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Effects of Deficiency Nitrogen Phosphorus Potassium Calcium in Okra (Abelmoschus esculentus L. Moench) Through Hydroponics

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Abstract*: Plants with nutrient deficiencies can not grow maximally and can even cause death. This study aims know to find out symptoms and the effect of deficiency elements of Nitrogen, Phosphorus, Potassium and Calcium in okra plants on growth. This study used a complete randomized design (RAL) consisting of 5 treatments and each treatment had 5 replications. The treatments consist of: Nutrition complete, without nitrogen (-N), without phosphorus (-P), without potassium (-K) and without Calcium (-Ca). The results of this study are the existence of significant differences in the treatment of nitrogen deficiency, phosphorus, potassium, and calcium. Treatment without nitrogen has a leaf color that tends to yellowish. Without phosphorus showing the color of yellowish green leaves, the tip of brown leaves like burning and dwarf leaves. Without potassium showing the color of yellowish leaves, leaves more wavy, the leaves dry and die. Without calcium showing the color of yellowish green leaves, withered leaves, brown leaf tip. Nitrogen, phosphorus, potassium and calcium deficiency affect plant height, leaf number, length and width of leaves, leaf color.

Index Terms*: Nutrient deficiencies, okra plants, treatments, randomized design, replications.

I. INTRODUCTION

Okra has been known as a multipurpose plant because almost all parts of the plant can be utilized [6]. Okra is one of the most interesting plants to study. Okra belongs to the Abelmoschus genus of the Malvaceae family (cotton-capas). Okra is one of the high nutritious vegetable commodities that started to be widely known and cultivated by the community [9]. This plant is very useful to provide the nutrients the body needs, almost half, in the form of soluble fiber in the form of mucus and peptin that can help lower cholesterol levels and reduce the risk of heart disease. The rest is insoluble fiber that can help maintain health conditions [10]. The number of utilization of okra as a medicinal plant or for consumption causes the need for increasing okra so that the need for maximal cultivation of okra plants. In the system of cultivation of plants needed sufficiency of nutrients, a plant that has nutrient deficiencies can not grow optimally. Excess nutrient deficiency can decrease crop productivity and even cause death [14]. Deficiency of one or several nutrients will cause abnormal plant growth that there are abnormalities or deviations and many plants that die young [12]. Plants lack specific nutrients, then specific symptoms of deficiency will appear. the symptoms of nutrient deficiency generally have some similarities.

According to [5] symptoms of deficiency of potassium and nitrogen have symptoms that are almost the same yellowish color on the leaf edge. Plants that have potassium deficiency, the symptoms will be seen mainly in the leaf. Each plant has almost the same visual symptoms of leaf tip and yellow spot or brown [7].

Based on the visual symptom, the need for knowledge about certain nutrient deficiency symptoms to anticipate the existence of errors in the handling, especially the symptoms of deficiency in the okra plant given the absence of information about nutrient deficiency in okra plants.

This study aims to identify the symptoms of elemental deficiency Nitrogen, Phosphorus, Potassium and Calcium and distinguish the symptoms of deficiency in each nutrient element so that the handling of deficiency of these elements can be done from the beginning of plant growth and can be handled appropriately in accordance with the symptoms seen.

II. RESEARCH METHODS

This study used a complete randomized design, consisting of 5 treatments and each treatment had 5 replications. The treatment consisted of: Nutrition complete, nitrogen-free (-N), no phosphorus (-P) solution, no potassium (-K) and without Calcium (-Ca).

A. Seedling Okra Seed

Okra seeds to be planted, soaked in warm water about 40˚C for 1 hour, then drained. The cutted rockwool is placed in the seeding tray and moistened with water evenly. Rockwool that has been dampened and given a hole using a toothpick. The okra seeds to be sown are placed at the top of the rockwool and pressed down to one-third of the rockwool sections for easy seeds to absorb water. The seeds are silenced for several days until the seeds break. After the rupture seeds can be placed in a place that is indirectly exposed to the sun.

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B. Manufacture of Hydroponics Systems

The container that has been filled with a solution of 4 liters of water and stirred so that the solution is evenly mixed. Impaboard or cover of container that has been perforated then placed on top of the container and the hole is filled with netpot. Furthermore, the aerator hose is inserted into the side or the center of the nutrient container. Seeds that have been sown and have 3 leaves moved together with rockwool and put in a netpot that has been axed flannel.

