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Impact of Controlled Release NPK (16:16:16) Fertilizer on Soil Total Nitrogen Content, Nitrogen Uptake, and Growth of Sweet Corn (*Zea mays saccharata* L.) in Jatinangor Inceptisols

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The potential for sweet corn in Indonesia is very high, however, its cultivation often experiences problems, one of which is that the planting land has a low fertility level. Optimizing the use of

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fertilizer is one way to increase soil fertility and increase the growth of sweet corn. Using controlled-release NPK fertilizer is the best way to ensure that nutrient availability meets plant nutrient needs. This experiment aims to obtain the best effect and treatment of coating and time on total soil N content and N uptake of sweet corn plants. The experiment was carried out from June to September 2021 at the Experimental Garden and Laboratory of Soil Chemistry and Plant Nutrition, Department of Soil Science and Land Resources, Faculty of Agriculture, Padjadjaran University, Jatinangor. This experiment used a Split Plot Repeated Observation Design experiment over time with 12 treatment combinations and 3 replications consisting of 3 levels of coating treatment, namely without coating (C0), 5-6% coating (C1) and 11-12% coating (C2); and 4 treatment time levels, namely 15 days after planting (W1), 30 days after planting (W2), 45 days after planting (W3), and 60 days after planting (W4). The research results show that; (1) there is no interaction between the coating factor and the time factor on total soil N content and plant N uptake; (2) There is an independent influence of the coating factor on soil N-total and plant N uptake. Coating treatments of 5-6% (C1) and 11-12% (C2) produced lower total soil N content and plant N uptake compared to the treatment without coating (C0); and (3) There is an independent influence of the time factor on the total N content of the soil, but it has no significant effect on plant N uptake. The longer the application time is followed the higher the total N content of the soil and plant N uptake.

Keywords: *Sweet corn; NPK controlled release fertilizer; soil nitrogen total; plant nitrogen uptake; InceptisolS from Jatinangor.*

1. INTRODUCTION

Sweet corn (*Zea mays* saccharata L.) is an annual plant, one life cycle is completed in 80-150 days. The first half of the cycle is the vegetative growth stage and the second half is the generative growth stage. This plant has a sweet taste with a sugar content of 5-6% while ordinary corn has a sugar content of 2-3%. This sweet taste is preferred by people and can be consumed fresh or canned. It was reported by [1] that the potential yield of sweet corn could reach 14-18 tons/ha. The great potential contained in the sweet corn plant must be utilized optimally and appropriately. Sweet corn is increasingly being consumed in the form of roasted corn, boiled corn, sweet corn cakes, vegetable mixtures, cake ingredients, and so on, so it has good prospects for development to increase farmers' income.

Indonesia has great potential in the agricultural sector but is hampered by uneven soil fertility. Efforts to increase agricultural production can be carried out through intensification, extensification, and diversification. One type of soil that has the potential for expanding agricultural areas is Inceptisols. This land is widespread in Indonesia, namely around 20.75 million ha (37.5%) of Indonesia's land area, and has low natural productivity because it contains the essential nutrients Nitrogen (N), Phosphorus (P), and Potassium (K) was low, so fertilization is necessary [2].

Fertilization is carried out to provide and fulfill plant nutrient needs, inorganic fertilizers commonly used by farmers are NPK fertilizer in the form of Urea, SP-36, and KCl. The nutrients N, P, and K are essential nutrients for plants, so these elements must always be available in the soil [3]. Fertilizer application is sometimes ineffective and inefficient due to the washing process, fixation by soil particles, and volatilization. The problem of fertilizer inefficiency needs to be overcome by developing the latest fertilizer technology, namely the Controlled Release Fertilizer or CRF method [4,5].

Controlled release fertilizer (CRF) is a fertilizer that can control or slow down the release of nutrients for plant growth, because some elements are usually easily lost due to their high solubility in water, are volatile, and the denitrification process occurs in these fertilizers [6].

CRF fertilizer is made from ordinary compound NPK fertilizer plus a layer that can control the rate of release of fertilizer nutrients into the soil. This coating material has biodegradable properties. The majority of CRF fertilizers use coating technology with polymer materials [7]. Application of CRF fertilizer which contains the nutrients N, P, K, and Mg (compound) so that it can fulfill the nutrients needed by plants. [8] stated that CRF fertilizer is designed to produce plant nutrients that can be adapted to specific plants, growth stages, and climates.

