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GROWTH AND YIELD OF OKRA (ABELMOSCHUS ESCULENTUS L.) WITH DIFFERENT LEVELS OF SHADE AND DOSES OF NITROGEN FERTILIZER ON DRY ACID ULTISOL LAND

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ABSTRACT
Acidic dry land Ultisol with low fertility in the area under oil palm stands still has economic potential for okra cultivation which can adapt to limited light intensity if accompanied by the provision of appropriate fertilizers. This study is a phase-1 trial of growth response and okra yields under artificial shade conditions in the form of paranet and the addition of nitrogen nutrients. The purpose of this study was to determine the effect of adding nitrogen fertilizer at different levels of shade, and to obtain the level of shade and dose of nitrogen fertilizer that can provide the highest growth and yield of okra. Factor I is the level of shade (with paranet): 0%; 50%; 65%; and 80% and Factor II is the dose of nitrogen fertilizer (in the form of Urea fertilizer): 0, 100, 200, 300 kg ha^{-1} (equivalent to 0; 2.5; 5.0; 7.5 g per polybag), each treatment was repeated three times. The results showed that the level of shade and the dose of nitrogen fertilizer showed little interaction, but each single factor, both the level of shade and the dose of nitrogen fertilizer, had a significant effect on the growth and yield of okra. The highest growth and yield of okra were obtained at a shade level of 80%, and at a dose of nitrogen fertilizer of 200 kg ha^{-1}.

KEY WORDS
Okra, production, response, shade, nutrient, ultisol.

One of the regions in Indonesia that has a very large Ultisol soil type is Jambi province, which reaches 3,447,915 ha (Mulyani and Sarwani, 2013) or around 64.5% of its total area of 5,343,500 ha (BPS, 2019). However, Ultisol has limitations as agricultural land because it has a low pH, high Al saturation, and low organic matter and macronutrient content (Mashfufah and Prasetya, 2019). In addition, the current problem is that most of the Ultisol land has developed into settlements due to the increasing population, and has become an oil palm plantation area so that the availability of land for cultivating seasonal crops is increasingly limited. Therefore, it is necessary to develop cultivation techniques that can utilize the area under the oil palm stands. This certainly requires types of plants that have tolerance to limited light intensity and other appropriate cultivation actions. Given the condition of the Ultisol soil type which is poor in nitrogen nutrients, it is necessary to add Urea fertilizer containing 46% nitrogen.

The problem that arises for the development of okra (*Abelmoschus esculentus* L.) cultivation in Indonesia (especially Jambi province) is that the majority of the existing land is in the form of dry acid ultisol land and has become an oil palm plantation. Therefore, it is necessary to test cultivation techniques that can describe this okra cultivation approach between the shade of oil palm trees and dry acid ultisol land which is characterized by low soil nutrient content, especially nitrogen. Thus, the purpose of this study is to obtain the level of shade and dose of nitrogen fertilizer that can provide the highest growth and yield of okra.

Okra is an exotic vegetable that has high nutritional value and is even efficacious as a herbal medicine, but this type of vegetable is not yet widely known by some people in Indonesia. The okra plant originates from the African continent which has a tropical climate, and this plant has a high adaptability so that it is also suitable for development in Indonesia. Okra is an exotic fruit vegetable that is not yet widely known by people in Indonesia so that data on the harvest area, production and productivity of okra are also not listed in the Central Statistics Agency of the Republic of Indonesia. However, some people who are already familiar with the okra plant consider that this type of plant has benefits as a vegetable and can even be used as a medicine for various types of diseases, so okra is a healthy vegetable.

Based on its development history, okra originated from Africa and is now widely cultivated in countries with tropical and subtropical climates (Tong, 2016). In some countries such as Africa and Asia, okra is already a type of commercial vegetable that has been widely developed (Benchasri, 2012). Even now, okra is very popular in Brazil, India, Spain, Thailand, the Philippines, the Southern United States, Türkiye and West Africa.

