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Response of three maize varieties (*Zea mays* L.) to different nitrogen dosages

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Abstract. The research was carried out at the Experimental Garden of the Cereal Research Institute, Bajeng District, Gowa Regency, South Sulawesi Province, which took place from September 2018 to January 2019. The research aimed to study the interaction between certain nitrogen doses and certain maize varieties and the presence of maize varieties, as well as nitrogen doses provide the highest growth and production. This research was conducted in the form of an experiment using a separate plot design. The nitrogen dose as the main plot consisting of 4 levels, namely urea 0 kg.ha^{-1}, 100 kg.ha^{-1}, 200 kg.ha^{-1}, and 300 kg.ha^{-1}, then three varieties of maize as subplots, namely Bima-19 variety as hybrid representative, Lamuru as composite representative, and Srikandi Kuning as synthetic representative. The results showed that the Bima-19 variety fertilized with urea 300 kg.ha^{-1} gave the highest seed yield per hectare (8.10 tons.ha^{-1}), and the Srikandi Kuning variety produced the highest ear height (91.25 cm) compared to other varieties tested. Application of urea 300 kg.ha^{-1} resulted in the highest ear height (113.19 cm), the longest ear length (20.02 cm), and the highest number of seeds. 33.83 seeds). All parameters observed had very significant positive correlation values, except for the age of flowering of the females and the number of seed rows of cob^{-1} which were significantly positive.

1. Introduction

In Indonesia, maize (*Zea mays* L.) is the main food commodity after rice which has a strategic role in agricultural and economic development. The development of this commodity contributes to the supply of food and industrial raw materials. Corn development on a broader scale with higher production has the potential to improve the regional economy.

Efforts to increase production continue to be carried out by referring to data in 2016, Indonesia's maize production is around 23.58 million tons or an increase of 20.22% from 2015 production of 19.61 million tons, likewise in 2017 it increased again by 10.39% to 26.03 million tonnes [1]. Then in 2018, corn production continued to increase until it reached 30 million tonnes of dry shelled [2].

On the other hand, the demand for maize in Indonesia is increasing in line with population growth. Efforts to increase corn production continue to be made through extensification and intensification. Extensification by clearing and expanding land requires considerable costs and energy, and the available land does not meet the sufficient nutrients suitable for optimum growth and production of maize, so that intensive land management is the choice of most farmers. According to Hosen [3], increasing production through increasing land area is not possible because ownership is limited and opportunities for increased production can be done through improved use of seeds (varieties), proper fertilization and use of labor.

The productivity of maize is influenced by the variety planted and the suitability of fertilization based on soil nutrient conditions. Currently, the varieties used by maize farmers are generally not based on the nutrient conditions of the soil in which the maize is cultivated. According to Tandisau and Muhammad [4], maize growth will be good if the nutrients are available in sufficient quantities according to the needs of the plant during growth, especially for superior varieties that have high yield potential if the level of nutrient availability is sufficient, but on the other hand there will be a sharp decrease in yield if insufficient nutrient availability.

In Indonesia, maize grown in agroecology includes dry or dry land, irrigated lowland, simply irrigated rice field and rainfed rice, which are generally in suboptimal conditions. Land with low productivity is mainly caused by low soil fertility, in addition to input (input) that is not optimal. On land with high productivity, namely in technically irrigated rice fields, maize crops are dominated by hybrid varieties. In subsistence to semi-commercial farming, which is generally on dry land, most farmers plant composite and synthetic maize [5]. One of the nutrients that has an important role in corn plants is the element N which is usually found in urea fertilizer. Nitrogen is the main nutrient for plant growth, which is generally indispensable for the formation or growth of vegetative parts of plants, such as leaves, stems and roots [6].

N fertilizer plays a very important role in increasing maize production. The widespread use of hybrid seeds that respond to fertilization also results in a high demand for fertilizers, especially N (nitrogen) fertilizers. According to Rahim and Halima [7], corn requires large amounts of N fertilizer, it takes 20-30% in its growth phase.

Currently, the use of fertilizers for maize is not rational and balanced. Farmers generally provide fertilizers, especially N which is very excessive, reaching 700 kg ha^{-1} with a condition where the price of fertilizers is getting more expensive from year to year, thereby reducing farmers' profits [8]. Based on the description above, it is necessary to conduct research on the growth and production of hybrid, composite and synthetic maize varieties at various nitrogen doses.