CRF fertilizer can increase the efficiency of fertilizer use to increase plant productivity as well as the efficiency and quality of plant nutrient uptake. The use of CRF fertilizer can also reduce toxicity, plant stress, and pollution of groundwater, soil, and the atmosphere. In addition, fertilizer application costs are reduced because CRF fertilizer is only applied once in one crop season. The use of polymer-coated CRF fertilizer has attracted great attention because it can provide a gradual and consistent pattern of nutrient release to the soil. CRF can be a good alternative to replace conventional inorganic fertilizers while increasing the efficiency of nutrient absorption [9]. The use of CRF fertilizer can increase the efficiency of nutrient use at the end of the crop season. This statement is supported by research results [10] which show that compound NPK fertilizer coated with a 2% copolymer layer can reduce the release of P elements by 21.05% compared to compound NPK fertilizer not coated with copolymer which releases nutrients by 84.56%.

The research aimed to determine the effect of coating and time on soil total N content, N uptake, and growth of sweet corn plants; and to obtain coating treatment data and time that can increase soil total N content, N uptake, and growth of sweet corn (*Zea mays* sacharata L.) plants in Jatinangor Inceptisols.

2. METHODOLOGY

2.1 Time and Place

This experiment was carried out from June to September 2021 at the Soil Chemistry and Plant Nutrition Laboratory Experiment Field, Department of Soil Science and Land Resources, Faculty of Agriculture, Padjadjaran University, and soil, plant, and NPK fertilizer analysis was carried out at the Soil Fertility and Plant Nutrition Laboratory, Department of Soil Science and Land Resources, Faculty of Agriculture, Padjadjaran University.

2.2 Experimental Design

Split Plot Repeated Observation Design Experiment in Time (Repeated Measurement Design Split Plot in Time) consisting of (1) Coating factor (C) consisting of 3 levels of coating concentration percentage, namely: 0% (C0), 5-6% (C1), and 11-12% (C2); (2) the time factor consists of four levels of observation time, namely: 15 days after planting (W1), 30 days after planting (W2), 45 days after planting (W3), and 60 days after planting (W4), each combination The treatment was repeated three times, totaling 36 polybags.

2.3 Experimental Activities

The experimental activities carried out were:

2.3.1 Preparation of CRF fertilizer

The stages of preparing CRF fertilizer are (a) setting the coating parameters with a fluidized gas volume of 200 m/hour, compressed air pressure of 0.2 MPa, gas volume of 200 L/hour, and fluidized gas temperature of 85°C; (b) weigh 1.5 kg of large granular Urea, add it through the air outlet and preheat for 2 minutes; (c) spraying 10 g of liquid paraffin inside and urea pre-treatment with a treatment time of 2 minutes; (d) a weight of about 12 g PAPI and 30 g polyether polyol (hydroxyl value 160-170) corresponding to a mole ratio of isocyanate to polyol 1.1: 1, was added into the nozzle with a peristaltic pump at a rate of 0.4 g PAPI/min and 1 g polyether polyol/min, and spraying to coat through the nozzle; (e) spray 10 g of liquid paraffin after the reaction agent is added, and remove the sample after 2 minutes, then the experiment is completed, and (f) the entire coating process takes half an hour to complete. In the release process, no solidification adhesion occurs. Coating products are measured for release performance by the water immersion method.

2.3.2 Preparation of planting media

The planting medium used was taken around the experimental location, the soil was taken at a depth of 0-20 cm from the surface of the soil, then the planting medium was air-dried, pounded, and filtered using a 2 mm diameter sieve to obtain uniform soil grains, then the soil was weighed 10 kg and then put into each polybag measuring 30 cm x 40 cm, and labeled with the treatment.

2.3.3 Planting

Make a planting hole 3 cm deep in each polybag, then plant 1 seed in each polybag and then cover the planting hole again with soil.

2.3.4 Providing NPK CRF fertilizer

The application of NPK CRF fertilizer to each polybag is adjusted to the treatment. Fertilization is done only once, namely at planting time.