Okra contains a lot of fiber, vitamin C, folic acid, and antioxidants (Kumar *et al*., 2013). Okra also contains a lot of fat, protein, carbohydrates, minerals and vitamins. Even the mucus from okra fruit is also widely used as an industrial material in the medical or health fields (Benchasri, 2012). According to Gemede *et al*. (2015) okra is called "*a perfect villager's vegetable*", because it contains a lot of fiber and protein that is balanced from the amino acids lysine and tryptophan. Therefore, okra cultivation also has promising economic prospects. The results of the study by Nwalieji *et al*. (2015) that based on the analysis of costs and production for okra cultivation that has been carried out in Nigeria, both in the rainy and dry seasons showed a fairly high profit, namely with a profit margin of 107.8% and 134.0% respectively.

Based on statistical data from 2010-2011, the largest okra producing country in the world is India, which reaches 73% of the world's okra production with a planting area of 498,000 hectares and a total production of 5,784,000 tons, and a productivity of 11.6 tons ha^{-1}, while the average okra productivity in the world has only reached 6.9 tons ha^{-1} (Vanitha *et al*., 2013). Thailand has also included okra as one of the vegetable commodities that has important economic value both for domestic consumption and for export purposes, even since 2005 the Ministry of Agriculture and Cooperatives has established the "*Good Agriculture Practices Standard*" for okra cultivation (National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives, 2008).

Based on data on the development of okra cultivation that has been carried out in countries with tropical climates, Indonesia also has great potential for the development of okra cultivation. The results of preliminary research that has been carried out indicate that okra is very suitable for cultivation in Indonesia. In addition, based on surveys in modern markets such as "*Supermarkets and Malls*", okra has a high selling price.

Okra has a very specific type of plant growth, namely after entering the generative phase, each appearance of leaves is always followed by the appearance of fruit. The growth of okra leaves and fruits occurs simultaneously and in balance, therefore treatments that can accelerate the formation of leaves will also increase plant growth and fruit yields. To obtain optimal okra growth and yields, technological input is needed, including the provision of nitrogen fertilizer. The results of the study by Ichsan *et al*. (2016) that the provision of nitrogen fertilizer as much as 200 kg ha^{-1} can provide the highest okra growth and yield. In addition, for the long-term target that has been designed in the "*road map*" of this study where okra plants will be used as intercropping plants between oil palm stands in the "*inter cropping*" planting pattern, it is also necessary to have treatments with various levels of shade (light intensity) to determine the ability of okra plants to adapt (resistance) to low light intensity under annual plant stands. Based on the results of the study by Dada and Adejumo (2015), it was shown that providing 76% light intensity can actually increase okra plant yields.

Based on the framework of thought that has been described, in an effort to develop okra cultivation technology, it is necessary to find the following answers: (1) How is the response (growth and yield) of okra plants at various levels of shade when given different doses of nitrogen fertilizer? (2) What level of shade and dose of nitrogen fertilizer provides the best response (growth and yield) of okra?

MATERIALS AND METHODS OF RESEARCH

This research was conducted at the Experimental Garden of the Faculty of Agriculture, University of Jambi with an altitude of ± 35 meters above sea level. The experiment was arranged in a randomized block design with a factorial pattern, namely factor I is the level of shade: 0%; 50%; 65%; and 80%. To obtain each percentage of shade, black paranet was used. Factor II is the dose of nitrogen fertilizer, which is given in the form of Urea fertilizer (N = 46%) as much as: 0, 100, 200, 300 kg ha^{-1}, equivalent to 0; 5; 10; 15 grams per plant (based on the conversion of a planting distance of 50 cm x 100 cm). Each treatment combination was repeated 3 times.

Table 1 – Factorial pattern formed between shade level and N fertilizer dose (in the form of Urea)

Urea (kg ha^{-1})	Shade (%)			
	0	50	65	80
0	(0; 0)	(0; 50)	(0; 65)	(0;80)
100	(100; 0)	(100; 50)	(100; 65)	(100; 80)
200	(200; 0)	(200; 50)	(200; 65)	(200; 80)
300	(300; 0)	(300; 50)	(300; 65)	(300; 65)

Okra seeds are germinated using a tub filled with sand media, and after 10 days (having 2 leaves) the seedlings are transferred to a 10 cm x 10 cm plastic bag with a planting medium consisting of a mixture of soil and manure (2:1). After the seedlings are 3 weeks old (having 4 leaves) they are transferred to a 40 cm x 40 cm polybag with a planting medium consisting of a mixture of soil and organic fertilizer (12 kg of top soil + 1 kg of organic fertilizer).

