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The Role of Inorganic Fertilizers in Corn Plant Growth

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Abstract: Inorganic fertilizers are critical for current agriculture, supplying vital nutrients that enhance plant development and increase crop yields. This study aimed to assess the impact of combining inorganic fertilizer on the optimal growth and yield of maize plants.This study used a Randomized Block Design (RBD) method using anorganicfertilizer, with the variation of doses inorganic fertilizer. The data collected from the parameters of plant height, number of leaves andyield parameters. The results of this investigation indicated that inorganic fertilizer significantly affects certain parameters. The use of inorganic fertilizer had significantly different outcomes compared to its non-application. The application of inorganic fertilizer at a dosage of 1 NP + 1 NK can improve the yield of sweet corn plants compared to the control and other treatments.

Keywords: Inorganic fertilizer, Sorption, Maize, Growth plant

1. Introduction:

These fertilizers are formulated to deliver precise amounts of nutrients like nitrogen, phosphorus, and potassium, which are vital for healthy plant development. Unlike organic fertilizers, inorganic fertilizers act quickly, making them ideal for addressing immediate nutrient deficiencies in soil. They help enhance soil fertility, ensuring that plants receive the nourishment they need to thrive, particularly in areas with poor or depleted soils[1]. Moreover, the use of inorganic fertilizers contributes to global food security by enabling farmers to produce higher yields on the same amount of land, thereby meeting the demands of a growing population[2]. However, their application should be managed responsibly to minimize environmental impacts, such as soil degradation or water pollution, and to promote sustainable agricultural practices.

Fertilizer is a material that enhances plant growth, productivity, and quality by augmenting nutrient availability and enhancing the chemical and physical characteristics of the soil [3]. Fertilization is the addition of more nutrients to the soil to enhance the yield of sweet corn plants[4]. The response of plants to fertilization is dependant upon soil type, various environmental factors, and the specific variety utilized. [5]argues that the production growth and quality of sweet corn yields are affected by two determinants: genetic variables and environmental factors, including soil fertility. Fertilization is conducted in a balanced manner based on plant requirements, taking into account the soil's natural nutrient supply, the sustainability of the production system, and the benefits for farmers. Phosphorus is a crucial element in substances involved in energy transfer (ATP and nucleoproteins), genetic information systems (DNA and RNA), cell membranes (phospholipids), and phosphoproteins. The annual utilization of fertilizers in agricultural production has escalated, necessitating regulations and standards to ensure optimal benefits for plant growth while preserving environmental sustainability.

2. Experimental Procedure

This experiment conducted using the experimental protocol with the effects of ten treatment combinations (each consisting of 7 treatments of doses inorganic fertilizer with content of NK, one treatment with the recommended fertilizer dose, and one control treatment (without fertilizer) on maize plants using a Randomized Block Design (RBD). This experiment repeated each treatment three times, resulting in a total experimental plot of twenty sevenplots. The experiment used a variety of materials, including inorganic fertilizer, urea, SP-36, KCl, soil from the Inceptisol order in Jatinangor (Picture 1), and sweet maize seeds. A variety of chemicals are required for soil analysis including chemistry and physics. For chemical analysis The total N was determined using the Kjeldahl method as an index for the N value [6]. Organic analysis for the C content used the Walkley and Black Method [7]. The soil pH was measured using a soil-water suspension ratio of 1:2.5 [8]. The available phosphorus was determined colorimetry using a spectrophotometer after the extraction of the soil samples, using 0.5 M sodium bicarbonate ($NaHCO_3$) at a pH value of 8.5, according to the Olsen extraction method [9]. We extracted the exchangeable basic cations (Ca, Mg, K, and Na) at a pH value of 7 using 1 N ammonium acetate [8]. We determined the exchangeable Ca and Mg from this extraction using an atomic absorption spectrophotometer, and the exchangeable K and Na from the same extract using a flame photometer. We determined the cation exchange capacity (CEC) of the soil by analyzing ammonium acetate-saturated samples. After removing excess ammonium through repeated alcohol washing, we replaced these samples with sodium from a percolated sodium chloride solution[8].The saturating the soil sample with a 1 M KCl solution and titrating it with 0.05 N NaOH to determine the exchangeable acidity. We extracted the exchangeable capacitance using an NH_4OAc (ammonium acetate) solution to achieve the maximum ex-change between NH_4 and the cations that originally occupied the exchange sites on the soil surface [8]. We determined the percentage base saturation by dividing the sum of exchangeable bases by the number of CEC. We employed the ethylene diamine tetraacetic acid (EDTA) method to extract soil micronutrient cations (Fe, Mn, Cu, and Zn) [8]. The extraction of fulvic acids (Sa-putro & Karmanto, 2020) employed a NaOH ratio of 1:10 (soil:extractor) to extract humic acids from the soil [10]. For physical analysis followed the procedure used H_2O_2 as an organic matter indicator in a pipette method to determine the soil composition. The method involved directly sampling soil particles from the suspension using a pipette at a fixed depth, h, and time, t [11]. We assessed the water content by conducting a gravimetric comparison between the mass and weight of the water in the sample before drying at 105 °C and the sample mass and weight after drying, until we achieved a consistent mass and weight [11].