Fertilizer is given next to the planting hole or sideband at a dose of 300 kg ha-1 or 10 g per polybag for one season by recommendations from the Cereals Research Institute (2016).

2.3.5 Maintenance

Plant maintenance is carried out by watering, weeding, controlling plant pests, and replanting.

2.4 Observation and Sampling

2.4.1 Main data

The main data are (a) growth of plant height, stem diameter, and number of leaves at 14, 28, 42, and 56 days after planting; (b) sampling for total N analysis in the soil is taken from the soil in the area around the roots (rhizosphere). Soil samples were taken at 14, 28, 42, and 56 days after planting. Soil was taken from 3 planting holes according to the specified time, composited, put into a plastic bag amounting to ± 200 g, labeled and then analyzed in the laboratory; and (c) sampling for analysis of N uptake by sweet corn plants is taken at the maximum vegetative phase, leaf characteristics are taken at maximum vegetative time (third leaf from the bottom), where the vegetative growth phase will stop when entering the generative phase or when the first male flower appears sweet corn plants at 56 days after planting. Sampling was taken at three different coating percentage levels multiplied by four different time levels, totaling 36 samples.

2.4.2 Supporting data

Supporting data was initial soil analysis.

2.5 Data Analysis

To determine the effect of treatment on total soil N content and plant N uptake, experimental data were analyzed using variance and continued with the DMRT test at a 5% level [11]. Meanwhile, supporting data such as growth in plant height, stem diameter, The number of leaves, initial soil analysis, and soil pH were carried out through quantitative descriptive analysis.

3. RESULTS AND DISCUSSION

3.1 Initial Soil Analysis

Initial soil analysis results show that the soil has a sandy clay loam texture (55% sand, 34% silt, and 11% clay), an N-total content of 0.23% (classified as medium); P_2O_5 was 24.93 mg 100 g^{-1} (classified as moderate); 23.88 mg 100 g^{-1} K_2O (classified as medium) and the soil is slightly acidic with a pH of 6.25.

3.2 Plant Growth

3.2.1 Plant height

The results of measuring the height of sweet corn plants in various treatments are presented in Fig. 1.

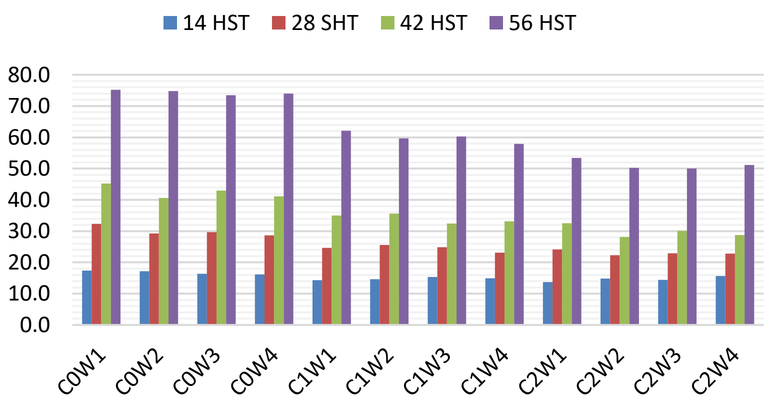

Fig. 1. Histogram of average height of sweet corn plants 14-56 DAP

Description: Treatment C0W1, C0W2, C0W3, and C0W4 (coating 0%); treatment C1W1, C1W2, C1W3, and C1W4 (coating 5-6%); and treatment C2W1, C2W2, C2W3, and C2W4 (coating 11-12%)

Based on Fig. 1, shows that the height of sweet corn plants at 14 days after planting tends to be uniform. This uniformity of sweet corn plant height is to the statement [12] that at the age of 14 days after planting, plants enter the stage of becoming new plants whose growth phase is slow because the roots have not yet developed so they are not actively absorbing nutrients. The height growth of sweet corn plants began to appear varied at the ages of 28, 42, and 56 days after planting. This is because plants require greater amounts of nutrients, so fertilization in this phase is necessary to meet the plant's nutrient needs.