Fertilization is done at planting time, and 3 and 6 weeks after planting. At planting time, P fertilizer is given in the form of SP-36 (P_2O_5 = 36%) as much as 150 kg ha^{-1} (equivalent to 7.5 grams per plant), while the N fertilizer given is in the form of Urea (N = 46%) according to the treatment dose level, and the K fertilizer given is in the form of KCl (K_2O = 60%) which is 1/3 dose, which is 2.5 grams per polybag. Follow-up fertilizer is done when the plants are 3 and 6 weeks old after planting, namely with N and K fertilizers each 1/3 dose at each fertilization time.

Plant maintenance includes: (1) Watering the plants twice a day, in the morning and evening; (2) Weed control is done manually on grass growing inside and outside the polybag; and (3) Pest and disease control is done chemically using the insecticide Curacron 500 EC (Active Ingredient: Profenofos 500 $g.L^{-1}$) with a solution concentration for spraying of 1.25 $mL.L^{-1}$ and the fungicide Dithane M-45 80 WP (Active Ingredient: Mancozeb 80%) with a solution concentration for spraying of 2.5 $g.L^{-1}$ each carried out with an interval of two weeks alternately. Harvesting is carried out on young fruit, namely 6 days after the flowers bloom, which is done in the morning.

The variables observed include: (1) plant growth, namely: plant height, stem diameter, number of leaves, leaf area, age of flowering plants; and (2) components of plant yield and results, namely: number of fruits per plant, fruit length, fruit diameter, fruit weight per plant. The results of the observations were analyzed using analysis of variance and continued with the BNT test (p=0.05).

RESULTS AND DISCUSSION

The results of the experiment showed that various levels of shade and doses of nitrogen fertilizer given together to okra plants, most of the observed variables did not show any interaction, except for the age of flowering plants. On the other hand, when viewed based on the influence of each single factor, various levels of shade affect all observed variables, and various doses of nitrogen fertilizer tried affected plant height, stem diameter, number of leaves, leaf area, number of fruits, and fruit weight per plant, but did not affect fruit length and fruit diameter. This shows that between the level of shade and the dose of nitrogen fertilizer are more dominant in influencing the growth and yield of okra plants independently and are not interdependent with each other.

Plant height is one of the components of okra plant growth that affects fruit yield, because after entering the generative phase each stem segment will produce leaves and fruit at once. However, due to different environmental growth factors, it can cause an increase in plant height not followed by an increase in the number of stem segments because the distance between stem segments is longer, for example due to lack of light or a different balance of fertilizer types.

Table 2 – Height plants of okra at 42 days after planting with various levels of shade and doses of nitrogen fertilizer

Plant height (cm)		Nitrogen fertilizer dosage (kg ha^{-1})				Average
		0	100	200	300	
Shade level (%)	0	38.97	41.37	43.50	41.07	41.23 a
	50	39.83	43.60	45.20	44.80	43.36 b
	65	42.07	44.47	47.27	46.77	45.15 bc
	80	44.30	45.70	47.97	47.30	46.32 c
Average		41.29 A	43.79 B	45.98 C	44.98 BC	

Note: The interaction is not significantly different (p<0.05). Numbers followed by the same letter indicate an insignificant difference (p=0.05; BNT=1.891).

The response shown by okra plants that all levels of shade and doses of nitrogen fertilizer given can increase plant height. The highest observation results were obtained at a shade level of 80% but were not significantly different from 65%, and a nitrogen dose of 200 kg ha^{-1} which was not significantly different from 300 kg ha^{-1} (Table 2).