2. Varieties of Corn

Varieties are individual plants that have traits that they can maintain after going through various progeny testing processes. Varieties based on their formation techniques are divided into hybrid varieties, synthetic varieties and composite varieties [9]. Corn plant is a cross-pollinating plant, meaning that most of its pollination comes from other plants. In general, cross-pollinated or free-pollinated plants, the genetic composition of one plant to another in a variety will be different. Varieties that have undergone selection and adaptation to an environment will show a phenotypic uniformity that can be distinguished from other varieties [8].

2.1. Hybrid varieties

Hybrid varieties are the first generation resulting from crosses between several parents in the form of inbred lines. Hybrid varieties can be formed in self-pollinated or cross-pollinated plants. Corn was the first crop that was formed to produce hybrid varieties commercially, and has been developing in the United States since 1930. Now hybrid maize seeds have been planted in most of the world's maize areas [10].

To meet the government's target of food self-sufficiency, the Agricultural Research and Development Agency through the Cereal Research Institute has produced hybrid corn variety technology with the name Bima-19 [11]. This variety comes from a cross between a single cross hybrid G193 // Mr14 as a female parent with a pure Nei9008P line as a male parent. Included in the three-lane cross hybrid group, has a harvest age of 102 days, strong roots, resistant to falling, round stems, 213 cm plant height, light yellow ear color with orange bursts [11]. Based on the results of research conducted by Haryati and Anna [12], application of Urea of 300 kg.ha^{-1} along with SP36 175 kg.ha^{-1} and KCl 75 kg.ha^{-1} gave dry shelled seeds of 6.17 tons.ha^{-1} for the Bima-19 variety, which was lower than the Bima-20 and Bima-18 of 7.05 ton.ha^{-1} and 9.24 ton.ha^{-1}, respectively.

2.2. Composite varieties

Composite maize is a variety of maize derived from a mixture of more than two varieties that has experienced a minimum of five free (random) interbreeding, then mass selection is held in the last generation. Mixing is based on the age equation, type of seed, and so on. The formation of composite varieties was carried out by selecting siblings (full-sib), half-siib (half-siib) and deep cross (selfing) [13].

This composite maize can be cultivated in a variety of growing environments and about 80% of it is planted with superior varieties consisting of 56% composite maize (free-seeded) and 24% hybrids, while the rest are local varieties, so from these data most farmers still use seeds. free-fringed maize [14]. Lamuru is the name of the composite maize variety (free-pollinated) released by the Agricultural Research and Development Agency in 2000.This corn is designed for areas with dry land and climate conditions such as East Nusa Tenggara (NTT), West Nusa Tenggara (NTB), Sulawesi Central and South Sulawesi, as well as a number of other regions in Indonesia. Farmers plant the Lamuru variety of maize seeds with yields of up to 4 to 5 tonnes.ha^{-1}, higher than local varieties whose productivity is less than 2 tonnes.ha^{-1} [15]. Based on the results of research conducted by Tabri [16], application Urea of 350 kg.ha^{-1} along with TSP 150 kg.ha^{-1} and KCl 100 kg.ha^{-1} resulted in dry seed yields of 7.86 tons.ha^{-1} for the Lamuru variety. Meanwhile, application of TSP and KCl fertilizers at the same dose without Urea gave the lowest dry seed yield, namely 5.23 tonnes.ha^{-1}.

2.3. Synthetic varieties

Synthetic maize varieties are free or composite varieties formed from the cross-product of a number of pure inbred (inbred) parents. Breeding activities to form synthetic varieties consist of several stages. Each stage involves evaluation activities that produce selected materials [17]. Srikandi Kuning is classified into "Quality Protein Maize" (QPM). Yellow Srikandi has a protein content of 10.38% and even twice the lamino acid content of ordinary corn. In addition, Srikandi Kuning has a relatively short lifespan of 105-110 days, a very sturdy stem so it is very strong to support a cob that has 12-14 rows, weighing in every 1000 corn kernels weighing up to 275 grams [18]. Based on the results of research conducted by Sirappa and Nasaruddin [19], application Urea of 350 kg.ha^{-1} along with SP36 200 kg.ha^{-1} and KCl 50 kg.ha^{-1} gave a seed yield of 6.42 tons per hectare of the Srikandi Kuning variety, which was lower than the Bima-3 Bantimurung variety (8.71 ton.ha^{-1}), but higher than the Bisi-2 variety (4.50 ton.ha^{-1}).

