

Analysis of production and growth of three varieties of spinach (*Amaranthus* spp L.) on AB Mix nutrition concentration in DFT (Deep Flow Technique) hydroponic system

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ABSTRACT

This study aims to determine the appropriate concentration of AB Mix for the growth of three varieties of spinach (*Amaranthus* spp. L.) in DFT hydroponic system. The parameters observed were plant height (cm), number of leaves (strands), root length (cm), fresh weight of the whole plant at harvest (g) and fresh weight of the consumed plant (g). The research will begin in July-August 2023. The research used hydroponic technique with DFT (Deep Flow Technique) system using BA202 green spinach, Mira red spinach, and BA132 red spinach seeds. The research was conducted using the Completely Randomized Design (CRD) method consisting of one treatment factor and applied to three spinach varieties namely green spinach (V1), red spinach (V2), mira spinach (V3) and repeated 3 times. The treatment factor is the addition of AB Mix (AB) nutrient concentration which consists of 3 levels, namely: AB1 = Addition of AB Mix 900 ppm, AB2 = Addition of AB Mix 1,100 ppm, AB3 = Addition of AB Mix 1,300 ppm. The research was conducted in the greenhouse of the Faculty of Agriculture, National Development University "Veteran" of East Java Medan. Based on Statistical Test and Analysis of Variance, the results showed that the effect of different varieties had a significant effect with the value of F count > F table on plant height, number of leaves, fresh weight of the whole plant at harvest and fresh weight of plants consumed but had no significant effect with the value of F count < F table on plant height (cm) on root length.

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1. INTRODUCTION

Spinach is a plant that is grown to consume the leaves as a green vegetable. Generally, people know spinach as a vegetable with a high iron content. Apart from that, spinach is also called the king of vegetables because of the large composition of vitamins and minerals contained in spinach. Spinach originates from Tropical America, and until now spinach has spread throughout tropical and subtropical areas. In East Asia and Southeast Asia, the vegetable spinach is commonly called *Chinese amaranth* (Nurliana *et al.*, 2017) . Prospects and technology for cultivating several types of local vegetables (Amir *et al.*, 2013) .

Nutrition is one of the determinants of the quality of human resources. Malnutrition will cause failure in physical growth and intellectual development, reduce work productivity and reduce body endurance, which results in increased morbidity and mortality rates. Spinach is loved by everyone because of its high nutrition. The iron content in spinach is relatively higher than other leaf vegetables (iron is a component of cytochrome, a protein involved in photosynthesis) so it is useful for anemia sufferers. Spinach taproot is also used as medicine (Yuniansyah *et al.*, 2022). Spinach can grow all year round in both the lowlands and highlands up to an altitude of 1,500 meters above sea level (Gürsoy *et al.*, 2016).

Spinach production in Indonesia has been decreasing for the last 2 years. Based on the results of a Central Statistics Agency (BPS) survey, spinach production in Indonesia in 2021 was 179,799 quintals, and in 2022 spinach production decreased by 166,349 quintals and spinach production in the city of Medan in 2022 amounted to 10,333 quintals and in 2022 it increased rapidly by 50% to 15,316 quintals (BPS, 2023). Therefore, efforts need to be made to increase spinach production in order to meet the demand for spinach on the market.

The demand for spinach is quite high and cannot be fulfilled optimally by many spinach farmers. The conversion of agricultural land to non-agricultural land reduces the use of land for agriculture. The quality of the spinach produced by farmers is still not good, so the yield loss is quite high. The decreasing agricultural land and the low quality of spinach produced by farmers are examples of problems faced in spinach cultivation activities (Wachjar & Anggayuhlin, 2013). Some spinach is cultivated, some is not cultivated. There are two types of wild and uncultivated spinach, namely ground spinach (*Amaranthus blitum* L.) and spiny spinach (*Amaranthus spinosus* L.). The color of the stem is reddish.

Efforts to improve the quality and productivity of spinach plants can use cultivation using hydroponic techniques. An important aspect that also needs to be considered in determining the success of hydroponic cultivation is plant management which includes preparation of media materials, nutrient solutions, maintenance, application of nutrient solutions, harvest and post-harvest (Hidayanti & Kartika, 2019). Cultivating spinach plants (*Amaranthus spp* L.) using this hydroponic technique will be more controlled and easier to cultivate spinach plants (*Amaranthus spp* L.) on narrow land, where agricultural land areas in Indonesia are decreasing, therefore farmers You need a way to cultivate plants in a small area of land that is easy to do in your yard, namely by using hydroponic techniques.