Stem diameter indicates the performance of okra plants in supporting vegetative and generative growth. The general theoretical concept states that plants that lack light will grow taller and have smaller stem diameters. However, the sensitivity of each type of plant to light intensity requirements varies. Even plants that have a C3 (*3-phosphoglycerate*) photosynthesis pathway will grow and develop more optimally in shaded conditions so that the crop yields obtained will also be higher.

The results of this study indicate that the provision of 65% and 80% shade, and nitrogen fertilizer doses of 200 kg ha^{-1} and 300 kg ha^{-1} can increase the stem diameter. The highest okra stem diameter was obtained at 80% shade which was not significantly different from 65%, and a nitrogen fertilizer dose of 200 kg ha^{-1} but not significantly different from 300 kg ha^{-1} (Table 3).

Table 3 – Stem diameter of okra at 42 days after planting with various levels of shade and doses of nitrogen fertilizer.

Stem diameter (mm)		Nitrogen fertilizer dosage (kg ha^{-1})				Average
		0	100	200	300	
Shading level (%)	0	10.77	11.93	13.80	13.23	12.43 a
	50	11.33	12.00	14.90	13.10	12.83 a
	65	13.57	14.01	15.83	15.33	14.69 b
	80	13.67	15.33	16.17	15.53	15.18 b
Average		12.34 A	13.32 AB	15.18 C	14.29 BC	

Note: The interaction is not significantly different (p<0.05). Numbers followed by the same letter indicate an insignificant difference (p=0.05; BNT=1.352).

Table 4 – Number leaves of okra at 42 days after planting with various levels of shade and doses of nitrogen fertilizer

Number leaves		Nitrogen fertilizer dosage (kg ha^{-1})				Average
		0	100	200	300	
Shade level (%)	0	8.00	8.33	10.33	8.33	8.75 a
	50	11.33	10,00	12.33	11,00	11.17 b
	65	11.67	12.03	14.67	12.67	12.76 c
	80	11.67	14.33	17.03	13.33	14.09 d
Average		10.67 A	11.17 A	13.59 B	11.33 A	

Description: The interaction is not significantly different (p<0.05). Numbers followed by the same letter indicate an insignificant difference (p=0.05; BNT=1.275).

The increase in the number of leaves is in line with the increase in the number of stem segments, and in general will correlate with the height of the plant. However, due to different environmental factors, plant height is often not always in line with the number of leaves and stem segments.

All levels of shade provided were able to increase the number of okra plant leaves, while only 200 kg ha^{-1} of nitrogen fertilizer was able to increase the number of okra leaves. The highest number of leaves was obtained at 80% shade level and 200 kg ha^{-1} of nitrogen (Table 4).

Leaves are the main organs that function to carry out photosynthesis activities in higher plants. Thus, if the surface area of the leaves is wider and gets enough sunlight, it will produce maximum photosynthate. However, on the contrary, if many leaves do not get enough sunlight, it can cause the opposite effect, where the leaves cannot or are less effective in carrying out the photosynthesis process so that they actually become users of photosynthate. However, the optimum light intensity requirements for each type of plant also vary, because many types of plants are found to be more optimal in their growth and development if they get shade to a certain extent.

All levels of shade and doses of nitrogen fertilizer can increase the leaf area of okra plants compared to without shade and without nitrogen fertilizer. The highest leaf area was obtained at a shade level of 80% but was not significantly different from 65%, and at a dose of 200 kg ha^{-1} nitrogen fertilizer (Table 5).

Table 5 – Leaf area of okra at 42 days after planting with various levels of shade and doses of nitrogen fertilizer

Leaf area (dm^2)		Nitrogen fertilizer dosage (kg ha^{-1})				Average
		0	100	200	300	
Shade level (%)	0	13.73	15.38	19.78	18.10	16.75 a
	50	16.35	20.50	22.85	21.37	20.27 b
	65	18.10	22.95	25.45	23.21	22.43 c
	80	20.60	22.99	26.21	25.10	23.73 c

Note: The interaction is not significantly different (p<0.05). Numbers followed by the same letter indicate an insignificant difference (p=0.05; BNT=1.592).