3. Nitrogen requirement for corn plants

One of the macro nutrients needed by maize plants during its life cycle is nitrogen [20]. The source of these nutrients can come from synthetic fertilizers such as urea, ZA and others. Nitrogen is one of the essential elements for plant growth, which functions not only to increase plant growth but also to form protein [21]. The nutrient N in Urea plays a role in the formation of leaves, but this element is easily washed so that organic matter is needed to increase the resistance of water and soil cations. Giving manure in addition to increasing the availability of nutrients, can also improve the physical, biological and chemical properties of the soil [22].

According to Saragih [23], higher N application affects plant height in phase V9 (42 DAS) and plant dry weight. The greater the N application, the greater the plant height and dry weight. This is related to the adequacy of nutrients that are absorbed by plants. In the early stages of growth, maize requires a large amount of nitrogen to be used for early vegetative growth. Nitrogen deficiency causes the cell division process to be inhibited and results in inhibition of plant growth. In addition, deficiency of protein compounds causes an increase in the C / N ratio, and this excess carbohydrate will increase the cellulose and lignin content. This causes the nitrogen deficiency corn plants show a small and dry leaves with a very sharp angle of the stems [24].

4. Methodology

The research was conducted at the Experimental Garden of the Cereal Research Institute in Bajeng District, Gowa Regency, South Sulawesi. The research was conducted from September 2018 to January

2019. The tools used in this research were hand tractor, hoe, meter, tugal, stake, treatment board, weed weed machine, mist blower, water pump machine, water hose, calipers, ruler, digital camera, paving board, scale, chlorophyll meter. (SPAD), measuring the moisture content of seeds, and writing instruments. The materials used in this study were the seeds of three corn varieties, namely Bima-19 (as a representative for the hybrid species), Lamuru (as the representative for the composite type), and Srikandi Kuning (as the representative for the synthetic type), furadan, the fungicide Saromil 35SD (metallaxyl), fertilizer. Urea ((NH_2) 2CO_2), SP36 (Ca (H_2PO_4), and KCl, Calaris herbicide, water, label paper, sacks, and sample bags.

4.1. Research methods
The study used a split plot design with the main plot being the dose of urea (N) which consisted of 4 levels, namely urea 0 kg.ha^{-1} (N0), urea 100 kg.ha^{-1} (N1), urea 200 kg.ha^{-1} (N2), and urea 300 kg.ha^{-1} (N3); while subplots were 3 varieties of maize (V), namely Bima-19 (V1), Lamuru (V2) and Srikandi Kuning (V3). Based on the number of treatments tested, there were 12 experimental combinations that were repeated three times, each treatment was repeated three times resulting in 36 experimental plots.

4.2. Soil processing and trial plot preparation
Soil processing was carried out using a tractor. The cultivated land was then made manually with a hoe. The size of each bed is 3 x 4 m, with the distance between the beds is 50 cm, and the distance between replicate is 1.5 m. A total number of beds made was 36 beds.

4.3. Seed preparation
The seeds used were from commercial seeds in the community. The selected seeds are seeds that are free from pests and diseases (healthy seeds), have a minimum growth capacity of 80%, are pithy, shiny, and physically and genetically pure (guaranteed purity). Before planting the seeds were applied with fungicide Saromil 35SD (metallaxil) first at a dose of 5 g for every one kilogram of corn seeds.

4.4. Planting
For each bed, a planting hole was made using a planting stick with a distance of 80 cm x 20 cm. Each hole was planted with 1 corn seed, each planting hole was given furadan to avoid pests and then covered with soil.

4.5. Fertilization
The first fertilization was carried out by applying SP36 200 kg.ha^{-1} (240 g.plot^{-1}) and KCl 100 kg.ha^{-1} (120 g.plot$^{-1)}$. At 10 days after planting (DAP) the plots were applied with fertilizer treatment of N0 Urea 0 kg.ha^{-1} (0 g. plot^{-1}), N1 Urea 50 kg.ha^{-1} (60 g.plot^{-1}), N2 Urea 100 kg.ha^{-1} (120 g.plot^{-1}), and N3 Urea 150 kg.ha^{-1} (180 g.plot^{-1}). Then the second fertilization was carried out with the same dose of urea when the plants were at 40 DAP.

4.6. Data analysis
The data obtained from the observations were analyzed using analysis of variance. A significant effect of the treatment was followed by a further analysis using the Least Significance Difference (LSD) test at α=0.05.

5. Results

5.1. Effect of nitrogen fertilization on the growth of three maize varieties
The analysis of variance showed that there was a significant interaction between the nitrogen dose treatment and maize varieties on plant height, number of leaves and stem diameter. The average plant height, number of leaves and stem diameter of three maize varieties at various nitrogen doses are presented in table 1.