Hydroponic farming has various advantages, such as relatively narrow land requirements (Siswanto & Widoretno, 2017), low levels of pest and disease attacks due to controlled environmental conditions (Abdullah, 2016), increased plant growth and production (*yield*) due to more controlled nutrition. (Barbosa *et al.*, 2015), saves the use of fertilizer and water (PA Putra & Yuliando, 2015; Rahmad *et al.*, 2019), and protects plants from drought, erosion and flooding (Barbosa *et al.*, 2015).

An important aspect that also needs to be considered in determining the success of hydroponic cultivation is plant management which includes preparation of media materials, nutrient solutions, maintenance, application of nutrient solutions, harvest and post-harvest (Hidayanti & Kartika, 2019). Plant vegetative growth is caused by meristematic activity in the growing point area which of course cannot be separated from the role of nutrients and water (Ali *et al.*, 2021).

Several types of spinach are green spinach, red spinach and striped spinach. Green spinach (*Amaranthus hybridus* L.) has complete nutritional content for the human body, including: protein, vitamin A, vitamin C, vitamin E, carbohydrates, minerals, fat, iron, magnesium, manganese, potassium and calcium. Green spinach contains lower levels of vitamin C and flavonoid compounds than red spinach. The highest levels of vitamin C and flavonoid compounds are in red spinach and can be used as a source of antioxidants which can inhibit free radicals.

Red spinach (*Amaranthus tricolor* L.) is a vegetable plant belonging to the *Amaranthaceae* family. In Indonesia, red spinach is a highly nutritious leaf vegetable and is popular with all levels of society. Apart from that, red spinach contains lots of vitamin A, vitamin B, vitamin C and iron which are very useful for growth. Red spinach was originally known as an ornamental plant, but in subsequent developments red spinach was used as a food source of protein, vitamins A and C and a little vitamin B, contains mineral salts and anthocyanin pigments (Khusni *et al.*, 2018).

Striped spinach (*Amaranthus tricolor* L.) is a plant belonging to the *Amaranthaceae* family originating from North America. Spinach is easy to grow in the highlands and lowlands. Spinach

plants have very high nutritional content, including vitamin A, vitamin C, iron, fiber, protein, pyridoxine, thiamin, riboflavin, magnesium, potassium, calcium and phosphorus (Rosyida *et al.*, 2017).

Currently, the area of agricultural land in Indonesia continues to decline due to changes in land use. Food needs for humans such as vegetables and fruit are increasing along with population growth. However, this is not accompanied by the growth of agricultural land which is actually getting narrower (AYH Putra & Pambudi, 2017). As land area becomes narrower, plant cultivation system technology has been developed using narrow land and still producing production according to community needs. Apart from that, the demand for hygienic vegetables on the market has resulted in the production of vegetables grown conventionally being abandoned. The reason is because the quality of the vegetables produced is still poor and unhygienic due to direct contamination between the vegetables and the soil (Wakerkwa *et al.*, 2017). Technically, the hydroponic system can be used as a cultivation method with these limitations (Subandi *et al.*, 2015).

Hydroponic cultivation is a cultivation system that uses AB Mix nutrients which are relatively expensive. A source of nutrition that is cheap and easy to obtain is needed as an alternative to replace AB Mix nutrition, so that the hydroponic cultivation system has high productivity at low cost.

Based on the description above, it is necessary to carry out research on "**Analysis of Production and Growth of Three Spinach Varieties (*Amaranthus spp* L.) on AB Mix Nutrient Concentrations in DFT (*Deep Flow Technique*) Hydroponic Systems**".

2. METHOD

This research was carried out in the Green House, Experimental Garden, Faculty of Agriculture, Indonesian Community Development University, Medan, Jl. Marindal II village hall, Amplas. This research was carried out starting in July - August 2023. The tools used in this research consisted of Box Container, styrofoam, net pot, seeding container, bucket, TDS meter, hacksaw, tape measure, *handsprayer*, scales, stationery, and other tools that support the implementation of this research. Materials are a very important part in a treatment or trial, generally materials are consumable parts. The materials used in this research were green spinach seeds, red spinach seeds, striped spinach seeds, *rockwool*, AB Mix Nutrition, water and other materials deemed necessary for the research.

