

The Effect of AB Mix Nutrient Formulations on The Growth and Yield of Several Red Chili Varieties in Hydroponics System

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Abstract Hydroponics is one of the options of red chili peppers (*Capsicum annum* L.) cultivation. Formulation of nutrient solutions can be done by combining several chemical fertilizers to obtain a complete nutrient content at more cost-effective and readily accessible. The study used factorial randomized block design (RBD) in split plot. The master plots were four AB Mix formulations, F1: P (75 ppm) K (402 ppm) Ca (150 ppm) Mg (60 ppm) and S (90 ppm), F2: P (105 ppm) K (432 ppm) Ca (180 ppm) Mg (90 ppm) and S (120 ppm), F3: P (135 ppm) K (462 ppm) Ca (210 ppm) Mg (120 ppm) and S (150), F4: P (165 ppm) K (492 ppm) Ca (240 ppm) Mg (150 ppm) and S (180 ppm). The subplots were 3 chili varieties; Kitavi variety (V1), Akar variety (V2) and CK F1 variety (V3). The results showed that AB Mix F4 formulation produced enhanced performance in plant height, stem diameter, crown width and fruit diameter. The use of CK curly red chili varieties exhibited better performance in the parameters of plant height, stem diameter, crown width and flowering age than the Kitavi dan Akar varieties. The AB Mix F4 nutrient formulation and the use of CK curly red chili varieties are the best combination for plant growth in the variables of plant height, stem diameter and crown width.

Keywords: AB Mix nutrient, Curly red chili, Hydroponics, Varieties

INTRODUCTION

Chili is a horticultural commodity that has high economic and nutrient value. The production of chili peppers in Lampung province has continued to decrease over the past five years, namely 2018 to 2022 [1]. The decrease in chili pepper production was due to pests and diseases, decreasing soil fertility and land conversion [2]. Therefore, the cultivation of red chili peppers requires optimal care and appropriate environmental conditions. Hydroponic cultivation technique is possible to be solution to increase the production of chili peppers [3]. Hydroponic cultivation techniques are able to increase crop yields as compared to conventional cultivation techniques [4]. Hydroponics is one of the soilless cultivations which commonly used husk-charcoal, sand, and cocopeat media [5]. This technique can be applied in many places such as home yards and urban areas, whereas the availability of land for planting is limited [6].

Nutrient solution is the main factor needed in the hydroponic system cultivation, that affecting to the growth and yield of the plants. The nutrient solution used in hydroponic systems is an inorganic fertilizer consisting of mineral salts needed by plants to grow well [7]. The nutrient used in hydroponic cultivation is AB Mix nutrient. AB Mix nutrition contains 16 essential nutrients needed by plants, 6 of which are needed in large quantities (macro) namely N, P, K, Ca, Mg, S, and 10 elements are needed in small quantities (micro) namely Fe, Mn, Bo, Cu, Zn, Mo, Cl, Si, Na, Co [8].

However, the main problem in the community is that AB mix nutrients are still rarely found in the market and the price is relatively-expensive, compared to the chemical fertilizers for conventional cultivation. The method that can be followed is to formulated independently AB mix nutrients by combining several chemical fertilizers so as to obtain

a complete nutritional content at more cost-effective and readily accessible. In addition to [9] stated AB Mix nutrition can be obtained by mixing it from various chemicals, but it requires high accuracy and skill. However, the problem is the making of hydroponic nutrient formulas using conventional chemical fertilizers is not yet known, therefore, it is imperative that this research be conducted.

The selection of superior varieties with high yield potential in hydroponic chili cultivation is important. Each variety has genetic differences that can affect yield and adaptability [10]. Chili varieties that can be cultivated hydroponically is hybrid chili Kitavi F1. This variety has several advantages, including resistance to viruses, resistance to curling and wilting, wide adaptability, strong stems and high productivity. Another potential hybrid chili variety for hydroponic cultivation is the CK Anvi variety which has a gene for resistance to anthracnose disease caused by the fungus *Collectirichum* [11]. In addition, local chili varieties have the potential to be cultivated hydroponically *e.g* Akar variety from Payakumbuh, West Sumatera. Akar has the advantage of being resistant to gemini virus and early maturing.