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Table 1. Average plant height (cm) of three varieties of maize at various nitrogen doses.

Varieties	Nitrogen dose (kg Urea.ha^{-1})				$LSD_{0,05}$ (V)
	0 (N0)	100 (N1)	200 (N2)	300 (N3)	
			Plant height (cm)		
Bima-19 (V1)	$163,29^{d}_{r}$	$182,06^{c}_{r}$	$201,53^{b}_{q}$	$217,64^{a}_{q}$	
Lamuru (V2)	$194,63^{d}_{p}$	$213,58^{c}_{p}$	$230,75^{b}_{p}$	$248,11^{a}_{p}$	11,25
Srikandi Kuning (V3)	$177,44^{d}_{q}$	$199,43^{c}_{q}$	$230,69^{b}_{p}$	$\mathbf{256,78^{a}_{p}}$	
$LSD_{0,05}$ (N)			11,00		
			Number of leaves (helai)		
Bima-19 (V1)	$7,73^{d}_{p}$	$9,93^{c}_{q}$	$12,33^{b}_{q}$	$\mathbf{15,30^{a}_{p}}$	
Lamuru (V2)	$7,97^{d}_{p}$	$11,77^{c}_{p}$	$13,47^{b}_{p}$	$14,30^{a}_{q}$	0,84
Srikandi Kuning (V3)	$8,10^{d}_{p}$	$10,67^{c}_{q}$	$12,93^{b}_{pq}$	$14,33^{a}_{q}$	
$LSD_{0,05}$ (N)			0,88		
			Stem diameter (mm)		
Bima-19 (V1)	$10,27^{d}_{q}$	$16,68^{c}_{p}$	$20,11^{b}_{q}$	$\mathbf{26,38^{a}_{p}}$	
Lamuru (V2)	$11,84^{d}_{p}$	$17,24^{c}_{p}$	$19,63^{b}_{q}$	$23,24^{a}_{q}$	0,84
Srikandi Kuning (V3)	$10,68^{c}_{q}$	$16,64^{b}_{p}$	$21,61^{a}_{p}$	$21,75^{a}_{r}$	
$LSD_{0,05}$ (N)			0,88		
			SPAD value		
Bima-19 (V1)	$33,28^{d}_{q}$	$36,18^{c}_{r}$	$45,24^{b}_{q}$	$\mathbf{51,80^{a}_{p}}$	
Lamuru (V2)	$34,39^{d}_{p}$	$40,70^{c}_{p}$	$46,94^{b}_{q}$	$51,56^{a}_{p}$	0,88
Srikandi Kuning (V3)	$34,57^{d}_{p}$	$39,09^{c}_{p}$	$46,40^{b}_{p}$	$50,44^{a}_{q}$	
$LSD_{0,05}$ (N)			1,10		

Numbers followed by the same letters in rows (a, b, c, d) and columns (p, q, r) are not significantly different in the LSD test of 0.05.

Table 1 shows that at a dose of urea 300 kg.ha^{-1}, the Srikandi Kuning (N3V3) variety produced the highest plant height (256.78 cm), not significantly different from the Lamuru variety (N3V2), but significantly higher than the Bima variety. -19 (N3V1). The plant height of Srikandi Kuning fertilized with urea 300 kg.ha^{-1} (N3V3) was significantly higher than the plant height in each of the other dosage treatments. Bima-19 variety that was not fertilized with urea (N0V1) produced the lowest plant height (163.29 cm).

At a dose of urea 300 kg.ha^{-1}, the Bima-19 (N3V1) variety produced the highest number of leaves (15.30), which was significantly higher than the Lamuru (N3V2) and Srikandi Kuning (N3V3) varieties. The number of leaves of the Bima-19 variety fertilized with urea 300 kg.ha^{-1} (N3V1) was significantly higher than the number of leaves in each other 73 strands). On the other hand, at a dose of urea 300 kg.ha^{-1}, the Bima-19 (N3V1) variety produced the largest stem diameter (26.38 mm), which was significantly higher than the Lamuru (N3V2) and Srikandi Kuning (N3V3) varieties. The stem diameter of Bima-19 variety fertilized with urea 300 kg.ha^{-1} (N3V1) was significantly higher than the stem diameter in each of the other dosage treatments. Bima-19 variety that was not fertilized with urea (N0V1) produced the smallest stem diameter (10.27 mm).

