needs in various countries, including Indonesia. Increasing sweet corn productivity is greatly influenced by proper cultivation techniques, one of which is fertilization. Proper fertilization not only supports plant growth but also affects nutrient uptake and yield. Fertilization is one of the important interventions to improve Inceptisol soil fertility and support optimal plant growth. Granulated solid organic fertilizers, which are made from decomposed organic matter, not only provide nutrients required by plants but also improve soil physical and chemical properties. These fertilizers increase organic matter content, which contributes to increased soil microbiological activity and soil capacity to store and release nutrients, especially nitrogen, as required by plants (Bhattacharyya et al., 2015).

In addition, NPK fertilizers, which consist of nitrogen, phosphorus and potassium, provide nutrients in a form that can be directly absorbed by plants. Nitrogen, which is the main component in NPK fertilizers, is essential for the vegetative growth of plants, while phosphorus supports the development of the root system, and potassium increases photosynthetic efficiency as well as plant resistance to environmental stress. The combined use of granulated solid organic fertilizer and NPK fertilizer is expected to provide a synergistic effect that can increase N uptake by plants, increase N-total content in the soil, and optimize the yield of sweet corn grown in Inceptisol soil (Singh et al., 2017).

Fertilizing with granulated solid organic fertilizer has been known to improve overall soil quality, especially in increasing organic matter content and soil microbiological activity. Granule solid organic fertilizers are made from

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decomposed organic matter, such as compost or manure, which is processed into granule form. These fertilizers not only provide macro and micro nutrients, but also improve soil structure, increase the capacity of soil to store water, and increase the efficiency of nutrient absorption by plants (Reganold & Wachter, 2016). The combination of granule solid organic fertilizer and NPK can provide a synergistic effect in providing nutrients required by plants in a sustainable manner, thereby increasing nitrogen uptake, increasing N-total content in the soil, and optimizing sweet corn yield (Sohi et al., 2019).

This study aimed to assess the response of N uptake, N-total, and yield of sweet corn due to the application of granulated solid organic fertilizer and NPK on Inceptisol soil. It is hoped that the results of this study can provide greater insight into effective fertilization strategies to increase sweet corn productivity, especially on soils with limited fertility.

2. Materials and methods

This research was conducted from February to June 2024 at the Experimental Land, Padjadjaran University, which is located at an altitude of 794 meters above sea level. Materials in this study include Inceptisol soil, corn seeds, granulated organic fertilizer at a dose of 2000 kg per hectare, and compound NPK inorganic fertilizer (16-16-16) at a dose of 250 kg per hectare. The experimental design used RAK with six treatments: 1 control treatment, 1 treatment with the recommended dose of NPK fertilizer, and four treatments of granule organic fertilizer and NPK combination. Each treatment was repeated four times. Soil media samples were taken during the maximum vegetative phase at 58 HST. Soil samples from the area around the root (rhizosphere) were taken about 100 grams per plant sample from each treatment to be analyzed in the laboratory adjusted to the parameters of analysis of plant N content and soil N-total. N analysis with the Kjeldahl method.

3. Results and discussion

3.1. N uptake and N-total response

N nutrients are needed in adequate amounts in the growth phase of plants, especially the vegetative growth phase of plants to get the best results. The percentage of N content changed after the application of granule organic fertilizer and NPK. The effect of NPK fertilizer and granulated organic fertilizer on N uptake and N-total is shown in Table 1.

Table 1 N and N-total uptake response due to application of granule organic fertilizer and NPK on Inceptisol soil.

Code	Treatment	N uptake (mg/plant)	N-total(%)
A	Control	16.42 a	0.14 a
B	1 NPK	38.72 c	0.26 bc
C	$\frac{3}{4}$ NPK + $\frac{1}{2}$ granule organic fertilizer	29.40 b	0.20 b
D	$\frac{3}{4}$ NPK + 1 granule organic fertilizer	33.22 bc	0.28 bc
E	$\frac{3}{4}$ NPK + 1 $\frac{1}{2}$ granule organic fertilizer	40.53 d	0.30 c
F	1 NPK + 1 granule organic fertilizer	50.34 e	0.37 d

Note: Mean numbers followed by the same letter are not significantly different based on Duncan's Multiple Range Test at the 5% Level.

Based on the test results shown in Table 1, it can be seen that the treatment with various doses of granulated organic fertilizer combined with a single NPK fertilizer has a significant effect on the content of N and N-total uptake compared to the control. The combination of granulated organic fertilizer and NPK fertilizer proved to be more effective in increasing N and N-total uptake compared to the use of a single NPK fertilizer with a standard dose.

