



Response of Superior Maize Varieties to Different Combination of Inorganic and Organic Fertilization

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Abstract

Productivity of superior genotypes often did not satisfyingly achieve its genetic yield potential. Interaction between genetics and environmental factors more likely to driven the final yield of the varieties. The concept of balanced fertilization is carried out by referring to the creation of a balance of macro-nutrients in the soil so that plants can produce optimally. The research was conducted in a form of experimental study at Tarowang village, Takalar Regency during growing season of 2021 from May to September 2021. A split plot design was used with fertilization package as the main plot and superior varieties as subplots. Three fertilization packages combined inorganic and organic fertilizer were used, namely fertilization package consisted of N: P: K with ratio of 225:100:75, fertilizer package that consisted of N: P: K ratio of 200:100:50 + KNO_3 25 kg + Biotani 5cc L^{-1} , and fertilizer package that consisted of N: P: K with a ratio of 200:100:50 + KNO_3 25 kg + Ecofarming 5cc L^{-1} . Six superior varieties used were Nasa 29, JH-37, Bisi 2, Bisi 18, SINHAS 1 and NK7328. Based on the level of both factors, 18 treatment combinations were obtained and repeated three times. Responses of maize varieties to fertilization packages, consisted of different combination and dosage of NPK fertilizers, KNO_3 and organic fertilizers, were varied between varieties. The treatment of fertilization package of N: P: K = 225:100:75 with Bisi 2 variety gave the highest maize productivity, namely 12.39ton ha^{-1}

Keywords: maize, balanced fertilization, superior varieties, inorganic fertilizers, organic fertilizers

A. Introduction

One of the efforts implemented by the Indonesian government to increase the productivity of Maize is plant breeding. This strategy has been implemented and has taken part in the maize self-sufficiency program in order to meet the national demand for the commodity. Despite many high yielding varieties have been released by the Ministry of Agriculture with different superior characters to adapt with diverse growing conditions, in fact the productivity of these superior genotypes often did not satisfyingly achieve its genetic yield potential. Interaction between genetics and environmental factors more likely to driven the final yield of the varieties. If the management of the growing environment is not carried out properly, the high yield potential of these superior varieties cannot be achieved. High genetic potential can only be obtained if environmental conditions, lights, water, and soil nutrient status, support growth and production. In order to optimize this growing conditions, technology on the management farmer used is need to be taken into account. Fertilization package is one of main factors that can provide a good nutrient absorption.

Under conditions of available soil nitrogen, it can improve plant appearance and cob formation. Therefore, additional KNO_3 fertilization and Ecofarming organic fertilizer were carried out to overcome the availability of nutrients in corn plants. The addition of KNO_3 is preferred over KCl because KCl contains chloride which can poison plants if the concentration is more than 0.1%. KNO_3 is very effective to use because the K_2O content is between 45-46% which can improve fruit quality during the generative period of plants (Marschner, 2012). In sweet corn, it can increase the filling of seeds, the number of seeds and the length of the rows of seeds. This is because KNO_3 reacts neutrally so it is more effective to use than urea as a nitrogen source in acidic soils (Widiastoety, 2007). In order to balance the ecosystem, Eco Farming organic fertilizer is added which can improve soil texture and is able to meet the 13 nutrients needed by various plants, so as to increase production by 50 to 100% (Anonymous, 2019).

Balanced fertilization is a combination of inorganic and organic fertilizers. The combination of inorganic and organic fertilizers aims to meet the nutritional needs of sweet corn plants through high and balanced nutrient content in inorganic fertilizers and maintain soil fertility and provide macro and micro nutrients for plants in organic fertilizers. In addition, organic fertilizers applied to the soil will affect the physical, chemical and biological properties of the soil, play a role in soil mineral decomposition, plant nutrient sources, form a stable soil structure and have a direct influence on plant growth and development (Soepardi, 1982).