Picture 1. Land Experiments

3. Result and Discussion

3.1 Quality Product of Inorganic Fertilizer

The fertilizer quality test findings indicated that the inorganic fertilizer contains a total nitrogen content of 18.17%, phosphorus (P_2O_5) of 46.90%, a water content of 0.68%, and metal concentrations of arsenic (As) at 0.00 ppm, mercury (Hg) at 0.00 ppm, lead (Pb) at 20.50 ppm, and cadmium (Cd) at 32.24 ppm. According to SNI 02-2858-2005 for Diamonium Phosphate Fertilizer, inorganic fertilizer is certified to fulfill the quality standards. The subsequent quality specifications for SNI 02-2858-2005 diammonium phosphate fertilizer.

a. Soil Analysis

The analysis of the soil utilized as a planting medium aims to ascertain its overall composition. The soil utilized is of the Inceptisols order, sourced from Jatinangor, Sumedang Regency. The soil study results indicate that this soil has beneficial characteristics for usage as a planting medium for sweet corn cultivation. The initial soil analysis results (Appendix 2) indicate a pH H_2O of 6.11, categorizing the soil as slightly acidic. The organic carbon content is 5.65%, classified as very high. The total nitrogen content is 0.41%, deemed moderate. The P-HCl content at 25% (P-potential) shows a high criterion of 45.17 mg 100 g-1. The P_2O_5 content (Bray) is at a low criterion of 5.74 ppm P, while the K2O HCl content at 25% has a moderate criterion of 31.77 mg 100 g-1. A test was done to assess the impact of inorganic fertilizer, which contains macronutrients, on the fertility of Inceptisols and the growth of sweet corn plants. The efficient application of fertilizer aligns with plant requirements, enabling optimal nutrient absorption and minimizing nutrient waste [12]. Deficiencies of specific nutrients in plants can lead to adverse effects, while excessive amounts might impair plant growth.

b. Plant Growth

The plant growth indicator from this experiments among others are plant height (Table 1).

Table 1. Plant Height

TREATMENTS	14DAP (cm)	28DAP (cm)	42DAP (cm)	56DAP (cm)
Control	9.4 a	10.8 a	45.1 a	121.3 a
NPK Standard	9.6 a	11.8 ab	56.3 b	142.3 b
¾ NP + ¾ NK	9.3 a	13.2 cd	58.5 bc	150.3 c

1 NP + ¾ NK	9.8 a	12.4 bc	59.6 bcd	152.4 cd
1½ NP + ¾ NK	11.1 b	12.8 bcd	61.0 bcd	153.8 cd
NP + 1 NK	11.1 b	13.2 cd	61.9 bcd	153.0 cd
¾ NP + 1 NK	10.8 b	13.6 d	62.9 cd	153.0 cd
1 NP + 1 NK	10.8 b	13.9 d	63.5 cd	155.9 d
1½ NP + 1 NK	10.8 b	13.7 d	64.6 d	154.6 cd

Information :DAP (day after planting)

The analysis of variance indicates that the application of inorganic fertilizer significantly influenced the average plant height from 14 DAP to 56 DAP in comparison to the control and standard NPK treatments. This transpires as enhanced plant growth unequivocally augments the roots' capacity to absorb nutrients, hence resulting in an increased quantity of nutrients assimilated by the plant[13]. The application of inorganic fertilizer effectively satisfies plant requirements by supplying nutrients in an accessible form, resulting in superior growth of plants compared to both the control treatment and standard NPK treatment.Treatment 1 NP + 1 NK yielded the maximum measurement of 155.9 cm at 56 hours post-treatment, whereas the control treatment recorded the minimum measurement of 121.3 cm. Plant height can be affected by nutrient availability in the environment, such as the provision of fertilizers that can be taken by the roots from the soil [14].