Table 1 shows that in the urea dose treatment of 300 kg.ha^{-1}, the Bima-19 (N3V1) variety had the highest SPAD value (51.80), not significantly different from the Lamuru variety (N3V2), but significantly higher than the variety. Yellow Heroine (N3V3). The SPAD value of Bima-19 variety fertilized with urea 300 kg.ha^{-1} (N3V1) was significantly higher than the SPAD value in each of the other dosage treatments. Bima-19 variety that was not fertilized with urea (N0V1) produced the lowest SPAD value (33.28).

Variance analysis showed that nitrogen dosage treatment and maize variety had a very significant effect, while the interaction had no significant effect on ear height. The average height of the cobs of three varieties of maize at various nitrogen doses is presented in table 2.

Table 2. The average ear height (cm) of three varieties of maize at various nitrogen doses.

Varietas	Nitrogen dose (kg Urea.ha^{-1})				Average	$LSD_{0,05}$ (V)
	0 (N0)	100 (N1)	200 (N2)	300 (N3)		
Bima-19 (V1)	53.22	73.89	101.23	109.10	84.46_q	2.05
Lamuru (V2)	59.55	81.59	106.15	112.80	90.02_p	
Srikandi Kuning (V3)	61.82	77.15	108.74	117.27	$\mathbf{91.25_p}$	
Average	58.20^d	77.54^c	105.37^b	$\mathbf{113.19^a}$		
$LSD_{0,05}$ (N)			2.73			

Numbers followed by the same letters in rows (a, b, c, d) and columns (p, q, r) are not significantly different in the LSD test of 0.05.

Table 2 shows that the urea dose of 300 kg.ha-1 (N3) produced the highest ear height (113.19 cm), which was significantly higher than the ear height in each of the other dose treatments. The Srikandi Kuning variety (V3) produced the highest ear height (91.25 cm), not significantly different from the Lamuru variety (V2), but significantly higher than the ear height of the Bima-19 variety (V1). In the dose treatment, the lowest ear height was found in plants that were not fertilized with urea (N0), namely 58.20 cm, while in the treatment of maize varieties, it was found in the Srikandi Kuning (V3) variety, which was 84.46 cm.

5.2. Effect of Nitrogen fertilization on phenology of three maize varieties

The variance survey showed that nitrogen dose treatment and maize varieties significantly interacted with the flowering age of the male and the flowering age of the female. The average flowering ages of males and females of three varieties of maize at various nitrogen doses are presented in table 3.

Table 3. The average flowering age of males and flowering ages of three maize varieties at various nitrogen doses.

Varieties	Nitrogen dose (kg Urea.ha^{-1})				$LSD_{0.05}$ (V)
	0 (N0)	0 (N0)	0 (N0)	0 (N0)	
		Silking (DAP)			
Bima-19 (V1)	54.03^a_q	54.13^a_q	54.73^b_q	55.63^c_r	0.36
Lamuru (V2)	$\mathbf{52.27^a_p}$	52.57^{ab}_p	52.73^b_p	52.47^{ab}_p	
Srikandi Kuning (V3)	54.23^a_q	54.70^b_r	55.00^b_q	54.93^b_q	
$LSD_{0,05}$ (N)			0.40		
			Tasseling (DAP)		
Bima-19 (V1)	55.39^a_q	56.40^a_q	57.10^b_q	58.10^c_r	0.62
Lamuru (V2)	$\mathbf{53.03^a_p}$	54.20^b_p	55.47^c_p	56.17^d_p	
Srikandi Kuning (V3)	55.93^a_q	55.97^a_q	57.37^b_q	57.37^b_q	
$LSD_{0,05}$ (N)			0.61		

Numbers followed by the same letters in rows (a, b, c, d) and columns (p, q, r) are not significantly different in the LSD test of 0.05.

Table 3 shows that in plants that are not fertilized with urea, the Lamuru variety (N0V2) has the fastest male flowering age (52.27 DAS), significantly lower than the Bima-19 (N0V1) and Srikandi Kuning (N0V3) varieties. Flowering age of male varieties of Lamuru that was not fertilized with urea (N0V2), was not significantly different from plants fertilized with urea 100 kg.ha-$^{-1}$ (N1V2) and 300 kg.ha^{-1} (N3V2), but significantly lower than those fertilized. urea 200 kg.ha^{-1} (N2V2). Bima-19 variety fertilized with urea 300 kg.ha^{-1} (N3V1) produced the longest flowering age in males (55.63 DAS).

