RESPONSE AND GROWTH OF SOME MAIZE VARIETIES \((\text{Zea mays L.})\) AT VARIOUS \(\text{KNO}_3\) CONCENTRATIONS

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ABSTRACT

This study aimed to determine the interaction effects of several maize varieties and \(\text{KNO}_3\) concentrations on maize production. The research was carried out from December 2020 to April 2021 at the Indonesian Cereal Research Institute Facility, Bajeng District, Gowa Regency, South Sulawesi \((5^\circ18'21.5''S, 119^\circ28'38.6''E)\). The study was designed using a split-plot experimental design, where the main plot was variety \((V)\) which consisted of 4 varieties \(V1\) (NASA -29), \(V2\) (JH -37), \(V3\) (BISI -2), and \(V4\) (Pioner P-35). The subplots were \(\text{KNO}_3\) \((K)\) concentration which consisted of 4 concentrations, namely Control \((K0)\), 2.5 \(g.L^{-1}\) \((K1)\), 5 \(g.L^{-1}\) \((K2)\), and 7.5 \(g.L^{-1}\) \((K3)\). Observational data were processed using ANOVA, and if there was a significant difference in the treatment, it was further tested with a 0.05 LSD follow-up test. The results showed that the JH-37 variety gave the best response, such as plant height, cob length, and production. The 7.5 \(g.L^{-1}\) \(\text{KNO}_3\) concentration gave the highest effect on all parameters of maize production; The interaction between the JH-37 variety with 7.5 \(g.L^{-1}\) \(\text{KNO}_3\) concentration gave the highest maize production; Parameters that have a positive correlation with maize productivity are expressed by plant height and weight of 1000 seeds.

INTRODUCTION

Maize \((\text{Zea mays L.})\) is one of the crops other than rice and wheat that are almost consumed by most of the population in various parts of the world. Data from Ministry of Trade Indonesia (2018) show that the national demand for maize reaches 15.50 million tons of dry shelled maize. Increment of maize production can be done with several methods, one of which uses hybrid varieties that have been proven to increase production, which is also supported by external factors such as fertilization to meet plant nutrient needs.

Potassium nitrate \((\text{KNO}_3)\) is a unique K source because of its nutritional value \((\text{it contains 38}\% \text{ K and 13}\% \text{ N})\) (El-Lethy, Abdelhamid, & Reda, 2013) and higher solubility in warm conditions (Singh, Singh, & Reddy, 2002). This fertilizer is also helpful to increase stem strength, prevent flower loss, improve fruit quality, and serve as a counterweight the excess nitrogen (Foth & Adisumarto, 1994). The \(\text{KNO}_3\) fertilizer is better to use than ZA or urea fertilizer because it can reduce soil pH and increase seedling height, leaf length, and the formation of leaves and roots numbers (Widistaetoey, 2007).

In addition to fertilization, using suitable varieties also will increase maize production. Variety is one of the many determining factors in plant growth and yield. In addition to environmental factors, high-yielding varieties are an essential technology component to achieve high production. Some of the maize varieties that have been cultivated include...
Sukmaraga, Lamuru, Bisi 18, Pioner, BISI 2, and Bima (Sutresna, Aryana, & Gunartha, 2018)

Research on the application of KNO₃ on hybrid maize varieties has not been done much because KNO₃ is more often used for horticultural crops or vegetable cultivation. Therefore, there are still vast opportunities for the use of KNO₃ fertilizer in the food crops such as maize. Based on the description above, the authors are interested in conducting research to determine the growth and production of various maize varieties using various KNO₃ fertilizer concentrations.

**MATERIALS AND METHODS**

**Materials**

The materials used are hybrid corn seeds, namely JH-37, NASA-29, BISI-2, PIONER-35, urea fertilizer, NPK Phonska (15:15:15) fertilizer, manure, KNO₃ fertilizer, water, and labels.

**Methods**

Land preparation was carried out with perfect tillage using a tractor, with a bed size of 4 × 5 with 1 meter between replicates. Maize seeds were planted at 75 × 20 cm. Planting holes were made individually; one hole was filled with one maize seed. Fertilizers used with recommended doses are Urea 300 kg.ha⁻¹, and NPK 350 kg.ha⁻¹ as basic fertilizer. Meanwhile, the concentrations of KNO₃ were 2.5 g.L⁻¹, 5 g.L⁻¹, and 7.5 g.L⁻¹. Spraying of KNO₃ was carried out on plants aged 10 DAP, 20 DAP, 30 DAP, 40 DAP, and 50 DAP. Weeds and Pests that exist should be cleaned so that the nutrients in the soil are not divided into other plants. Weeding was done when the plants are 1–4 weeks old. Harvesting was done when the plants show physiologically ripe signs. This sign was indicated by morphological characteristics, namely the leaves have started to turn yellow, the cob was yellowish-green, and the cob hair was brown, which was done manually by taking the maize cobs on each plant by turning the cobs with the cob, or it can also be done by broke the maize stalk which indicated by a black layer on the backside of the seed.