The seeds are positioned so as not to be submerged by the treatment solution. Aerator on the system can be used to decompose the deposition of nutrients as well as providing adequate dissolved oxygen.

C. Observation and Maintenance

Each treatment container was examined to ensure that each treatment was complete and the pH of the solution was checked for each suitable pH nutrient container for the hydroponic system of 5.8-6.3[8]. Water is added when the water in the nutrient container is reduced. After one week of plant conditions checked. Observation of nutrient deficiency symptoms that appear to be checked and recorded every week for 4 weeks

D. Parameters

This research was conducted with morphological and anatomical observation of nutrient deficiency symptoms. The morphology includes, plant height, leaf number, leaf length, leaf width, leaf color

E. Data Analysis

Data analysis was performed using ANNOVA at 5% test level, if it showed significant result then continued with Duncan test.

III. RESULTS AND DISCUSSION

A. Plant Height

The plant height in the control treatment showed the highest yield. This suggests that the complete nutrient treatment or control indicates maximum plant height growth. In the treatment of nutrient deficiency shows the average plant height is smaller than the control treatment. The opinion of [7] which states that the availability of nutrients will affect plant growth in this case is the availability of nutrients that plants need during vegetative and generative growth.

Plant growth can be attributable to the availability of nutrients and water. Especially the element of nitrogen used for the growth of stems and leaves. If the N element is available enough then the photosynthesis process will run smoothly and the result of photosynthate will be much so that the plant height will be accelerated [4].

Table 1. Average of Okra Plant Height (cm) at Treatment Without N P.K and Ca

Treatment	Higher Plants On The Week Of-					
	1	2	3	4	5	6
Control	16.1^{b}	18.8^{d}	24.1^{c}	28.5^{d}	35^{d}	40.4^{d}
Nitrogen (-N)	15.2^{ab}	17^{bc}	19^{b}	22^{c}	22.8^{b}	26.6^{b}
Phosphor (-P)	14.2^{a}	15.3^{a}	16.2^{a}	18^{b}	18.4^{a}	18.6^{a}
Potassium (-K)	14.6^{ab}	15.7^{ab}	15.8^{a}	15.8^{a}	16.4^{a}	16.4^{a}
Calcium (-Ca)	15.6^{ab}	18.1^{cd}	23.4^{c}	28.8^{d}	29.4^{c}	31.4^{c}

Numbers followed by the same letter in one column show that they are not significantly different based on Duncan's 5% test.

Based on the results of analysis of observation data of high plants (Table 1.) using Anova showed significant or significantly different results mean nutrient deficiency effect on plant height growth. After further testing using the Duncan test showed that all treatments began to differ significantly at week 2. During the 6 weeks observation, phosphorus and potassium treatments showed no significant difference.

Mean treatment without phosphorus and potassium the same effect on plant height. Treatment of nitrogen deficiency with calcium deficiency showed significant difference or significantly different, but each deficiency treatment showed significant difference of plant height to control treatment.

Phosphorus has the function of stimulating root growth, In addition, phosphorus functions for the formation of certain proteins and potassium has almost the same function of helping the formation of proteins and carbohydrates. Potassium also plays a role in strengthening the plant body so that leaves, flowers, and fruit are not easily killed [14].

B. Leaf Amount

Based on observations on the number of leaves (Table 2.) showed that the average number of leaves of okra plants for 6 weeks was seen in the control of the mean number of leaves greater than the treatment without nitrogen, phosphorus, potassium and calcium.

Table 2. Average Number of Okra Leaves On Treatment Without N, P.K and Ca

Treatment	Number of leaves at week-					
	1	2	3	4	5	6
Control	4^{b}	5^{c}	6^{b}	5^{c}	7^{c}	7^{c}
Nitrogen (-N)	3^{a}	5^{c}	4^{b}	3^{ab}	1^{b}	1^{b}
Phosphor (-P)	3^{a}	4^{a}	3^{a}	2^{a}	1^{ab}	0^{a}
Potassium (-K)	4^{a}	4^{a}	3^{a}	2^{a}	0^{a}	0^{a}
Calcium (-Ca)	4^{b}	4^{b}	6^{c}	4^{b}	1^{b}	0^{a}

Numbers followed by the same letter in one column show that they are not significantly different based on Duncan's 5% test.