The flowering age of a plant is an indication of its early nature, which is marked by the appearance of the first flower in its life cycle. The length of time required for the first flower to appear on a plant can be influenced by genetic factors and the growing environment. In plants that have a determinate growth type, after entering the generative phase (flowering), vegetative growth becomes very limited. However, in plants that have an indeterminate growth type such as okra, the appearance of flowers occurs simultaneously with the appearance of new leaves. Thus, various environmental factors that can inhibit the emergence of new leaves can be interpreted as also inhibiting the formation of flowers and fruits.

Table 6 – Flowering age of okra with various levels of shade and doses of nitrogen fertilizer

Flowering age (days)		Nitrogen fertilizer dosage (kg ha^{-1})				Average
		0	100	200	300	
Shade level (%)	0	21.33 A a	21.00 A a	20.67 A a	21.00 A a	21.00
	50	22.67 A a	26.33 B c	27.63 B c	26.00 B c	25.66
	65	25.00 A b	24.67 A b	26.00 A c	25.00 A bc	25.17
	80	26.00 B b	24.33 A b	23.33 A b	24.37 A b	24.50
Average		23.75	24.08	24.41	24.08	

Note: The interaction is significantly different (p<0.05). Capital letters are read per row, lowercase letters are read per column. Numbers followed by the same letter indicate no significant difference (p=0.05; BNT=1.652).

Each level of shade shows a different pattern of changes in the flowering age of okra plants. For the shade levels of 0% and 65% did not affect the flowering age at each dose of nitrogen fertilizer applied. While at the shade level of 50% with the addition of nitrogen fertilizer can slow down the flowering age, conversely at the shade level of 80% it actually accelerates the flowering age. Furthermore, for all doses of nitrogen fertilizer administration can cause okra plants to flower more slowly when given shade. While in okra plants that are not given nitrogen fertilizer, they become slower to flower after being given 65% and 80% shade (Table 6).

The number of fruits is one of the components of the results that play a role in determining the productivity of a plant. In plants where the emergence of fruits does not occur at every appearance of leaves, then the maximum vegetative growth will not necessarily be followed by a large number of fruits, in fact the number of fruits may be less. This occurs as a result of the dominance of vegetative growth that suppresses its generative growth. However, okra plants have a characteristic property, namely that after entering the generative phase, fruit will appear at every appearance of leaves. This means that the growth of vegetative organs, especially the number of leaves, is in line or directly proportional to the increase in the number of fruits.

Table 7 – Fruits number per plant with various levels of shade and doses of nitrogen fertilizer

Number of fruits		Nitrogen fertilizer dosage (kg ha^{-1})				Average
		0	100	200	300	
Shade level (%)	0	12.33	14.00	14.67	14.33	13.84 a
	50	13.33	14.67	16.67	14.00	14.67 a
	65	15.00	16.33	18.21	16.90	16.61 b
	80	16.33	18.30	20.20	18.10	18.23 c
Average		14.25 A	15.83 B	17.44 C	15.83 B	

Note: The interaction is not significantly different ($p<0.05$). Numbers followed by the same letter indicate an insignificant difference ($p=0.05$; BNT=1.465).

Shade levels of 65% and 80% can increase the number of fruits. Furthermore, the number of fruits also increased at all doses of nitrogen fertilizer given. The highest number of okra fruits was obtained at a shade level of 80%, and a dose of nitrogen fertilizer of 200 kg ha^{-1} (Table 7).

Fruit length is a component that greatly influences the weight of okra fruit, so if other fruit weight components also support it, increasing fruit length will play an important role in increasing the weight of okra fruit.

Table 8 – Fruits length of okra with various levels of shade and doses of nitrogen fertilizer

Fruits length (cm)		Nitrogen fertilizer dosage (kg ha^{-1})				Average
		0	100	200	300	
Shade level (%)	0	10.4	10.71	11.01	10.91	10.76 a
	50	10.15	9.59	10.24	10.33	10.08 a
	65	10.68	10.81	11.56	10.66	10.93 a
	80	11.43	12.05	12.87	12.12	12.12 b
Average		10.67 A	10.79 A	11.42 A	11.01 A	

Note: The interaction is not significantly different ($p<0.05$). Numbers followed by the same letter indicate an insignificant difference ($p=0.05$; BNT=0.913).