**Study Area**

This research was conducted at the Indonesian Cereal Research Institute Facility, Bajeng District, Gowa Regency, South Sulawesi Province (5°18’21.5”S, 119°28’38.6”E) at an altitude of 27.2 meter above sea level. This research took place from December 2020 to April 2021.

**Experimental Design**

This research was conducted using a split-plot randomized design. Maize variety (V) is used as the main plot and consists of 4 varieties, namely V1 (NASA-29), V2 (JH-37), V3 (BISI-2), and V4 (Pioner P-35). The subplots were KNO₃ (K) concentration which consisted of 4 concentrations, namely Control (K0), 2.5 g.L⁻¹ (K1), 5 g.L⁻¹ (K2), and 7.5 g.L⁻¹ (K3). Each combination is repeated three times so that there are 48 plots with a plot size of 4 × 5 m.

**Data Analysis**

Data were analyzed using an ANOVA, and if there was a significant difference in the treatment, it was further tested with a 0.05 LSD test. Observational data were analyzed using correlation analysis using Microsoft Office Excel.

**RESULT AND DISCUSSION**

**Plant Height**

The results of ANOVA showed that the interaction between maize varieties and KNO₃ concentration had a significant effect on plant height. Based on the 5% LSD test, it can be seen that the interaction between the JH-37 (V2) variety with 7.5 g.L⁻¹ KNO₃ concentration (K3) has the highest plant height (201.13 cm), while the interaction between the NASA-29 variety (V1) with 7.5 g.L⁻¹ KNO₃ concentration of (K3) resulted to the shortest plant height (175.80 cm).

The use of high concentrations of KNO₃ gave different results to the NASA-29 and JH-37 varieties. This proves that genetic characters in each variety give different responses to the given KNO₃ concentration level. In KNO₃ fertilizer, nitrogen (N) and potassium (K) are essential elements for the
plants. An optimal nitrogen dose will increase plant growth, while lack of nitrogen will decrease plants growth, and excess nitrogen will make plants easily fall (Syafuddin, 2015).

Cob Height

The results of ANOVA showed that the maize variety had a significant effect on cob height, while there was no significant interaction between the maize variety and the KNO₃ concentration. The BISI-2 (V3) variety cob height shows the highest (94.70 cm from the ground surface), while the lowest cob height from the ground is the P-35 (V4) variety (80.73 cm). The tendency of cob height is influenced by plant height in each variety which is used as one of the factors for providing nutrients to affect plant height increment. Wardani (2009) expressed the same phenomena, stating that the taller the plant, the higher the cob.

| KNO₃ Concentration | Variety                      | LSD (p) |
|--------------------|------------------------------|---------|
| K0 (Control)       | V1 (NASA-29)                 | 91.13   |
| K1 (2.5 g·L⁻¹)     | 83.00                        | 7.71    |
| K2 (5 g·L⁻¹)       | 86.07                        | 6.90    |
| K3 (7.5 g·L⁻¹)     | 86.17b                       | 3.81    |
| Average            | 86.17b                       | 3.81    |

The numbers followed by the same letter in the main plot column (a, b, c) means that they are not significantly different in the LSD 𝛼 = 0.05 test.

Stomata Density

Analysis of variance showed an interaction between maize varieties and KNO₃ concentration on the stomatal density parameter. The interaction between varieties P-35 (V4) with 2.5 g·L⁻¹ KNO₃ concentration (K1) resulted in the best stomata density (65.98/mm²), while the interaction between varieties P-35 (V4) with 7.5 g·L⁻¹ KNO₃ concentration resulted in the lowest stomata density (54.17/mm²).

The results in Table 3 show that the denser the stomata resulted in more stomata. The stomata function as a gas exchange for photosynthesis (Harrison, Cubas, Gray, & Hepworth, 2020). Stomata are closely related to the rate and intensity of transpiration in leaves. According to Passioua and Srifraker (1993), more pores on the leaf resulted in faster evaporation. If the holes’ gaps are close, then evaporation from one hole will inhibit the evaporation of the nearby hole.