Cow urine liquid organic fertilizer contains high nitrogen and potassium, as well as growth stimulants that can be used as growth regulators including IAA and can accelerate seed filling on corn cobs. It was further explained that cow urine also had a positive effect on the vegetative growth of corn plants. Normal urine contains a very complex chemical composition, namely: water, urea, creatinine, allanthion, hippuric acid, ammonia, amino acids, sulfates, sulfur, organic salts, urochrome pigments, urobilins (Masparry, 2011). According to Sutedjo (2010) that cow urine has fast-acting properties and can stimulate plant development so as to increase plant production.

The nutrient content of cow urine, especially the amount of nitrogen, phosphorus, potassium, and water is higher than that of solid cow dung which has been used more as organic fertilizer. Cow urine contains growth-stimulating substances that can be used as growth regulators, including IAA. Because of the distinctive smell of livestock urine, it can also prevent the arrival of various plant pests so that cow urine can also function as plant pest control from attacks (Sudiro, 2011).

In the study of Tandisau & Thamrin (2005) regarding the application of complete fertilizers N, P, and K (200:35:100) showed the highest average yield (5.5 t/ha). Purwanto, J. K., K. Agustina & Yursida (2014) showed that sweet corn plants given 50% recommended dose of inorganic fertilizer and cow urine produced 10 -12 tons/ha higher than the national average corn productivity (4.5 tons/ha). The results of Pangaribuan, D.H., Sarno, Kurniawan, M.C. (2017) showed that the use of liquid fertilizer cow urine 7 ml/l or a concentration of 7,000 ppm with application times of 2, 4, 6 and 8 weeks after planting showed that the dose gave production results (11.02 tons/ha) which is better than control (7.3 tons/ha), so this treatment is recommended to sweet corn farmers. Cow urine liquid fertilizer should be applied at intervals of 2 weeks from the beginning of the vegetative growth phase (2 WAP) to the beginning of the generative phase (8 WAP). Yenni & Yayuk's (2015) research on optimizing sweet corn

production using organic and inorganic fertilizers resulted in the highest average production of 12.57 t/ha at 200 kg/ha NPK+10 t/ha manure treatment.

The concept of balanced fertilization is carried out by referring to the creation of a balance of macro-nutrients in the soil so that plants can produce optimally. The comparison between N:P:K elements will determine the ability of maize plants in genetic expression to optimally produce prolific cobs, so that the percentage of prolific produced is higher. In order for the potential yield to be more optimal, it is necessary to add organic fertilizer as additional nutrients in the form of biological fertilizers such as the use of eco farming. A research is necessary to be undertaken to study fertilizer package model that provides high productivity (≥ 12.5 t/ha) for each maize variety.

B. Methodology

1. Research Methods

The research was conducted in a form of experimental study at Tarawang village, Takalar Regency during growing season of 2021 from May to September 2021. A split plot design was used with fertilization package as the main plot and superior varieties as subplots. Three fertilization packages combined inorganic and organic fertilizer were used, namely fertilization package P1 consisted of N: P: K with ratio of 225:100:75, fertilizer package P2 that consisted of N: P: K ratio of 200:100:50 + KNO_3 25 kg + Biotani 5cc L⁻¹, and fertilizer package P3 that consisted of N: P: K with a ratio of 200:100:50 + KNO_3 25 kg + Ecofarming 5cc L⁻¹. Six superior varieties used were Nasa 29, JH-37, Bisi 2, Bisi 18, SINHAS 1 dan NK7328. Based on the level of both factors, 18 treatment combinations were obtained and repeated three times resulted in 54 experimental units.

Maize were planted using Legowo planting system of (50 + 100) x 20 cm. Soil tillage were conducted using a maximum tillage prior to setting the experimental plots with a size of 3,5 m x 5 m per plot. Maize seeds were planted in five rows on each plot according to the Legowo planting system. Two seeds were planted in the planting hole using a planting stick and covered with compost subsequently with a total of 1.7 kg/plot or 3 ton.ha⁻¹.