The highest sweet corn plant growth during the maximum vegetative phase (56 days after planting) was produced in the C0W1 treatment, namely 75.30 cm, while the lowest was in the C2W3 treatment, namely 50.00 cm. This is due to the slow release of N nutrients in controlled-release NPK (16-16-16) fertilizer at a coating level of 11-12% which causes the availability of N nutrients in the soil to be low so that the nutrients that can be absorbed by plants to support growth are also low.

Based on Fig. 1, also shows that the greater the level of NPK fertilizer coating given, the lower the plant height. This is different from treatment with a coating level of 0%, producing taller plants.

3.2.2 Diameter of stem

The results of observations of stem diameter in various treatments are presented in Fig. 2.

Based on Fig. 2, shows that the greatest growth in stem diameter of sweet corn plants in the maximum vegetative phase (56 days after planting) was produced in the 0% coating level treatment, especially (C0W3), namely 14.97 mm. Meanwhile, the smallest growth in stem diameter was produced in the 11-12% coating treatment, especially C2W4, namely 10.58 mm. This is due to the treatment using controlled release NPK (16-16-16) fertilizer with a coating level of 11-12%, the release of nutrients from the fertilizer is slow so that the availability of nutrients, especially N, P, K, is also low and this results in stunted stem diameter growth. As stated by [13] the nutrients N, P, and K are important macronutrients for plants, especially in the vegetative growth phase. N, P, and K fertilizers are needed for plant growth, especially in stimulating the formation of plant height and enlargement of stem diameter.

3.2.3 Number of leaves

The experimental results of the average number of leaves of sweet corn plants observed in various treatments are presented in Fig. 3.

Based on Fig. 3, shows that the highest average number of leaves in the maximum vegetative phase (plant age 56 days after planting) was produced in the C0W4 treatment, amounting to 10.7 pieces. This is because in this treatment nutrient absorption occurs optimally. This increase in the number of leaves is in line with the results of research by [14] that the application of NPK fertilizer provides several leaves of 10-12 leaves when the plant is 60 days after planting. Meanwhile, the smallest number of leaves produced in the C2W3 treatment was 6.3 pieces. This is due to the slow release of controlled-release NPK (16-16-16) fertilizer nutrients with a coating level of 11-12% so that few nutrients are available in the soil. Research results [15] that

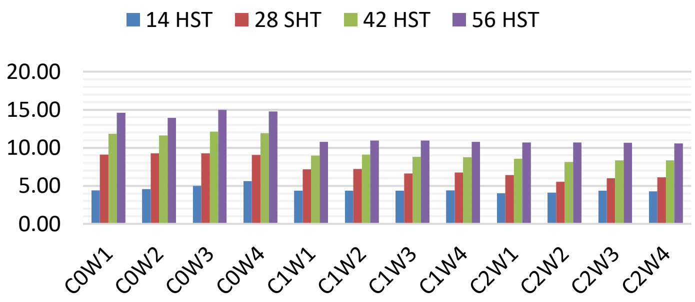

Fig. 2. Histogram of average stem diameter of sweet corn plants

Description: C0W1, C0W2, C0W3, and C0W4 treatment (0% coating); treatment C1W1, C1W2, C1W3, and C1W4 (coating 5-6%); and treatment C2W1, C2W2, C2W3, and C2W4 (coating 11-12%)

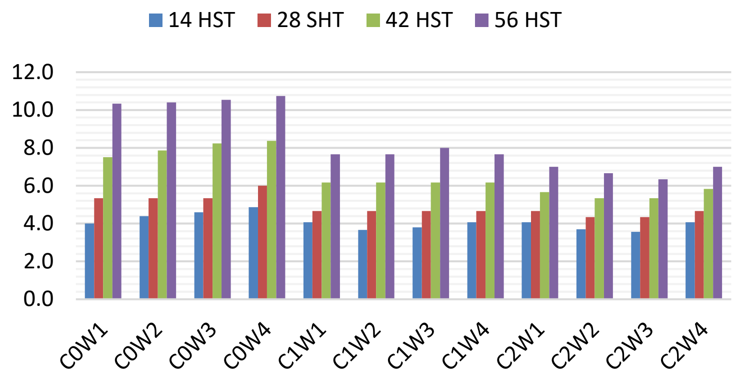

Fig. 3. Histogram of the average number of sweet corn plant leaves

Description: Treatment C0W1, C0W2, C0W3, and C0W4 (coating 0%); treatment C1W1, C1W2, C1W3, and C1W4 (coating 5-6%); and treatment C2W1, C2W2, C2W3, and C2W4 (coating 11-12%)

the use of NPK fertilizer coated with a coating consistently influences the growth of corn plants, including the growth of the number of leaves, stem, and root diameter. Furthermore, it was stated by [16] that the application of N, P, and K fertilizers resulted in 31.2% more leaves on sweet corn plants than without N fertilizer application.