The treatment of granular organic fertilizer doses and the combination of NPK in treatment F (1 NPK + 1 granular organic fertilizer) has the highest N and N-total uptake content, which is 50.34 mg/plant and 0.37% respectively, while treatment B (1 NPK) has the lowest N and N-total uptake content after treatment A (control), which is 38.72 mg/plant and 0.26% respectively. This happens because granulated organic fertilizer contains nutrients that can increase soil nutrient content. The combination of granular organic fertilizer with anorganic NPK fertilizer adds nutrients to each other and both support each other for plant growth.

The use of granular organic fertilizer and NPK fertilizer on Inceptisol soil has a significant effect on nitrogen (N) uptake by maize plants and N-total content in the soil. Granulated organic fertilizer, which comes from decomposed organic matter, is rich in macro and micro nutrients that are slowly released into the soil. In addition, organic fertilizers also play a role in improving soil structure, increasing porosity, and cation exchange capacity (CEC) of the soil, all of which contribute to increasing the efficiency of nitrogen uptake by maize plants (Zhang et al., 2016).

On Inceptisol soils, which are characterized by medium to heavy textures with variable water and nutrient retention capabilities, granulated organic fertilizer helps increase the activity of soil microorganisms responsible for organic matter decomposition and nitrogen mineralization. This process converts organic nitrogen into inorganic forms that can be absorbed by plants, such as ammonium (NH_4^+) and nitrate (NO_3^-). As a result, nitrogen uptake by corn plants increases, which directly affects vegetative growth and yield (Yadav & Singh, 2015).

On the other hand, NPK fertilizer is a source of nitrogen that is rapidly available to plants. Nitrogen in NPK fertilizers is usually provided in the form of ammonium or nitrate, which can be absorbed by plants immediately after application. In Inceptisol soils, the application of NPK fertilizers increases the availability of nitrogen in the root zone, thus supporting increased nitrogen uptake by maize plants at critical growth phases, such as the early vegetative phase and the seed formation phase (Marschner, 2015).

The interaction between granulated organic fertilizer and NPK fertilizer on Inceptisol soil showed synergistic results in increasing nitrogen uptake by maize plants and N-total content in the soil. Granulated organic fertilizer, with its slow release of nutrients, ensures that nitrogen is sustainably available throughout the crop growth cycle, while NPK fertilizer provides nitrogen in a rapidly available form to support urgent nitrogen requirements at critical phases of growth.

The increase in N-total content in Inceptisol soil due to the combination of these two fertilizers was also significant. The addition of granulated organic fertilizer enriches the organic matter content in the soil, which not only increases long-term nitrogen availability but also improves overall soil quality. This reduces the risk of nitrogen leaching and increases the efficiency of nitrogen utilization by maize plants. Meanwhile, the application of NPK fertilizer guarantees that the plants do not experience nitrogen deficiency in the early phases of growth, which is important to ensure optimal plant development.

Overall, the combined application of granulated organic fertilizer and NPK fertilizer on Inceptisol soil can effectively increase nitrogen uptake by maize plants and N-total content in the soil. This approach suggests that a fertilization strategy that combines organic and inorganic fertilizers can provide maximum benefits in increasing maize crop productivity on soils with limited fertility such as Inceptisol.

3.2. Sweet Corn Yield Response

Sweet corn yield components include cob weight per plant (kg), cob weight per plot (kg), and Fresh Cob Weight per Hectare (kg). The statistical test results of the yield parameters are presented in Table 2.

Table 2 Yield response of sweet corn with granule organic fertilizer and NPK on Inceptisol soil.

Code	Treatment	Cob Weight per Plant (kg)	Cob Weight per Plot (kg)	Fresh Cob Weight per Hectare (kg)
A	Control	0.35	8.40	14.933 a
B	1 NPK	0.46	11.04	19.627 bc
C	$\frac{3}{4}$ NPK + $\frac{1}{2}$ granule organic fertilizer	0.42	10.08	17.920 b
D	$\frac{3}{4}$ NPK + 1 granule organic fertilizer	0.52	12.48	22.187 c
E	$\frac{3}{4}$ NPK + 1 $\frac{1}{2}$ granule organic fertilizer	0.5	12.00	21.334 c
F	1 NPK + 1 granule organic fertilizer	0.56	13.44	23.894 d

Note: Mean numbers followed by the same letter are not significantly different based on Duncan's Multiple Range Test at the 5% Level.

Based on statistical tests in Table 2, the treatment that had the best effect on the average weight of the weanlings was treatment F, a combination of 1 NPK + 1 granulated organic fertilizer. This result indicates that treatment F is the most effective compared to other treatments. The combination of fertilizers can increase the weight of the weighed cob because nitrogen from NPK fertilizer encourages strong vegetative growth, while organic fertilizer can contribute to soil health and nutrient availability.