Fertilization were applied with dosage according to treatment. Eco farming and Biotani organic fertilizers were sprayed five times prior to planting at 2 days before planting, and following planting at 10 days after planting (DAP), 30, 50, and 70 DAP. Urea, NPK Ponska and KNO_3 were at the 7, 35, and 50 DAP, except for the SP36 fertilizers that was given once at 7 DAP. Weeding was done by clearing weeds around the plants, while mulching was carried out by elevating the mounds and loosening the soil to create better soil aeration. The first weeding was done before the second fertilization, while the hoarding was done after the second fertilization. Harvesting was conducted when the plant is physiologically ripe which is indicated by the appearance of a black layer on the back side of the seeds. Harvesting was done manually on two middle rows of plants per number and then processed for observation of yield and other yield components.

2. Data Analysis

Data analysis was conducted using Analysis of variance (ANOVA) on growth and production parameters. A further test was conducted on parameters with significant effect of the treatments using Least Significance Difference (LSD) test at a level of confidence of 95%.

C. Result

1. Effect of Fertilization packages on Growth of Maize Superior Varieties.

Use of different packages of fertilization that combined inorganic (N,P,K and KNO_3) and organic (Ecofarming/Biotani) significantly affected the growth of various type of superior maize varieties (Tables 1, 2, and 3). Nevertheless, plant height of the maize varieties were determined by the effect of genetic variability of the varieties rather than the fertilization applied (Table 1). Analysis of variance show that plant height varied significantly between varieties. Tallest plant was shown by JH-37 that was not significantly different from other varieties except SINHAS 1 that slightly shorter compared to other varieties. On the other hand, no significant difference between the varieties was found in the parameter of number of leaves. In this parameter, the fertilization package significantly affected the values (Table 2). Application of single N, P, and K resulted in the highest number of leaves (12.48 leaves) compared to other fertilization package that combined the NPK fertilizer with KNO_3 and organic liquid fertilizers. The lowest leaves number was shown by the application of NPK (200:100:50), added by KNO_3 25 kg and Biotani 5cc L⁻¹.

When Ecofarming fertilizer used as the substitute of the Biotani fertilizer at the same concentration, it resulted in a value that did not differ with the fertilization package that gave the highest number of leaves.

Table 1. Average plant height (cm) of superior maize varieties on various fertilization packages.

	P1	P2	P3	Average
V1 (Nasa 29)	230.33	239.33	243.33	237.66 ab
V2 (JH-37)	259.34	248.67	254.22	254.08 a
V3 (Bisi 2)	254.33	254.44	250.78	253.18 a
V4 (Bisi 18)	243.89	244.11	251	246.33 a
V5 (SINHAS 1)	228.78	223.33	221.89	224.67 b
V6 (NK7328)	249.67	238.11	245.89	244.56 a
Average	244.39	241.33	244.52	
LSD _{0.05} (V)	19.73			

Numbers followed by the same letter in a column (a, b) are not significantly different based on LSD test at $\alpha = 0.05$. P1=N : P : K (225:100:75), P2=N : P : K (200:100:50) + KNO₃ 25 kg + Biotani 5cc L⁻¹; P3=N : P : K (200:100:50) + KNO₃ 25 kg + Ecofarming 5cc L⁻¹

Table 2. Average leaves numbers (leaves) of superior maize varieties on various fertilization packages.

	P1	P2	P3	Average	LSD _{0.05} (P)
V1 (Nasa 29)	11.89	11.56	11.89	11.78	0.50
V2 (JH-37)	12.44	11.44	11.44	11.78	
V3 (Bisi 2)	13.00	11.67	12.33	12.33	
V4 (Bisi 18)	12.89	11.89	12.56	12.45	
V5 (SINHAS 1)	12.22	11.33	11.33	11.63	
V6 (NK7328)	12.44	12.44	12.78	12.56	
Average	12.48 p	11.72 q	12.06 pq		

Numbers followed by the same letter in a column (a, b) are not significantly different based on LSD test at $\alpha = 0.05$. P1=N : P : K (225:100:75), P2=N : P : K (200:100:50) + KNO₃ 25 kg + Biotani 5cc/L; P3=N : P : K (200:100:50) + KNO₃ 25 kg + Ecofarming 5cc/L.