3.3 Soil N-Total Content

The results of the analysis of variance showed that the treatment of the coating factor (C) and the time factor (W) had a significant effect, but there was no interaction effect between the coating factor and the time factor on the total N content of the soil. The experimental results of the effect of coating treatment (C) and time and their interaction on soil N-total content are presented in Table 1.

The experimental results in Table 1 show that the coating treatment affects the total N content in the soil, namely the thicker the NPK 16-16-16 controlled release fertilizer layer, the less N nutrients are released into the soil. Even though the 5-6% coating treatment (C1) and the 11-12% coating treatment (C2) are not significantly different, when compared with those without coating (C0), it shows that the nutrient release from fertilizer treated with the coating is less than fertilizer without coating. According to the CRF standard reported by [17], it can be said to be CRF if the nutrient release in CRF fertilizer is at least 75% after 40-360 days after application. The thickness of the fertilizer coating greatly influences nutrient release, as reported by [18] that the ability of the coating on CRF fertilizer to coat the surface of the fertilizer granule, where the ability of the granule structure to withstand water pressure was recorded, was observed after 6 months of the fertilizer granule being coated with the coating material not being destroyed. Furthermore, it was explained by [19] that when CRF is applied, the water in the soil will enter the fertilizer through the pores in the coating layer. Water that manages to enter the fertilizer core will dissolve the nutrients in the core and create osmotic pressure. The coating layer will withstand the osmotic pressure and nutrients will be released slowly through the coating pores.

In the treatment, the time factor influences the total N content in the soil, namely the longer the controlled release NPK (16-16-16) fertilizer is in the soil, the higher the release of N nutrients into the soil. The experimental results showed that the treatment 60 days after planting (W4) produced quite high soil total N content, namely 0.22% compared to the treatment 15, 30, and 45 days after planting, namely 0.13% respectively; 0.15%, and 0.18%. In line with the research report [20] that the release of layered Urea fertilizer increases over time, and [21] reports that the longer the time, the higher the solubility and the higher the mass of fertilizer that is transformed from the solid phase into the soil solution.

3.4 Plant N Uptake

The results of the analysis of variance showed that the treatment of the coating factor (C) and the time factor (W) had a significant effect, but there was no interaction effect between the coating factor and the time factor on the N uptake of sweet corn plants. The experimental results of the effect of coating treatment (C) and time and their interaction on the N uptake of sweet corn plants are presented in Table 2.

The experimental results in Table 2 show that the coating treatment factors influence the N uptake of sweet corn plants, the thicker the coating on the controlled release NPK (16-16-16) fertilizer, the smaller the nutrient release in the soil, and the smaller the N nutrient uptake by the plants. The 5-6% (C1) and 11-12 (C2) treatments released fewer nutrients than the C0 treatment, resulting in less plant N uptake, namely 1.44% and 1.28%, whereas in the C0 treatment, namely plant N uptake was 1.94%. As reported by [10] several factors can influence the release of CRF fertilizer, namely the interaction of the core material with the coating solution, the drying process, especially temperature, and the uniformity of the coating distribution. The structure of the CRF layer plays a role in controlling the diffusion rate, besides that the level of nutrient release in CRF depends on the porosity of the layer and also the layer thickness of each CRF grain. It was reported by [22] that the main factors influencing the nutrient release of CRF fertilizer are temperature and humidity and the type of coating also has an important role in the nutrient release mechanism.