The aim of this research is to obtain the optimal AB mix formulation and the best varieties to increase the growth and yield of chili peppers in hydroponics system.

METHODS

This study used a split plot design in a factorial group randomized design with three replications. The main plot tested was AB Mix nutrient formulation (F), consist of 4 level formulations : F1 : Concentration of nutrients to nitrogen = P (75 ppm) K (402 ppm) Ca (150 ppm) Mg (60 ppm) and S (90 ppm), F2: Concentration of nutrients to nitrogen = P (105 ppm) K (432 ppm) Ca (180 ppm) Mg (90 ppm) and S (120 ppm), F3: Concentration of nutrients to nitrogen = P (135 ppm) K (462 ppm) Ca (210 ppm) Mg (120 ppm) and S (150), F4: Concentration of nutrients to nitrogen = P (165 ppm) K (492 ppm) Ca (240 ppm) Mg (150 ppm) and S (180 ppm). The subplot is chili peppers variety (V) with 3 different varieties namely Kitavi variety (V1), Akar variety (V2) and CK F1 variety (V3); there are 12 treatment combinations and 36 experimental.

Each experimental unit consisted of 6 plants, 4 plants were used as samples. The data obtained was analyzed using ANOVA test. If the results are significantly different, then the mean difference test was continued by LSD at an accuracy of 5%.

RESULTS AND DISCUSSION

VEGETATIVE GROWTH

AB mix nutrient formulation treatment and red chili peppers variety treatment showed a significant effect on vegetative growth variables of plant height, stem diameter, and crown width. The result showed that vegetatif parameters of red chili peppers were differently affected by AB mix nutrient formulations and varieties. In addition, there is an interaction between the AB Mix nutrient formulation treatment and red chili peppers varieties on the variables of plant height, stem diameter, and crown width. (Table 1.). The AB Mix F4 formulation treatment; CK variety produces the highest plant height compared to other treatments.

Table 1. showed that the combination has a positive impact to increase chili plant height. AB mix F4 nutrient formulations; CK varieties which was 56.21 cm and the lowest was in AB mix F3 nutrient formulation; Akar variety which was 41,74 cm. This is suspected due to the CK variety of chili plants is more responsive to fertilization, in order to provision of nutrients in the AB Mix F4 formulation to fulfil the nutrient requirements of chili plants for optimal height growth. The proportional element K (Potassium) produces optimal plant development. The K element contained in the AB Mix F4 nutrient formulation has a higher ppm concentration (492 ppm) when compared to the AB Mix F1 (402 ppm); F2 (432 ppm); and F3 (462 ppm) nutrient formulations. [12] stated, K element plays an important role to support metabolism and encourage vegetative growth of plants. This is confirmed by the research of [13] which states that increasing the supply of nutrients, especially potassium, can increase the growth of chili plant height.

Table 1. Vegetative growth parameters of red chili peppers plants under four differences AB mix nutrient formulation and three varieties of red chili peppers.

Treatment	Plant height (cm)	Stem diameter (mm)	Crown width (cm)
F1 x Kitavi	44,45 bc	8,13 b	45,58 c
F1 x Akar	42,65 bc	8,82 ab	50,17 bc
F1 x CK	44,66 bc	8,21 b	48,80 bc
F2 x Kitavi	44,18 bc	8,31 b	46,00 c
F2 x Akar	43,06 bc	7,68 b	43,08 c
F2 x CK	42,28 bc	8,72 ab	53,85 abc
F3 x Kitavi	44,04 bc	8,03 b	51,07 bc
F3 x Akar	41,74 c	7,77 b	49,13 bc
F3 x CK	50,20 ab	8,12 b	49,67 bc
F4 x Kitavi	47,44 bc	9,08 ab	67,86 a
F4 x Akar	51,61 ab	9,02 ab	52,68 bc
F4 x CK	56,21 a	10,62 a	62,37 ab