3.2 The Diameter of Plant

In general, the average of leaf plant parameter indicates that control and treated plants is not substantially different from 1 DAP to 7 DAP, start the 14 DAP the differences in amount of diameter of plant is shown in Table 3.

Table 3. Amount of Diameter of Plant

Treatments	14DAP	28DAP	42DAP	56DAP
Control	3.1 a	5.2 a	10.3 a	14.4 a
NPK Standard	3.5 b	5.5 ab	11.5 ab	17.1 b
¾ NP + ¾ NK	3.6 b	5.7 bc	12.9 bc	18.1 bc
1 NP + ¾ NK	3.8 b	5.5 ab	13.1 bc	18.4 bc
1½ NP + ¾ NK	3.6 b	5.7 bc	13.0 bc	18.9 cd
NP + 1 NK	3.6 b	5.7 bc	13.2 c	19.2 cd
¾ NP + 1 NK	3.6 b	5.8 bc	13.4 c	18.4 bc
1 NP + 1 NK	3.5 b	5.9 bc	14.1 c	20.0 d
1½ NP + 1 NK	3.6 b	6.0 c	13.0 bc	18.3 bc

Information : DAP (day after planting)

The analysis of variance indicates that the application of different doses of inorganic fertilizer substantially influenced stem diameter from 14 DAP to 56 DAP in comparison to the control and standard NPK treatments. The application of inorganic fertilizer resulted in a greater stem diameter than other treatments, observable from 14 DAP onwards. The combination of 1 NP and 1 NK yielded the greatest measurement of 20.0 mm at 56 DAP, whereas the control therapy recorded the lowest measurement of 14.4 mm. Observations of stem diameter indicated that the use of inorganic fertilizer might enhance the stem diameter of sweet corn plants. The occurrence is attributed to the presence of phosphorus and nitrogen in inorganic fertilizer, which fulfill the macro nutrient requirements of sweet corn plants. The synergistic relationship between phosphorus and nitrogen nutrients serves distinct purposes for plants. Nitrogen serves as a constituent of proteins, chlorophyll, amino acids, and various organic compounds, whereas phosphorus is integral to phospholipid nucleoproteins, sugar phosphates, and particularly in energy transport and storage, with the functions and roles of these materials and compounds mutually supporting and complementing one another[15].

3.3 The Average of Leaf

Statistical test findings indicate that the use of inorganic fertilizer significantly impacts the average leaf on sweet corn plants, as illustrated in Table 4.

Table 4. The Average of Leaf

Treatments	14DAP	28DAP	42DAP	56DAP
Control	4 a	5 a	7 a	8 a
NPK Standard	4 a	5 ab	9 b	10 b
¾ NP + ¾ NK	4 ab	5 ab	9 b	10 bc
1 NP + ¾ NK	4 ab	6 ab	9 b	11 bc
1½ NP + ¾ NK	4 ab	5 a	9 b	11 bc
NP + 1 NK	5 b	6 ab	9 b	11 bc
¾ NP + 1 NK	4 ab	5 a	9 b	12 bc
1 NP + 1 NK	4 ab	6 b	9 b	12 c
1½ NP + 1 NK	4 ab	5 ab	9 b	11 bc
Control	4 a	5 a	7 a	8 a

Information : DAP (day after planting)

The analysis of variance showed that the application of inorganic fertilizer doses significantly influenced the leaf count of sweet corn plants from 42 DAP to 56 DAP, while showing no significant effect from 14 DAP to 28 DAP.[16]assert that the correlation between fertilizer application and leaf quantity is often ambiguous, as leaf development is significantly influenced by genetic factors. At 56 DAP, the administration of inorganic fertilizer significantly influenced the leaf count in comparison to the control treatment and the normal NPK treatment. The application of inorganic fertilizer at a dosage of 1 NP + 1 NK resulted in the highest leaf count, totaling 12 leaves. Inorganic fertilizer includes nitrogen elements essential for plant growth and development. asserted that the application of nitrogen fertilizer to sweet corn plants is crucial, as nitrogen significantly influences plant growth by promoting the development of roots, stems, leaves, and enhancing plant height.[17]stated that the presence of adequate nitrogen ensures a balance in the ratio of leaves to roots, hence facilitating normal and optimal vegetative growth.