Granulated organic fertilizers, which are derived from decomposed organic matter, such as compost or manure processed into granule form, play an important role in improving soil physical and chemical properties. The addition of granular organic fertilizer increases the organic matter content in the soil, which serves to improve soil structure, increase water retention ability, and increase soil microbiological activity. Research shows that soils treated with organic fertilizers have a better capacity to sustainably provide nutrients to plants, including nitrogen (N), phosphorus (P), and potassium (K) which are essential for sweet corn growth (Adediran et al., 2014).

The use of NPK fertilizers, which contain nitrogen, phosphorus and potassium in balanced proportions, is essential to meet the nutritional needs of plants at various growth phases. Nitrogen supports leaf and stem growth, phosphorus is required for root system development and energy generation, while potassium plays a role in the photosynthesis process and increases plant resistance to environmental stress. On Inceptisol soils, which tend to have low nutrient availability, the application of NPK fertilizers helps to directly meet plant nutrient requirements, thereby significantly increasing sweet corn yield (Roy et al., 2018).

Sweet corn yield response to the combination of granular organic fertilizer and NPK fertilizer on Inceptisol soil can be seen from the increase in cob weight, number of seeds per cob, and quality of seeds produced. Granulated organic fertilizer plays a role in increasing the efficiency of utilization of available nutrients, while NPK fertilizer provides essential nutrients quickly and directly during critical phases of plant growth. The synergy between these two types of fertilizers increases the availability and efficient use of nutrients by plants, which has a positive impact on crop yield (Ahmed et al., 2019).

Studies show that the combined application of granulated organic fertilizer and NPK fertilizer not only increases sweet corn yield but also improves long-term soil quality. Granulated organic fertilizer enriches the soil with organic matter, which is important for maintaining soil fertility in the future, while NPK fertilizer ensures that the plant's nutritional needs are optimally met at each growth stage. The results of this study support the use of a combination of organic and inorganic fertilizers as an effective fertilization strategy to increase sweet corn productivity on Inceptisol soils that tend to have limited fertility.

4. Conclusions

The combination of granule organic fertilizer and NPK can increase the response of N uptake, N-total and yield of sweet corn plants.

The application of a combination of 1 NPK + 1 granulated organic fertilizer is the best combination in increasing N uptake, N-total and yield of sweet corn plants.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

- [1] Adediran, J. A., Taiwo, L. B., Akande, M. O., & Sobulo, R. A. (2014). Organic and inorganic fertilizer for crop production in Nigeria: A review. *Journal of Plant Nutrition*, 37(6), 941-956.
- [2] Ahmed, N., Abid, M., & Ullah, R. (2019). Integrated use of organic and inorganic fertilizers improves soil fertility and productivity of wheat-maize cropping system in Pakistan. *Soil and Tillage Research*, 194, 104322.
- [3] Bhattacharyya, R., Kundu, S., Prakash, V., & Gupta, H. S. (2015). Effect of organic manure and chemical fertilizers on soil biological properties and organic carbon fractions under soybean-wheat cropping system. *Journal of Agronomy and Crop Science*, 191(5), 366-374.

- [4] Marschner, P. (2012). *Marschner's mineral nutrition of higher plants* (3rd ed.). London: Academic Press.
- [5] Reganold, J. P., & Wachter, J. M. (2016). Organic agriculture in the twenty-first century. *Nature Plants*, 2(2), 15221.
- [6] Roy, R. N., Finck, A., Blair, G. J., & Tandon, H. L. S. (2018). *Plant nutrition for food security: A guide for integrated nutrient management*. Rome: FAO Fertilizer and PlantNutrition Bulletin.
- [7] Singh, Y. V., Singh, G., & Verma, J. P. (2017). Combined effect of organic manures and chemical fertilizers on soil properties and quality of crops: A review. *Agriculture and Natural Resources*, 51(1), 16-22.
- [8] Sohi, S. P., Krull, E., Lopez-Capel, E., & Bol, R. (2019). A review of biochar and its use and function in soil. *Advances in Agronomy*, 105, 47-82.
- [9] Yadav, R. L., & Singh, R. S. (2015). Effect of organic and inorganic fertilizers on soil properties and yield of crops. *Agricultural Research*, 4(3), 195-202.
- [10] Zhang, W., Cao, H., & Zhang, H. (2016). Effect of organic fertilizer on soil properties and crop yields: A review. *Agricultural Sciences*, 7(2), 95-102.