During the observation on the average control of the total number of leaves is 4-7 strands. In the treatment without nitrogen the number of leaves as many as 1-5 strands, phosphorus treatment with the number of leaves of 1-4 strands, the treatment without potassium leaves amounting to 0-4 strands and without the amount of leaf calcium 0-6 strands, the number of leaf strands on the deficiency less than control. It is presumably much damaged in leaves such as leaves turn yellow and withered so that the leaves become broken or falling. The increase in plant growth leads to an increase in the number of leaves as the rate of growth increases with the age of the plant [7]. Based on Anova showed significant or significantly different results.

After Duncan's advanced test,

on the treatment without potassium, phosphorus and nitrogen showed no difference in leaf number at week 1, as well as calcium deficiency with control showed no difference in leaf number. [10] Nitrogen deficiency in plants causes growth to be inhibited, trubus stops faster and leaves early fall. Nitrogen deficiency not only causes poor growth but also inhibits flowering initiation in fruit crops, lack of nitrogen elements also causes slow growth, yellowish, short, old leaves quickly turn yellow and die and then miscarried, chlorosis in the older leaves gets worse usually on young leaves. Phosphorus deficiency of thin plant stems, fractured leaves, chlorosis, erratic leaf shape and stunted plant growth [8]. Plants that lack potassium show symptoms on the lower leaves of yellowing and dead ends [1]. Potassium deficiency can cause weak tissue of the stem so easily falling due to reduced plant turgor. In addition, the leaves on the plant experience necrosis and become dry tissue and the leaves become damaged perforated [7]. Plants that lack calcium cause the shoot ends to turn yellow and die, the growth of abnormal young shoots, most affected on young leaves [8].

C. Length and Leaf Width

Based on observations on leaf lengths in okra plants (Table 3) showed the average results of different leaf lengths between treatments during the 6 weeks of observation. The average leaf length in the control treatment was greater than for all nutrient deficiency treatments.

Table 3. Average Length of Okra Plant Leaves On Treatment Without N, P.K and Ca

Treatment	Leaf length at week					
	1	2	3	4	5	6
Control	4.3^{c}	8.1^{c}	10.8^{c}	10.5^{d}	7.4^{d}	8^{c}
Nitrogen (-N)	3.6^{b}	4.0^{b}	6.0^{b}	8.7^{c}	4^{b}	3,4^{b}
Phosphor (-P)	2.9^{a}	3.6^{a}	4.2^{a}	4.6^{ab}	1^{ab}	0^{a}
Potassium (-K)	3.7^{bc}	3.3^{a}	3.5^{a}	2.9^{a}	0^{a}	0^{a}
Calcium (-Ca)	4.2^{bc}	7.5^{c}	10.8^{c}	8.7^{c}	8.7^{b}	0^{a}

Numbers followed by the same letter in one column show that they are not significantly different based on Duncan's 5% test.

The average leaf length in the control is 4.3-10.8 cm, in the leafless nitrogen treatment ranged from 3.4 to 8.7 cm, treatment without phosphorus of leaf length of 0-4.6 cm, treatment without potassium length leaves of 0-3,7 cm and on treatment without calcium leaves length of 0-10,8 cm. Based on Anova showed significant results. After the Duncan test, at treatment without phosphorus and potassium for 6 weeks, the observations showed no significant difference or the treatment had the same effect on leaf length.

Table 4. Average Okra Plant Leaf Width On Treatment Without N, P.K and Ca

Treatmnent	Leaf Width at week					
	1	**2**	**3**	**4**	**5**	**6**
Control	4.6 $_{c}$	11.8 $_{c}$	16.4 $_{d}$	14,5 $_{b}$	9.2 $_{c}$	9^{c}
Nitrogen (-N)	3.8 $_{b}$	6.4^{b}	8.0^{b}	6,1^{a}	3.2 $_{b}$	4.4 $_{b}$
Phosphor (-P)	2.9 $_{a}$	4.2^{a}	5.4 ^{a}	6,1^{a}	2.4 $_{b}$	0^{a}
Potassium (-K)	3.6 $_{b}$	4.1^{a}	4.7^{a}	3,6^{a}	0^{a}	0^{a}
Calcium (-Ca)	4^{c}	10.8 $_{c}$	14.0 $_{c}$	12,8 $_{a}$	2.2 $_{b}$	0^{a}

Numbers followed by the same letter in one column show that they are not significantly different based on Duncan's 5% test.