Table 3. Average stem diameter (mm) of superior maize varieties on various fertilization packages.

	P1	P2	P3	Average	LSD _{0.05} (P)
V1 (Nasa 29)	23.90 _{ab} ^p	20.8 _{bc} ^q	22.33 _{ab} ^{pq}	22.34	2.72
V2 (JH-37)	23.26 _b ^p	21.88 _{abc} ^p	24.30 _a ^p	23.15	
V3 (Bisi 2)	26.99 _a ^p	22.03 _{abc} ^q	23.15 _{ab} ^q	24.06	
V4 (Bisi 18)	24.23 _{ab} ^p	23.99 _{ab} ^p	22.49 _{ab} ^p	23.57	
V5 (SINHAS 1)	25.11 _{ab} ^p	20.49 _c ^q	20.76 _b ^q	22.12	
V6 (NK7328)	26.40 _{ab} ^p	24.78 _a ^p	25.18 _a ^p	25.45	
Average	24.98	22.33	23.04		
LSD _{0.05} (V)	3.34				

Numbers followed by the same letter in a column (a, b), and in row (p, q) are not significantly different based on LSD test at $\alpha = 0.05$. P1=N : P : K (225:100:75), P2=N : P : K (200:100:50) + KNO₃ 25 kg + Biotani 5cc L⁻¹; P3=N : P : K (200:100:50) + KNO₃ 25 kg + Ecofarming 5cc L⁻¹.

Fertilization packages and varieties significantly affected the stem diameter of maize. The biggest stem diameter was found in the variety of Bisi 2 applied with N: P: K (225:100:75) fertilizers. The use of dosage also seems to resulted in bigger stem diameter in all varieties compared to other fertilization packages except in JH-37 variety that showed the biggest stem diameter obtained by plants applied with fertilization package of N: P: K (200:100:50) + KNO₃ 25 kg + Ecofarming 5cc L⁻¹ (Table 3).

2. Effect of Fertilization Packages on the Production Component of Maize Superior Varieties

Analysis of variance on fertilization packages and superior varieties treatments show that couple of production components i.e. weight of peeled cob and the ratio between kernels net weight and weight of kernels with the corn cob, expressed as percentage of grain yield were affected only by the varieties treatment. No significant effect of the combination of inorganic and organic fertilizers on these parameters (Table 4). On the other hand, yield per hectare or the productivity of the maize were varied between varieties and fertilization applied.

Highest productivity that exceed the 12 ton.ha⁻¹ target was shown by variety of Bisi 2 applied with N : P : K (225:100:75), followed by Bisi 18 applied with slightly lower NPK dosage (200:100:50), combined with KNO₃ (25 kg), and Biotani organic fertilizers (Biotani 5cc L⁻¹)

Table 4. Average peeled cob weight (kg) and grain yield* (%) of superior maize varieties on various fertilization packages.

Varieties	Peeled Cob Weight (kg)	Grain Yield* (%)
V1 (Nasa 29)	18.28 ab	74.41 ab
V2 (JH-37)	16.50 b	74.05 ab
V3 (Bisi 2)	19.06 ab	75.63 ab
V4 (Bisi 18)	18.50 ab	76.74 a
V5 (SINHAS 1)	12.94 c	71.85 b
V6 (NK7328)	20.44 a	72.68 ab
LSD _{0.05} (V)	3.32	4.52

Numbers followed by the same letter in a column (a, b) are not significantly different based on LSD test at $\alpha = 0.05$. *The ratio between the net weight of the corn kernels and the weight of the corn kernels that are still with the cob.

Table 5. Average productivity (ton.ha⁻¹) of superior maize varieties on various fertilization packages.