The experimental results in Table 2 also show that the time factor influences the N uptake of sweet corn plants, the longer the time is followed the greater the N uptake by sweet corn plants. The greatest plant N uptake was produced in the treatment 60 days after planting, namely 1.72%, followed by the treatment 45, 30, and 15 days after planting, namely 1.62%, 1.50%, and 1.38% respectively. In line with the research results of [23] the release of the nutrient N decreased gradually over time with a release rate of 30% at the beginning of incubation until the second day and began to decrease slowly on the third day until it was exhausted on the 61st day and vice versa. The formation of ammonium and conversion to nitrate continues to increase until the end of the incubation period.

Table 1. Effect of coating treatment and time and their interaction on the N-total content of Inceptisols

Factor of Time	Factor of Coating (C)			Average of W
(W)	0% (c0)	5-6% (c1)	11-12% (c2)	Treatment
15 DAP(w1)	0,16	0,14	0,12	0,13 a
30 DAP(w2)	0,19	0,15	0,13	0,15 ab
45 DAP(w3)	0,24	0,17	0,15	0,18 bc
60 DAP(w4)	0,32	0,18	0,16	0,22 c
Average of C Treatment	0,23 b	0,15 a	0,14 a	

Note: The average value followed by the same letter notation at each level of the same treatment factor is not significantly different based on Duncan's advanced test at the 5% significance level. DAP = days after planting

Table 2. Effect of coating treatment and time and their interaction on N uptake of sweet corn plants on Inceptisols

Factor of Time	Factor of Coating (C)			Average of W
(W)	0% (c0)	5-6% (C1)	11-12% (C2)	Treatment
15 DAP(w1)	1,55	1,41	1,19	1,38
30 DAP(w2)	1,90	1,41	1,20	1,50
45 DAP(w3)	2,07	1,44	1,36	1,62
60 DAP(w4)	2,27	1,51	1,37	1,72
Average of C Treatment	1,94 b	1,44 a	1,28 a	

Note: The average value followed by the same letter notation at each level of the same treatment factor is not significantly different based on Duncan's advanced test at the 5% significance level. DAP = days after planting

4. CONCLUSIONS AND RECOMMENDATIONS

Based on the experimental results and discussion, conclusions are drawn, namely as follows:

1. There is no interaction between the coating factor treatment and the NPK fertilizer application time factor (16-16-16) on total soil N content and plant N uptake.
2. The independent factor of NPK fertilizer coating (16-16-16) has a significant effect on soil total N content and plant N uptake. The 5-6% (C1) and 11-12% (C2) coating treatments produced lower total soil N content and plant N uptake compared to the treatment without coating.
3. The independent factor of NPK fertilizer application time (16-16-16) had a significant effect on total soil N content but had no significant effect on plant N uptake. The longer the application time is followed the higher the total N content of the soil and plant N uptake.