Remarks: values in the same column followed by different letters differ significantly under LSD 5%

The results showed (Table 1), the most effective combination for increasing stem diameter is the AB Mix F4 nutrient formulation; the CK variety, which was 10.62 mm. It is suspected due to the P (Phosphorus) element in the AB Mix F4 nutrient formulation has a higher number of ppm (165 ppm) than the AB Mix F1 (75 ppm) F2 (105 ppm) and F3 (135 ppm) nutrient formulations, so it plays a role in increasing the diameter of the chili plant stem. Phosphorus is responsible for forming plant tissues including stems [14]. The increase in P nutrients will affect cell division and stem diameter. The division area is located at the tip of the plant, where new cells continue to be generated through the process of cell division, increasing cell size. [15] explained that plant stem development is influenced by the phosphorus element, which plays a role in the process of stem cell division.

The best combination on the crown width parameter is AB Mix F4 formulation; Kitavi and CK varieties. This is expected due to the Ca (Calcium) contained in the F4 formulation has a greater amount (240 ppm) compared to other formulations, F1 (150 ppm); F2 (180 ppm); and F2 (210 ppm) which functions for plant cell elongation, thereby increasing crown width. [16] stated that chili plants need calcium elements, including to increase plant vegetative growth. Calcium plays a role in plant apical growth, cell division and seed germination [17].

The plant growth takes place due to cell division in plants (cell's size increase or length increase). The cell division area is located at terminal of the plant's growing point, growth occurs gradually in order to the cell size increase, due to this growth the plant experiences elongation. The results of research by [16] calcium nutrients play a role in cell division and cell elongation in cayenne pepper plants.

The result of branch number showed that the AB Mix nutrient formulation and chili peppers variety has no significant effect to the number of branches (Table 2.). This was indicated, lack of availability of micro-nutrients contained in AB Mix nutrients that inhibit branch growth in each variety. According to [18], a good supply of nutrients increases plant growth and facilitates their absorption, so that plants can form new branches better. Completion of nutrient absorption can be optimized the metabolic process of plants, so that plants are more effective in forming new branches. All nutrients contained in AB Mix nutrition are crucial nutrients that are needed to support the growth and development of hydroponically grown plants. If macronutrients or micronutrients are not complete, it can interfere with plant growth and development [19].

Table 2. Average of number of branches (unit) plants under four differences AB mix nutrient formulation and three varieties of red chili peppers.

Treatment	Number of branches (unit)
AB mix nutrient formulation	
F1	8,41
F2	8,08
F3	8,25
F4	9,80
Chili peppers varieties	
Kitavi	8,58
Akar	8,37
CK	8,96

GENERATIVE GROWTH

AB mix nutrient formulation treatment and red chili peppers variety treatment showed a significant effect on generative growth variables of age flowering and fruit diameter. However, had no significantly affected to the number of fruits per plant, fruit length, weight per fruit, and fruit weight per plant (Table 3.)

Table 3. showed that chili peppers varieties, CK variety, has a faster flowering age compared to Kitavi and Akar varieties. This is expected to be due to the fact that flowering period of red chili peppers is largely influenced by each variety's adaptability to its environment. According to the statement of [20], genetic variations determine the response of each species to environmental factors. Varieties that are compatible with environmental conditions will have higher growth potential, and flowering age is influenced by the performance of the plant itself. According to [21], the phenotypic diversity of each variety is affected by genetic and environmental diversity. In line with the observation data of [22], genetic and environmental factors have a significant influence on the time of flower emergence in chili plants.

The lack of ability of a variety to adapt to the environment affected to the growth and production of plants. The results of research by [23], the environment affects the yield of red chili plants and the ability of each variety to absorb nutrients varies according to plant height, number of productive branches.