	P1	P2	P3	Average	LSD _{0.05} (P)
V1 (Nasa 29)	11.03 ab ^p	10.40 abc ^p	10.39 ab ^p	10.61	
V2 (JH-37)	10.71 ab ^p	8.99 bc ^q	11.24 a ^p	10.31	
V3 (Bisi 2)	12.39 a^p	11.01 ab ^q	11.18 a ^{pq}	11.53	1.36
V4 (Bisi 18)	10.55 ab ^q	12.12 a ^p	10.84 a ^{pq}	11.17	
V5 (SINHAS 1)	9.88 b ^p	8.61 c ^{pq}	8.23 b ^q	8.91	
V6 (NK7328)	10.68 ab ^p	9.30 bc ^q	10.23 ab ^{pq}	10.07	
Average	10.87	10.07	10.35		
LSD _{0.05} (V)	2.21				

Numbers followed by the same letter in a column (a, b), and in a row (p,q) are not significantly different based on LSD test at $\alpha = 0.05$. P1=N : P : K (225:100:75), P2=N : P : K (200:100:50) + KNO₃ 25 kg + Biotani 5cc L⁻¹; P3=N : P : K (200:100:50) + KNO₃ 25 kg + Ecofarming 5cc L⁻¹.

D. Discussion

High yielding superior varieties are the results from the breeding program where the pants were designed to have superior characters including yield, resistance to certain pest and disease attacks and can adapt well under limiting growing conditions. Nevertheless, the final yield or productivity of these superior genotypes can be determined by a complex interaction between the genotypes and the environment. In this recent study, it was shown that some superior varieties of Maize had different responses to the soil nutrient management in the form of

combination of inorganic and organic fertilizers. According to Adisarwanto (2006), management of the growing environment determine the achievement of the high yield potential of these superior varieties. High genetic potential can only be obtained if environmental conditions, lights, water, and soil nutrient status, support growth and production.

The interaction between genetic potential and environment was shown in the growth parameter such as in stem diameter. Variety Bisi 2 applied with the highest dosage of NPK fertilizers (225:100:75) resulted in the biggest stem compared to other variety. N, P, K fertilizers are needed for plant growth, especially in stimulating the formation of plant height and enlargement of stem diameter. In addition to nutrients N, P, K, organic fertilizers also have a role in supporting plant vegetative growth. Soil with the help of high organic matter content can be ensured to have better soil physical, chemical and biological properties.

Organic fertilizers contain a mix of macro and micro nutrients. Some organic fertilizers also added with different kind of microbes to enrich and improve the benefit of using the fertilizers. Therefore, each type of the organic fertilizer can have different effect on the plant. Recent study shows that in parameter of leaves numbers, use of lower dosage of NPK fertilizers but combined with additional K fertilizers and Ecofarming organic fertilizer resulted in plants with leaves number that similar to plants applied with only inorganic NPK fertilizers. The availability of sufficient nitrogen causes a balance ratio between leaves and roots, hence the vegetative growth is normal.

In the production component, Varieties V4 (Bisi 18) and V1 (Nasa 29) produced the highest average percentage of seed yield, namely 76.74% and 74.41%, and significantly different from the treatment of V5 variety (SINHAS 1), which was 71.85%. The percentage of high corn yield is influenced by the phosphorus content contained an increase in P uptake is needed by plants because it is used as a material for the formation of ATP in the respiration process to increase metabolic processes, including photosynthesis, especially during the seed filling phase.

The highest average productivity was obtained from the interaction of the P1 (N: P: K = 225: 100: 75) fertilization package with the V3 (Bisi 2) variety, which was 12.39 ton.ha⁻¹. Production is an important benchmark that determines the success of a research carried out, both production per plot and production per hectare. Appropriate fertilization and the response of varieties to the given treatment will result in high production.

E. Conclusion

Responses of maize varieties to fertilization packages, consisted of different combination and dosage of NPK fertilizers, KNO₃ and organic fertilizers, varied between varieties. The treatment of fertilization package of N: P: K = 225:100:75 with Bisi 2 variety gave the highest maize productivity, namely 12.39ton ha⁻¹.

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