5. SUGGESTIONS

Further experiments need to be carried out regarding the causes of controlled release of NPK (16-16-16) fertilizer nutrients at all coating levels and time does not have a significant effect on total soil N content and plant N uptake. Apart from that, it is recommended that research be carried out in the field by paying attention to field water capacity as a comparison, with the hope of strengthening information about the effect of using NPK (16-16-16) CRF fertilizer on the nutrient content in the soil of sweet corn plants.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Dedek I. Effect of gibberellic acid dosage and variety on the growth and yield of sweet corn (*Zea mays* L. saccharata Sturt) [thesis]. Dharma Wacana Metro College of Agricultural Sciences; 2016. Lampung.
2. Muyassir, Sufardi, Saputra I. Changes in the physical properties of Inceptisols due to differences in types and doses of organic fertilizer. Lantern. 2012;12(1):1-8.
3. Sofatin S, Betty NF, Yuliati M. Effect of a combination of NPK fertilizer and biological fertilizer on the total population of soil microbes and yield of sweet corn (*Zea mays* L. saccharata Sturt) in Jatinangor Inceptisols. Soilrens. 2016;14(2):33-37.
4. Hamzah M, Adiwirman, Fifi P. Interaction of controlled release fertilizer with soil conditioner on vegetative growth and nutrient uptake of nitrogen and phosphorus in oil palm seedlings. J Agrotek Tropika. 2015;4(1):16-23.
5. Mason MG, Brennan RF. Comparison of growth response and nitrogen uptake by canola and wheat following application of nitrogen fertilizer. Journal of Plant Nutrition. 1998 Jul 1;21(7):1483-99.
6. Tarida R, Dina KM. Elemental composition analysis of chitosan-silica-glutaraldehyde slow-release fertilizer. Unesa J Chem. 2018;7(1):21-24.
7. Rosjidi M, Saputra H, Wahyudi I, Setyorini D, Widowati LR. Controlled release fertilizer (CRF) for shallot plants. M I P I. 2018;12(3):191-196.
8. Rivaldi DS, Ninuk, Agung. The effect of controlled release fertilizer (CRF) application and planting system application on the viability of sugarcane seeds (*Saccharum officinarum* L.). J Crop Prod. 2019;7(3):429-436.
9. Wang C, Lv J, Coulter JA, Xie J, Yu J, Li J, Zhang C, Tang T, Niu T, Gan Y. Slow-release fertilizer improves the growth, quality, and nutrient utilization of wintering Chinese chives (*Allium tuberosum* Rottler ex Spreng.). Agronomy. 2020;10(3):381-399.
DOI: 10.3390/agronomy10030381.
10. Suardi M, Rahmayulis, Elfi SB, Akmal D. Slow-release NPK double coating granules using Biolends polystyrene-polycaprolactone as a coating polymer. IOSR J Agric Vet Sci (IOSR-JAVS). 2020; 13(4):59-64.
11. Gomez KA, Gomez AA. Statistical procedures for agricultural research [translated from Statistical procedures for agricultural research, translator: Sjamjuddin E, Baharsjah JS]. University of Indonesia; 2007. Jakarta.

12. Mahdiannoor N, Istiqomah, Syarifudin. Application of liquid organic fertilizer on the growth and yield of sweet corn plants. Ziraa'ah J. 2016;41(1):1-10.
13. Puspadewi S, Sutari W, Kusumiyati. The effect of organic liquid fertilizer concentration and N, P, K fertilizer dosage on growth and yield of sweet corn (*Zea mays* L. var. Rugosa bonaf) cultivar Talenta. J Cultivation. 2016;15(3):1-7.
14. Verdiana MA, Sebayar HT, Sumarni T. Effect of various doses of rice husk biochar and NPK fertilizer on the growth and yield of corn plants (*Zea Mays* L.). J Crop Prod. 2016;4(8):611-616.
15. Himmah NIF, Gunawan D, Darwaman. Nutrient release performance of starch-coated NPK fertilizers and their effects on corn growth. J Soil Sci Agroclimatol. 2018; 15(2):104-114.
16. Marlina N, Rosmiah, Marlina. Utilization of inorganic fertilizer types for sweet corn (*Zea mays* saccharata Sturt) in Lebak fields. In: Proceedings of the National Seminar on Suboptimal Land. 2016;442-447.
17. Liu G, Zotarelli L, Li Y, Dinkins D, Wang Q, Ozores M. Controlled-release and slow-release fertilizers as nutrient management tools; 2014.
18. Hamzah M, Eryanti K, Hidayat AS, Kurniawati F. Nutrient release characteristics of fertilizer coated with latex-chitosan. J Chem Mater Technol Center-TIEM, BPP Technology Puspiptek Serpong Area, Tangerang; 2018.
19. Beig B, Niazi MBK, Jahan Z, Hussain A, Zia MH, Mehran MT. Coating materials for slow release of nitrogen from urea fertilizer: A review. J Plant Nutr. 2020; 43(10):1510-1533.
DOI: 10.1080/01904167.2020.17446.
20. Kavessina M, Chitra H, Meylani TH. Smart urea controlled release nitrogen fertilizer using biodegradable polylactic acid plastic as a carrier. Equilibrium. 2017;16(2):40-44.
21. Shavit U, Shaviv A, Shalit G, Zaslavsky. Release characteristics of a new controlled release fertilizer. J Controlled Release. 1997;43:131-138.
22. Ali S, Danafar F. Controlled release fertilizer: Advances and challenges. Life Sci J. 2015;12(11):33-45.
23. Rosjidi M, Saputra H, Wahyudi I, Setyorini D, Widowati LR. Controlled release fertilizer (CRF) for shallot plants. M I P I. 2018;12(3):191-196.

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