Table 3. Generative growth parameters of red chili peppers plants under four differences AB mix nutrient formulation and three varieties of red chili peppers

Treatment	Age of flowering (DAP)	Number of fruits per plant (unit)	Fruit length (cm)	Fruit diameter (mm)	Weight per fruit (g)	Fruit weight per plant (g)
AB Mix nutrient formulation						
F1	28,44	7,92	12,44	4,32 c	2,70	21,38
F2	29,00	7,61	12,19	5,10 b	2,52	19,17
F3	28,56	8,05	12,18	5,01 b	2,59	20,84
F4	29,78	8,58	13,38	5,37 a	2,79	23,93
Chili peppers varieties						
Kitavi	32,50 a	7,81	12,21	4,88	2,61	20,38
Akar	27,58 b	7,94	12,69	4,95	2,63	20,88
CK	26,75 b	8,38	12,74	5,22	2,71	22,70

Remarks: values in the same column followed by different letters differ significantly under LSD 5%

The treatment of AB Mix nutrient formulations and red chili peppers varieties showed insignificant results. This phenomenon occurs due to the influence of the number of flowers emerging on each axillary branch of the chili plant on the resulting fruit count. [24] stated that the number of axillary branches can be used to estimate the number of flowers that will develop. The number of axillary branches is related to the number of flowers, which is related to

the number of fruits. According to [25], increasing the number of branches on the plant can encourage the growth of more flowers and fruits.

The treatment of AB Mix nutrient formulation and red chili peppers varieties showed insignificantly different on fruit length. This is expected due to the average length of chili fruit in Kitavi, Akar and CK varieties has no significant difference. Thus, ensuring similar genetic factors among the different varieties. The influence of genetic factors on chili fruit length is greater than environmental factors [26]. Based on the results of research by [22] that genetic factors are more influential on chili fruit length parameters. The results of this study are consistent with [27], showed that fruit length in chili plants is influenced by genetic factors. In addition, these results are also in line with [28] which states that genetic factors affect characteristics such as fruit number, fruit weight, and fruit length.

Table 3. showed the AB mix F4 formulation produced larger average fruit diameter compared to F1, F2, and F3. This is expected to be due to the content of P and K nutrients contained in F4 nutrient formulation has a higher number of ppm compared to other AB Mix nutritional formulations, P contained in the AB Mix F4 nutrient formulation (165 ppm) and K nutrients (492 ppm) are optimal for the growth and yield of chili plants and can be absorbed effectively by plants. According to [29], fruit formation is strongly influenced by the element phosphorus, which plays a role in photosynthesis and the formation of saccharides, lipids, amino, minerals, and vitamins that are translocated to the storage part of the fruit. According to the statement of [30], fruit diameter is influenced by the results of photosynthesis which are translocated to the fruit organs, so that the diameter of the fruit increases.

AB mix nutrient formulation treatment and red chili peppers varieties showed insignificantly different. Weight per fruit is related to fruit length; the longer the fruit on the plant, the greater the weight per fruit. Therefore, these two variables show a positive correlation. [31] suggested that there is a positive correlation between fruit length and weight per fruit; meaning, the longer the fruit, the weight per fruit will also increase. This is in accordance with research by [21] which showed that branching of chili plants is related to several agronomic characters, especially the total weight of fruit per plant or production yield.

The treatment has insignificantly different to the fruit weight per plant. Fruit weight per plant is influenced by the number and size of chilies. Fruit weight per plant is positively correlated with the number of fruits, weight per fruit and the number of branches where there are axillary places the flowers and fruits appear. [24] states that increasing the number of flowers that appear on the plant can increase the potential number of fruits produced.

Fruit weight per plant is positively correlated with the number of fruits. [32] stated, the number of fruits has a significant correlation with the final yield of the plant. That is, the more fruit produced, the heavier the fruit weight. According to the results of research by [32], fruit weight per plant is due to the high number of fruits produced.

CONCLUSIONS

In the present study, AB Mix F4 nutrient formulation treatment with the amount of nutrients showed the best result in the parameters of plant height, stem diameter, crown width, and fruit diameter. The CK red chili peppers variety showed the best result compare to Kitavi and Akar varieties in the parameters of plant height, stem diameter, crown width, and flowering age. The AB Mix F4 nutrient formulation; CK variety is the best combination for plant growth in the parameters of plant height, stem diameter, and crown width.

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