Based on observations on leaf width for 6 weeks, the control has a leaf width of 4.6-16.4 cm. Treatment without nitrogen has a leaf width of 0-8 cm. Treatment without phosphorus has a leaf width of 0-6.1 cm. Treatment without potassium has a leaf width of 0-4.7 cm. Treatment without calcium has a leaf width of 0-14 cm. in the control treatment had a larger leaf width compared with the treatment without nitrogen, phosphorus, potassium and calcium. This is because the effect of nutrient availability on the control treatment is more satisfying than the lack of air. In the treatment of potassium leaf width is smaller than the control, treatment without nitrogen, phosphorus, calcium.

D. Leaf Color

Leaf color conditions in all treatments showed leaf color and diverse traits. Leaf color in deficient plants exhibits a variety of nutrient deficiency symptoms In the complete treatment or control leaves dark green and fresh and leaf size larger than the treatment of deficiency. According to [3] plants that have nutrient sufficiency is characterized by the running of photosynthesis activity, so the leaves will look more green. The nitrogen minus treatment has a leaf color that tends to be yellowish in color compared to the control treatment as shown in Figure 1. The yellow at the treatment without or minus Calcium shows the color of yellowish green leaves, old leaves wither, the tip of brown leaf like burning. This is thought to be due to the influence of the role of calcium itself, where calcium has a role, among others, stimulate the development of roots and leaves. So if the calcium deficiency crop, it will trouble root development process and affect the process of nutrient uptake will also interfere with the process of photosynthesis. Color of the leaves is due to the absence of nitrogen as the leaf chlorophyll element, so nitrogen is responsible for the formation of green leaf color. According to [11], the symptoms of N deficiency are chlorosis (pale green to yellow) in old leaves, stunted growth (dwarf), and necrosis of the lower leaves in cases of severe N deficiency.

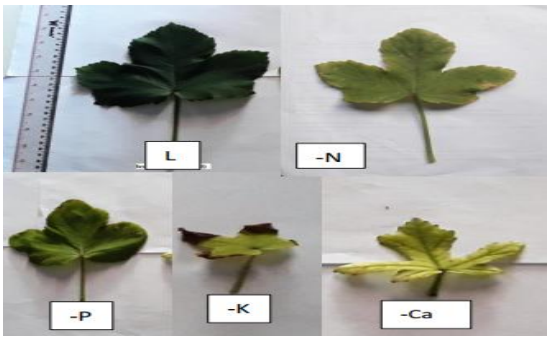

Figure 1. Okra leaf color condition after 4 weeks. L (complete nutriens), without N(-N), without P (-P), without K(-K), without Ca (-Ca)

In the treatment without or minus Potassium has a yellowish leaf color, leaves more wavy, some leaves dry and die. Leaf deficient K can also show small local patches or chlorosis area with burnt leaves on the edge. This is related to the function of potassium used by plants for the activation of enzymes (special proteins that act as catalysts and co-factors), photosynthesis, protein formation, and sugar transport [11].

The element K is also required for movement of stomata and maintains the neutrality of the charge in the cell. The deficiency symptom K is chlorosis starts primarily at the leaf tip and develops on the leaf edge downward (leaf base) with the main leaf bone in the center of the leaves remains green which forms V for the yellow color At the treatment without or minus calcium shows the color of yellowish green leaves, old leaves wither, the tip of brown leaf like burning. This is thought to be due to the influence of the role of calcium itself, where calcium has a role, among others, stimulate the development of roots and leaves. So if the calcium deficiency crop, it will disturb root development process and affect the process of nutrient uptake will also interfere with the process of photosynthesis. Calcium also plays a role in forming the compound of the cell wall, thus strengthening the cell wall and also the calcium can increase the uptake of other nutrients, such as nitrate, but if the calcium content is too high it can cause nutrient inhibition such as Mg, K and NH4 + [2]

IV. CONCLUSION

There are significant differences in the treatment of nitrogen, phosphorus, potassium, and calcium deficiency. Leaf color in deficient plants exhibits diverse symptoms. Treatment without nitrogen has a leaf color that tends to yellowish. Treatment without phosphorus has a yellowish green leaf color, the tip of a brown leaf as burning and the size of the leaves smaller or dwarf. in the treatment without potassium has a yellowish leaf color, leaves more wavy, some leaves dry and die. In the treatment without calcium showed the color of yellowish green leaves, old leaves withered, the tip of brown leaf like burning. Nitrogen, phosphorus, potassium and calcium deficiency effect on plant height, leaf number, length and width of leaves.

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