The lack of nitrogen supply in maize plants can also affect the amount of chlorophyll in plants so that the rate of photosynthesis becomes less optimal. It was also found in the research of Mu, Chen, Chen, Yuan, and Mi (2016) that nitrogen deficiency will reduce the
amount of chlorophyll in the leaves, which leads to the photosynthesis rate decrease.

**Cob Length**

The ANOVA result in table 4 showed a significant interaction between maize varieties and KNO3 concentration to the cob length. The results found that the longest cob length resulted from the interaction between Varieties JH-37 (V2) with a 2.5 g.L⁻¹ KNO₃ concentration (K1) (20.87 cm).

The combination of maize varieties in accordance with the required nutrient resulted in the optimal length of the cob. This agrees with These results were closely related to findings of Oktem and Oktem (2005) who observed that increasing fertilizer concentration, will increased cob length, cob diameter and grains per cob.

| KNO₃ Concentration | Variety | LSD (p) |
|--------------------|---------|---------|
| K0 (Control)       | V1 (NASA-29) | 60.45ᵃᵃ  78.51ᵇᵇ  63.59ᵃᵃ  54.95ᵇᵇ |
| K1 (2.5 g.L⁻¹)     | V2 (JH-37)   | 60.45ᵇᵇ  57.31ᵇᵇ  61.23ᵃᵃ  65.98ᵇᵇ |
| K2 (5 g.L⁻¹)       | V3 (BISI-2)  | 65.16ᵃᵃ  56.52ᵃᵃ  58.09ᵇᵇ  63.59ᵇᵇ |
| K3 (7.5 g.L⁻¹)     | V4 (P-35)    | 65.94ᵃᵃ  59.55ᵇᵇ  60.45ᵃᵃ  54.17ᵇᵇ |

The numbers followed by the same letter in the main plot column (a, b), and subplot column (p, q) means that they are not significantly different in the LSDα = 0.05 test.

| KNO₃ Concentration | Variety | LSD (p) |
|--------------------|---------|---------|
| K0 (Control)       | V1 (NASA-29) | 19.00ᵇᵇ  18.47ᵇᵇ  18.20ᵇᵇ  20.07ᵃᵃ |
| K1 (2.5 g.L⁻¹)     | V2 (JH-37)   | 18.60ᵇᵇ  20.87ᵇᵇ  19.13ᵇᵇ  19.20ᵇᵇ |
| K2 (5 g.L⁻¹)       | V3 (BISI-2)  | 19.73ᵇᵇ  19.13ᵇᵇ  20.53ᵃᵃ  18.33ᵇᵇ |
| K3 (7.5 g.L⁻¹)     | V4 (P-35)    | 20.00ᵃᵃ  20.33ᵇᵇ  19.27ᵇᵇ  18.80ᵇᵇ |

The numbers followed by the same letter in the main plot column (a, b), and subplot column (p, q) means that they are not significantly different in the LSDα = 0.05 test.

**1000-Grain Weight**

Analysis of variance showed that there was an interaction between the maize variety and KNO₃ fertilizer concentration on the parameter weight of 1000 seeds. In table 5, the 1000-grain weight parameter shows the interaction between varieties BISI-2 (V3) with 5 g.L⁻¹ KNO₃ concentration (K2) with an average of 300.71 g. Genetic characters in varieties that match the right nutrient concentration can make the weight of each maize kernel fuller, and large or dense so that it can contribute to the weight of yield per plot and productivity. This is in line with Ferayanti and Idawanni (2021) opinion that the difference in 1000 grain weight is closely related to the characteristics of each variety related to its ability to absorb nutrients during its growth period. The increase in 1000 grain-weight is also related to the magnitude of photosynthate translocation into the seeds and the plant root system’s ability to absorb nutrients from the soil.

**Productivity**

Analysis of variance in Table 6 showed significant interaction between maize varieties and KNO₃ concentration on productivity parameters. The productivity parameter shows that the interaction between the JH-37 (V2) variety with 7.5 g.L⁻¹ KNO₃ concentration (K3) produces the best average productivity (9.32 t.ha⁻¹), for the lowest
productivity result is the interaction between the NASA-29 variety (V1) with 2.5 g.L⁻¹ KNO₃ concentration (K1) with average productivity of 6.13 t.ha⁻¹. This is in accordance with the result of Pangaribuan et al. (2017) which stated that KNO₃ fertilizers can increase maize productivity.