3.4 Yield Result

Based on the results of statistical tests that have been carriedout, the yield of plant shows a significant impact (Table 4).

Table 4. The Yield of Corn

Treatments	CD	CL	FCW	PCW	CWP
Control	37.7 a	18.6 a	367.9 a	286.1 a	6.92 a
NPK Standard	42.7 b	19.3 ab	409.1 b	314.8 b	10.48 cd
¾ NP + ¾ NK	47.1 c	19.6 ab	470.1 c	373.8 c	9.92 bc
1 NP + ¾ NK	47.2 c	19.4 ab	472.1 c	373.7 c	10.59 cd
1½ NP + ¾ NK	47.2 c	19.3 ab	468.5 c	375.9 c	11.02 d
NP + 1 NK	46.4 c	20.1 bc	470.9 c	371.1 c	9.46 b
¾ NP + 1 NK	47.0 c	20.8 cd	467.5 c	371.5 c	10.67 cd
1 NP + 1 NK	47.6 c	21.2 d	473.7 c	377.5 c	12.06 e
1½ NP + 1 NK	46.4 c	20.1 bc	464.1 c	374.2 c	10.62 cd

Information : The mean numbers followed by the same letter are not significantly different based on Duncan's Multiple Range Test at the 5% Level. CD = cob diameter (mm); CL = cob length (cm); FCW = fresh cob weight with husk (g); PCW = peeled cob weight (g); CWP = cob weight per plot (kg).

The statistical test results in Table 4 indicate that varying doses of inorganic fertilizer in each treatment produced significantly different outcomes in cob diameter, cob length, fresh cob weight, peeled cob weight, and cob weight per plot when compared to the control treatment. The treatment comprising 1 NP and 1 NK showed a greater cob diameter of 47.6 mm compared to the control treatment and standard NPK, which recorded the lowest cob diameter of 37.7 mm. Inorganic fertilizer, which contains phosphorus elements, can influence cob diameter, thus enhancing sweet corn production. The increase in cob diameter correlates with the availability of phosphorus components. Phosphorus nutrients can result in cobs with an increased diameter[18]. The diameter and length of the cob are critical factors influencing yield, since an increase in both dimensions correlates with a higher cob weight. The analysis of variance data indicated that the application of inorganic fertilizer significantly influenced the length of sweet corn cobs. The control treatment exhibited the shortest cob length at 18.6 mm, whereas the 1NP + 1 NK treatment demonstrated the longest cob length at 21.2 mm. This may occur due to the absence of supplementary fertilizer in the control treatment, which is essential for providing the nutrients required for plant growth and development. The presence of P elements as ATP precursors will ensure energy availability for growth, facilitating the effective production of assimilates and their transfer to storage. According to enough phosphorus (P) in corn plants enhances the development of maize cobs, resulting in larger sizes and fully populated rows of seeds.

The application of inorganic fertilizer doses substantially influenced the weight of fresh husked cobs, the weight of peeled cobs per plant, and the weight of cobs per plot. The treatment yielding the most significant results was the 1 NP + 1 NK treatment for the parameters of fresh husked cob weight, peeled cob weight per plant, and cob weight per plot, which were 473.7 g, 377.5 g, and 12.06 kg, respectively.Phosphorus (P) is essential for optimizing agricultural output and constitutes a significant input expense[19]. The optimal and balanced availability of nutrients in the inorganic fertilizer treatment can provide an appropriate equilibrium of macronutrients for plants. The development and maturation of fruit are significantly affected by the nutrients nitrogen (N), phosphorus (P), and potassium (K), which serve as constituents of carbohydrates, lipids, proteins, minerals, and vitamins that are transported to the fruit storage area. The heightened availability of minerals, particularly phosphorus, facilitates the development of fruit and seeds on the cobs. The P element can enhance plant productivity, augment yields, and expedite the maturation period of seeds and fruit.

4. Conclutions

1. The application of inorganic fertilizer yielded markedly different results compared to the absence of its application.
2. The application of the inorganic fertilizer at a dosage of 1 NP + 1 NK can enhance the production of sweet corn plants relative to the control compared to other treatments.

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Conflict of Interest

The authors certify that they do not have any competing interest to declare.

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