When compared to without shade, only 80% shade level can increase the length of okra fruit. While various levels of nitrogen fertilizer doses given are also unable to increase fruit length (Table 8).

Fruit diameter also plays a role in determining the weight of okra fruit. If the okra fruit has a higher length and diameter, the weight of the okra fruit obtained will also be higher. The results of the experiment showed that the growth of fruit diameter is directly proportional to the length of the fruit.

The shade level of 80% can provide the highest okra fruit diameter compared to other treatments, while the administration of various doses of nitrogen fertilizer cannot increase the okra fruit diameter (Table 9).

Table 9 – Fruit diameter of okra plants with various levels of shade and doses of nitrogen fertilizer

Fruit diameter (cm)		Nitrogen fertilizer dosage (kg ha^{-1})				Average
		0	100	200	300	
Shade level (%)	0	2.08	2.13	2.12	2.14	2.12 a
	50	2.04	2.01	2.02	2.08	2.04 a
	65	2.57	2.68	2.46	2.36	2.52 b
	80	2.78	2.85	2.78	2.98	2.85 c
Average		2.37 A	2.42 A	2.34 A	2.39 A	

Note: The interaction is not significantly different (p<0.05). Numbers followed by the same letter indicate an insignificant difference (p=0.05; BNT=0.095).

Fruit weight per plant is the final target of the expected okra yield, and high fruit weight must be supported by its components such as fruit length and diameter. It is often found that the effects of genetic factors and different growing environment factors can cause fruit sizes that are longer or shorter or larger or smaller, so that one of the more dominant yield components or both will determine the size of the okra fruit weight. Furthermore, fruit weight per plant can also be supported by the number of fruits.

Table 10 – Fruit weight per plant with various levels of shade and doses of nitrogen fertilizer

Fruit weight per plant (gram)		Nitrogen fertilizer dosage (kg ha^{-1})				Average
		0	100	200	300	
Shade level (%)	0	213.93	219.30	274.30	268.30	243.96 a
	50	268.13	258.00	301.20	300.50	281.96 b
	65	302.10	315.20	339.50	317.00	318.45 c
	80	312.10	332.80	383.30	337.20	341.35 d
Average		274.07 A	281.33 A	324.58 C	305.75 B	

Note: The interaction is not significantly different (p<0.05). Numbers followed by the same letter indicate an insignificant difference (p=0.05; BNT=17.513).

The weight of okra fruit per plant increases with increasing shade levels. While the dose of nitrogen fertilizer that can increase the weight of okra fruit per plant is 200 kg ha^{-1} and 300 kg ha^{-1}. Furthermore, the highest weight of okra fruit per plant is obtained at a shade level of 80% and a dose of nitrogen fertilizer of 200 kg ha^{-1} (Table 10).

Providing shade can affect the amount of sunlight received by the plant canopy. Sunlight is the main source of energy for higher plants to carry out their biochemical and physiological activities. Without the role of sunlight, higher plants will not be able to survive. According to Pantilu *et al*. (2012), the effect of shade can reduce the intensity of light received by plants, and will then affect the photosynthesis process. However, the need for sunlight intensity is very dependent on the plant species. There are several types of plants that require full sunlight intensity (100%) or without shade to get maximum growth and yields, and there are other plant species that prefer shade to be able to grow and produce higher yields. Various plant species that can grow better with shade conditions, to get optimal growth and yields also require different levels of shade. The results of Buntoro *et al.'s* research. (2014) conducted on white turmeric plants (*Curcuma zedoaria* Rosc.) showed that with a shade level of 75% it can provide the highest growth and yield, namely in the form of plant height, fresh plant weight, dry plant weight, leaf area, plant growth rate, and harvest index. Meanwhile, the results of research by Suyanto *et al*. (2017) on celery plants (*Apium graveolens* L.) obtained the best plant growth and yield at a shade level of 50%.