Table 3 shows that in plants that are not fertilized with urea, the Lamuru variety (N0V2) produces the fastest female flowering age (53.03 DAS), which is significantly lower than the Bima-19 (N0V1) and Srikandi Kuning (N0V3) varieties. The flowering age of female Lamuru variety that was not fertilized with urea (N0V2) was significantly lower than the flowering age of females in each of the other doses of treatment. Bima-19 varieties fertilized with urea 300 kg.ha^{-1} (N3V1) produced the longest flowering age of females (58.10 DAS).

5.3. Effect of Nitrogen fertilization on grain production of three maize varieties

The analysis of variance showed that the nitrogen dose treatment and the interaction of maize varieties significantly affected the number of seed rows per ear, the number of seeds per row, the weight of 100 seeds and the yield of seeds per hectare (table 4).

Table 4. Average number of rows per cob, number of grain per row, weight of 1000 grains, productivity of three varieties of maize at various nitrogen doses.

Varieties	Nitrogen dose (kg Urea.ha^{-1})				$LSD_{0.05}$ (V)
	0 (N0)	100 (N1)	200 (N2)	300 (N3)	
	Number of rows per cob (rows)				
Bima-19 (V1)	12.40^{b}_{q}	15.23^{a}_{p}	14.90^{a}_{p}	15.23^{a}_{p}	
Lamuru (V2)	14.57^{a}_{p}	14.13^{a}_{p}	$\mathbf{15.33^{a}_{p}}$	14.53^{a}_{p}	1.44
Srikandi Kuning (V3)	14.30^{a}_{p}	15.13^{a}_{p}	14.80^{a}_{p}	14.20^{a}_{p}	
$LSD_{0.05}$ (N)	1.40				
	Number of grain per row (grains)				
Bima-19 (V1)	28.10	32.03	32.63	34.43	
Lamuru (V2)	32.10	31.67	33.57	33.40	
Srikandi Kuning (V3)	30.33	32.70	31.53	33.67	
Average	30.18^{c}	32.1^{b}	32.58^{ab}	$\mathbf{33.83^{a}}$	
$LSD_{0.05}$ (N)	0.93				
	Weight of 1000 grains (g)				
Bima-19 (V1)	297.79^{d}_{q}	319.56^{c}_{q}	350.86^{b}_{q}	$\mathbf{388.96^{a}_{p}}$	
Lamuru (V2)	317.41^{c}_{p}	341.65^{b}_{p}	368.32^{a}_{p}	375.20^{a}_{p}	16.29
Srikandi Kuning (V3)	318.54^{c}_{p}	340.29^{b}_{p}	366.74^{a}_{pq}	373.35^{a}_{p}	
$LSD_{0.05}$ (N)	15.51				
	Productivity (ton ha^{-1})				
Bima-19 (V1)	3.38^{d}_{q}	5.30^{c}_{q}	6.23^{b}_{q}	$\mathbf{8.10^{a}_{p}}$	
Lamuru (V2)	4.64^{c}_{p}	5.58^{b}_{p}	6.51^{a}_{pq}	6.99^{a}_{q}	0.47
Srikandi Kuning (V3)	4.34^{c}_{p}	5.37^{b}_{p}	6.74^{a}_{p}	7.18^{a}_{q}	
$LSD_{0.05}$ (N)	0.56				

Numbers followed by the same letters in rows (a, b, c, d) and columns (p, q, r) are not significantly different in the LSD test of 0.05.

Table 4 shows that at the urea dose of 200 kg.ha^{-1}, the Lamuru (N2V2) variety had the highest number of cob-1 seed rows (15.33 rows), not significantly different from the Bima-19 (N2V1) and Srikandi Kuning varieties. (N2V3). The number of seed rows of cob^{-1} of Lamuru variety fertilized with urea 200 kg.ha^{-1} (N3V2) was not significantly different from the number of seed rows of cob^{-1} in each of the other doses of treatment. Bima-19 variety that was not fertilized with urea (N0V1) produced the least number of seed rows cob^{-1} (12.40 rows).

Table 4 shows that at a dose of urea 300 kg.ha^{-1} (N3) produced the highest number of rows-1 seeds (33.83 seeds), not significantly different from the dose of urea 200 kg.ha-1 (N2), significantly different higher than the dose of urea 100 kg.ha-1 (N1) and not fertilized urea (N0). Bima-19 variety that was not fertilized with urea (N0V1) produced the lowest number of rows-1 seeds (28.10 seeds). At dose of urea 300 kg.ha^{-1}, the Bima-19 variety (N3V1) produced the heaviest weight of 1000 seeds (388.96 g), not significantly different from the Lamuru (N3V2) and Srikandi Kuning (N3V3) varieties. . The weight of 1000 seeds of Bima-19 variety fertilized with urea 300 kg.ha-1 (N3V1) was significantly higher than the weight of 1000 seeds in each of the other doses of treatment. Bima-19 variety that was not fertilized with urea (N0V1) produced the lightest 1000 seeds weight (297.79 g).