### Table 5. The average 1000-grain weight (g) in various maize varieties and KNO₃ concentrations

| KNO₃ Concentration | Variety       | LSD (p) |
|-------------------|---------------|---------|
|                   | V1 (NASA-29)  | V2 (JH-37) | V3 (BISI-2) | V4 (P-35) |
| K0 (Control)      | 274.27ᵃᵇ      | 271.84ᵇרות | 284.23ᵇרות | 292.48ᵇרות |
| K1 (2.5 g.L⁻¹)    | 267.82ᵇרות   | 297.83ᵃᵇ | 297.15ᵃᵇ | 287.93ᵃᵇ |
| K2 (5 g.L⁻¹)      | 296.75ᵃᵇ      | 290.20ᵇרות | 300.71ᵃᵇ | 276.75ᵇרות |
| K3 (7.5 g.L⁻¹)    | 294.54ᵃᵇ      | 300.06ᵇרות | 294.77ᵃᵇ | 290.40ᵇרות |
| LSD (v)           | 18.16         | |

The numbers followed by the same letter in the main plot column (a, b), and subplot column (p, q) means that they are not significantly different in the LSD α = 0.05 test.

### Table 6. The average productivity (t.ha⁻¹) on various maize varieties and KNO₃ concentrations

| KNO₃ Concentration | Variety       | LSD (p) |
|-------------------|---------------|---------|
|                   | V1 (NASA-29)  | V2 (JH-37) | V3 (BISI-2) | V4 (P-35) |
| K0 (Control)      | 6.16ᵇרות    | 8.50ᵃᵇʰרות | 7.49ᵃᵇ | 8.74ᵃᵇ |
| K1 (2.5 g.L⁻¹)    | 6.13ᵃᵇ      | 9.04ᵃᵇʰרות | 7.87ᵃᵇ | 8.27ᵃᵇʰרות |
| K2 (5 g.L⁻¹)      | 7.02ᵃᵇʰרות | 7.91ᵇרות | 8.40ᵇורים | 8.00ᵇ褚 |
| K3 (7.5 g.L⁻¹)    | 7.85ᵃᵇʰusaha | 9.32ᵃᵇʰusaha | 7.86ᵃᵇʰusaha | 8.20ᵃᵇʰusaha |
| LSD (v)           | 1.05         | |

The numbers followed by the same letter in the main plot column (a, b), and subplot column (p, q) means that they are not significantly different in the LSD α = 0.05 test.

### Table 7. Correlation between observation character and productivity

| Characters | PH | CH | SD | PT | B-1000 | P |
|------------|----|----|----|----|--------|---|
| PH         | 1.000 |    |    |    |        |   |
| CH         | 0.766 | 1.000 |    |    |        |   |
| SD         | 0.604 | 0.565 | 1.000 |    |        |   |
| PT         | 0.576 | 0.719 | 0.347 | 1.000 |        |   |
| B-1000     | 0.647 | 0.832 | 0.977* | 0.236 | 1.000 |   |
| P          | 0.985* | 0.566 | 0.816 | 0.538 | 0.959* | 1.000 |

*Significant at 5% level, PH = Plant height, CH = Cob height, SD = Stomata density, PT = Cob length, 1000 = Weight of 1000 seeds, P = Productivity.

**Correlation between Characters**

Correlation between characters in plants can be used as the basis for an efficient selection program, such as in maize (Ogunniyan & Olakojo, 2014), rice (Okasa et al., 2021), and wheat (Mecha, Alamerew, Assefa, Assefa, & Dutamo, 2017). Table 7 shows the correlation coefficient value, which
shows the relationship between the observed characters.

Characters that have a positive correlation with production are the character of plant height and weight of 1000 seeds. Plant height can maximize the absorption of sunlight to maximize seed production. This is in accordance with Herawati and Efendi (2017), which states that higher plants can absorb more sunlight, resulting in a higher photosynthesis rate, leading to increment seed yield and translocation for seed formation in the generative phase. While the positive correlation between the character of the 1000-grain weight with productivity is also found in the research of Mohsin, Ahmad, Farooq, and Ullah (2014), that stating character the 1000-grain weight have significant correlation with productivity.

CONCLUSION

We concluded that the JH-37 variety gave the best response to plant height parameters, cob length and production. The 7.5 g L⁻¹ KNO₃ concentration gave the highest effect on all parameters of maize production. The interaction between the JH-37 variety with 7.5 g L⁻¹ KNO₃ concentration gave the highest maize production. Parameters that positively correlate with productivity are plant height and 1000-grain weight.

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