In line with the results of previous studies on several other plant species, the results of the study conducted on okra plants showed that all growth variables, namely plant height, stem diameter, number of leaves, and leaf area, as well as yield and yield components, namely number of fruits, fruit length, fruit diameter, and fruit weight per plant gave a positive response (increased) due to the provision of shade. Even the highest growth and yield of okra plants were obtained at a shade level of 80%. According to Dada and Adejumo (2015), the increase in growth and yield of okra plants was obtained through the mechanism of extending the leaf and fruit formation period. Okra plants can actually grow better and get higher fruit yields in conditions of 80% shade, because according to Overdieck et al. (1988 *in* Gerhart and Ward, 2010) that okra plants are included in the C3 plant group.

An additional explanation is that this experiment was conducted during the dry season so that the weather conditions during the day were very bright and the intensity of sunlight was full, so that the air temperature was high and the humidity was low. Therefore, okra plants that received 80% shade actually grew and developed better, because they could minimize the negative effects of these weather conditions.

To obtain optimum okra growth and yields, an air temperature of between 20-30^{o}C is required (Benchasri, 2012), but when this study was conducted, the maximum daytime temperature could reach more than 35^{o}C. The real effect of weather conditions during the study also occurred in the flowering age of okra plants becoming faster, namely between 21-28 days after planting, whereas based on the biological properties of okra plants written by Tripathi *et al*. (2011) that okra plants will only flower after 41-48 days after planting. Furthermore, okra plants will continue to flower and bear fruit depending on the season, soil moisture, and soil fertility.

In addition to light factors, okra growth and yield are also influenced by the availability of nutrients needed by plants, namely nitrogen. In this experiment, to meet the nitrogen needs of okra plants, it was added by giving Urea fertilizer (N = 46%). The results showed that the addition of nitrogen fertilizer can increase plant height, stem diameter, number of leaves, leaf area, number of fruits, and fruit weight per plant, but does not affect fruit length and fruit diameter. This shows that the results of okra plants in the form of fruit weight per plant are more determined by the variable number of fruits than the length and diameter of the fruit. The highest growth and yield of okra were obtained by giving 200 kg ha^{-1} nitrogen fertilizer. Increasing the dose of nitrogen fertilizer to 300 kg ha^{-1} actually began to reduce the growth and yield of okra.

The efficiency of nitrogen requirements for plant growth and development is greatly influenced by plant species and environmental factors. This study shows that the highest growth and yield of okra fruit were obtained at 80% shade level with the provision of nitrogen fertilizer as much as 200 kg ha^{-1}. This is also still in line with previous studies that the efficiency of nitrogen fertilization in okra plants varies due to different environmental conditions. The results of the study by Meena *et al*. (2017) on clay loamy soil obtained the highest okra yields when given nitrogen fertilizer with a dose of 90 kg ha^{-1}, while the results of the study by Kumar *et al*. (2017) on ultisol soil with sandy clay texture obtained the highest results when given 180 kg ha^{-1}.

Nitrogen is an essential element that can limit plant productivity, therefore research is needed on the efficiency of nitrogen fertilizer use in agriculture (Schmollinger *et al*., 2014). Recent research results show that nitrogen plays a role in various stages of the growth and development of primary roots and lateral roots of plants (Forde, 2014). Furthermore, nitrogen plays a key role in the life cycle of plants, namely as the main element that is absolutely necessary in the formation of chlorophyll and other important compounds such as proteins, nucleic acids, and amino acids.

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CONCLUSION

Based on the results of the research and discussion that has been done, it can be concluded that the level of shade and the dose of nitrogen fertilizer given to okra plants do not show any interdependent influence (interaction), but each single factor, both the level of shade and the dose of nitrogen fertilizer, has a significant effect on the growth and yield of okra. The highest growth and yield of okra were obtained at a shade level of 80%, and at a nitrogen fertilizer dose of 200 kg ha^{-1}.

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