Application of urea 300 kg.ha^{-1} in Bima-19 (N3V1) variety produced the highest yield of acres-1 (8.10 tons.ha-1), which was significantly higher than the Lamuru variety (N3V2).) and Srikandi Kuning (N3V3). The yield of the seed variety of Bima-19, fertilized with urea 300 kg.ha-1 (N3V1) was significantly higher than that of seed per hectar in each of the other doses of treatment. Bima-19 varieties that were not fertilized with urea (N0V1) produced the lowest yield of seeds per hectare (3.38 ton.ha^{-1}).

5.4. Relationship between nitrogen dose and seed yield of three maize varieties

The relationship between nitrogen dose and seed yield per hectare in Bima-19, Lamuru, and Srikandi Kuning varieties is presented in figure 1.

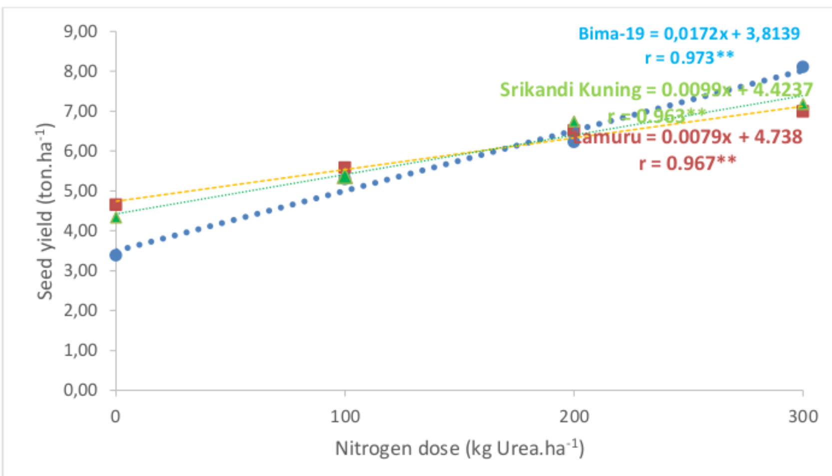

Figure 1. The relationship between nitrogen dose and seed yield in Bima-19, Lamuru, and Srikandi Kuning varieties.

Figure 1 shows the relationship between several nitrogen doses on seed yield. Hectare-1 in all tested varieties was linear with a very significant positive regression coefficient for each, namely Bima-19 (r = 0.973 **), and Lamuru (r = 0.967). **), and the Srikandi Kuning variety (r = 0.963 **).

6. Discussion

The results of variance showed that nitrogen treatment had a very significant effect on ear height, ear length and number of seeds per row, and had a significant effect on ear length, but had no significant effect on plant height, number of leaves, stem diameter, SPAD value. male flowering age, female flowering age, dry ear weight with husked ear, dry ear weight without husk, ear diameter, number of seeds rows per cob, number of seeds per cob, weight of 1000 seeds, yield, and production.

The of the highest ear (113.19 cm), the longest ear (20.02 cm), the longest ear length (18.19 cm), and the highest number of seeds rows per cob (33.83 seeds) were obtained at the urea dose treatment.

300 kg.ha^{-1}. This shows that urea, which in this case is related to nitrogen, is needed in the process of growth and production of maize plants. This is in line with the opinion of Sutoro et al. [25], that nitrogen is the main key in the effort to increase corn production. The absorption of N by maize plants takes place during its growth. Therefore, to get good results, nitrogen nutrients in the soil must be sufficiently available during the growth and development phase of the maize plant.

The location of the cobs determines the resistance of the maize plant to felling and its prevention against pests such as dogs and wild boar. Plants that are assumed to have a good level of resistance to fall have the cob located in the middle of the stem. This is in accordance with the opinion of Hamidah [26], that the best location of the cob is in the middle of the stem so that the plant is resistant to falling. Furthermore, Amir and Najmah [27] added that the high location of the cob can prevent pests on corn plants.

Cobs are the initial part of the initiation of the generative phase in maize plants, where the re-translocation process of N is needed as a store of nutrients for production. This is in accordance with the opinion of Planet and Lemaire [28], that nutrient storage in the early generative phase plays a role in the process of forming corn cobs. The nitrogen content in the urea fertilizer that is given is a macro nutrient that can support the formation of seeds in the corncob row if it can be properly absorbed when the plant enters the generative phase. This is in accordance with the opinion of Maintang and Nurdin [29], that the total accumulation of dry matter is directed at ear development and seed formation so that it can increase high yields. In line with that, Leiwakabessy [30] stated that plant growth and development is strongly influenced by nutrients that are available so that plants can produce well.

The results of variance showed that the treatment of three varieties of maize had no significant effect on almost all observed parameters, except for the height of the ear which had a very significant effect. This parameter is influenced by the genetic traits of the variety itself. In line with Mangoendidjojo's [9] statement that the variations that occur in each plant group can be found based on genetic factors.

The results of variance showed that there was an interaction between the treatment of several nitrogen doses with three types of corn varieties which had a very significant effect on the parameters of plant height, number of leaves, stem diameter, SPAD value, male flowering age, dry ear weight with husks, dry ear weight without husks, yield and production. The leaves are part of the plant which is the center of the formation of "food" for plants to grow and produce. The large number of leaves will help the absorption of sunlight as energy for photosynthesis which results will trigger the growth and development of stems. This is in accordance with the opinion of Subaedah et al. [31] that more leaves allow for greater capture of solar energy which will spur the photosynthesis process more rapidly and ultimately will produce plants with growth and development of stems.

The enlarged diameter of the stem is caused by the activity of cell division and enlargement, whose energy source comes from photosynthesis which occurs as a result of processing chlorophyll by sunlight. The amount of chlorophyll uptake can be seen by looking at the SPAD value recorded on the chlorophyll meter (SPAD), the amount of which is determined by the application of nitrogen contained in urea fertilizer. This is in accordance with the opinion of Hardjowigeno [32] that nitrogen is needed by plants to produce protein and other important ingredients in the process of forming cells and plays a role in the formation of chlorophyll which leaves will increase the ability of leaves to absorb sunlight so that photosynthesis occurs.

The vegetative phase continues until the generative period, which begins with flower primordia, followed by the formation and filling of fruit, the formation of seeds, pods or the like, then ends with the ripening period. Difference in flowering age, presumably due to genetic factors that control the age of first flowering and plant age at harvest when compared with other factors [33, 34]. Flowering age of males and females is short, so the pollination process will take place quickly so it is hoped that it will shorten the harvest time.

Varieties play an important role for the growth of maize plants and to achieve high productivity is very much determined by the potential yield of the superior varieties planted and influenced by the interaction between the genetic factors of the variety and its management, which can be in the form of fertilization [35]. Sebayang and Winarto [36] suggest that if plant management is not carried out properly, the high potential yield for seeds from these superior varieties cannot be achieved.

Bima-19 is a variety that is classified as a hybrid maize type, which generally requires a high fertilizer dose for hybrid plants. This is in accordance with the opinion of Mejaya et al. [37] that to get maximum yield, hybrid varieties require high fertilization. Whereas for Lamuru which is a type of composite maize and Srikandi Kuning which is a type of synthetic maize, which is not fertilized by urea, it can still develop well, this is because the genetics of the composite type obtained from free (random) interbreeding, so that it can be cultivated in various conditions although without fertilization. This is in accordance with the opinion of Iriany et al. [14], that maize from free-sided types such as composite and synthetic can be cultivated in a variety of growing environments and conditions.

Compared to the Lamuru variety which is a composite type (free-pollinated) and Srikandi Kuning which is a synthetic type, the Bima-19 variety has a hybrid vigor or heterosis effect as a result of the hybrid status which is the first offspring (F1) from crosses between several parents in the form of inbred lines.. In accordance with the opinion of Takdir et al. [10] that hybrid maize has a higher yield potential than free-pollinated varieties due to the effect of hybrid vigor or heterosis.

7. Conclusion

Based on the research results that have been obtained, it is concluded that:

- Bima-19 variety fertilized with urea 300 kg.ha^{-1} gave the highest yield of seeds.hectare^{-1} (8.10 ton.ha^{-1}).
- The Srikandi Kuning variety produced the highest ear height (91.25 cm) compared to all other varieties tested.
- Application of urea 300 kg.ha^{-1} resulted in the highest ear height (113.19 cm), the longest ear length (20.02 cm), the longest ear ear (18.19 cm), and the highest number of seeds (33.83 seeds).

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