This research was carried out using the Completely Randomized Design (CRD) method which consisted of one treatment factor and was applied to three varieties of spinach, namely Green Spinach (V1), Red Spinach (V2), Striped Spinach (V3) and repeated 3 times. The treatment factor is the addition of AB Mix concentration to nutrients (AB) consisting of 3 levels, namely: AB₁ = Addition of 900 ppm AB Mix to nutrients; AB₂ = Addition of AB Mix 1,100 ppm to nutrients; AB₃ = Addition of AB Mix 1,300 ppm on nutrients. Factor I : AB Mix Nutrient Concentration which consists of 3 treatment levels, namely: AB₁ = 900 ppm; AB₂ = 1,100 ppm; AB₃ = 1,300 ppm; Factor II : Differences in Spinach Varieties (V) which consists of 3 levels of treatment, namely: V₁ : Green Spinach Seeds; V₂ : Red Spinach Seeds; and V₃ : B striped chicken seeds. The parameters observed in this research include: plant height, number of leaves and root length.

3. RESULTS AND DISCUSSION

3.1 Research results

Results of the effect of application of AB Mix Concentration on the growth of spinach plants (*Amaranthus spp* L.) with the observed parameters Plant height (cm), Number of leaves (strands), Root length (cm) are described as follows:

3.1.1 Plant Height (cm)

The following are the results of the analysis of plant height according to the AB Mix (AB) fertilizer treatment, which did not have a very significant effect on observations 1, 2, 3, 4 and 5 WAP. It can be seen in the following table.

Table 1. Average plant height when given AB Mix at the ages of 1, 2, 3, 4, and 5 WAP

AB Mix (AB) Fertilizer	Plant Height (cm)				
	1 mst	2 mst	3 mst	4 mst	5 mst
AB1	14.55	23.57	32.72	46.48	67.65

AB2	11.18	24.58	37.05	53.83	80.55
AB3	12.37	26.58	37.80	53.48	76.33

Table 1 above can be seen that there was an increase each time AB Mix was given in plant height at the ages of 1, 2, 3, 4 and 5 WAP. It can be said that giving AB Mix at the AB2 = 1,100 ppm level gives the highest average results compared to the AB1 = 900 ppm and AB3 = 1,300 ppm levels. The graph of the average plant height at the ages of 1 WAP, 2 WAP, 3 WAP, 4 WAP, and 5 WAP can be seen in Figure 1. Meanwhile, the results of the varietal difference treatment (V) had a very significant effect on observations 2, 3, 4, and 5 WAP. Data on average plant height for different varieties can be seen in table 2 and figure 2.

Table 2. Average plant height versus variety differences at ages 1, 2, 3, 4, and 5 WAP

Varietal Difference (V)	Plant Height (cm)				
	1 mst	2 mst	3 mst	4 mst	5 mst
V1	15.88	29.67 a	44.92 a	65.33 a	98.65 a
V2	10.98	19.90 ab	24.92 ab	32.68 ab	46.33 ab
V3	11.23	25.17 b	37.73 b	55.78 b	79.55 b

Note: Numbers followed by different lowercase letters in columns indicate very significant differences at the 5% test level (DMRT)

Table 2 above can be seen that there was an increase in each treatment of different varieties at ages 1, 2, 3, 4 and 5 WAP. It can be said that the difference in variety (V) in plant height at level V1 = Green Spinach Seeds gives the highest average yield compared to level V2 = Red Spinach Seeds and V3 = Striped Chicken B Seeds.

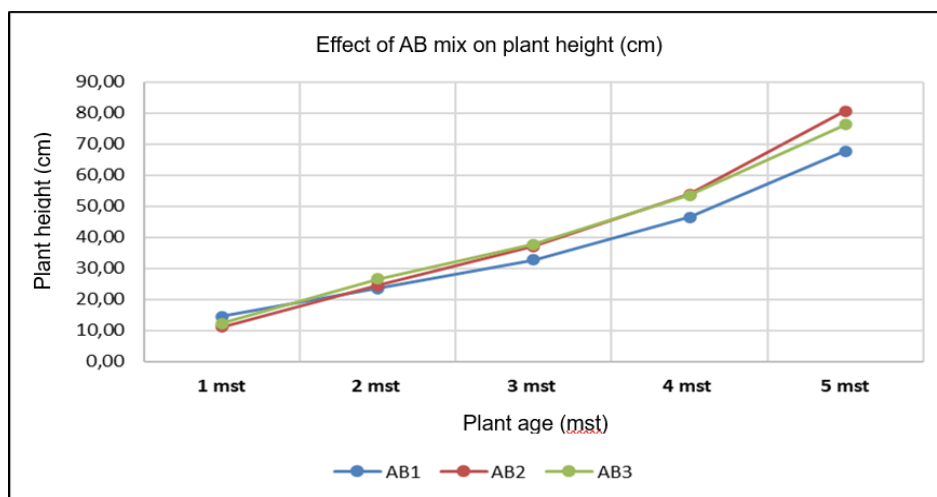


Figure 1. Graph of average plant height against AB Mix (AB)

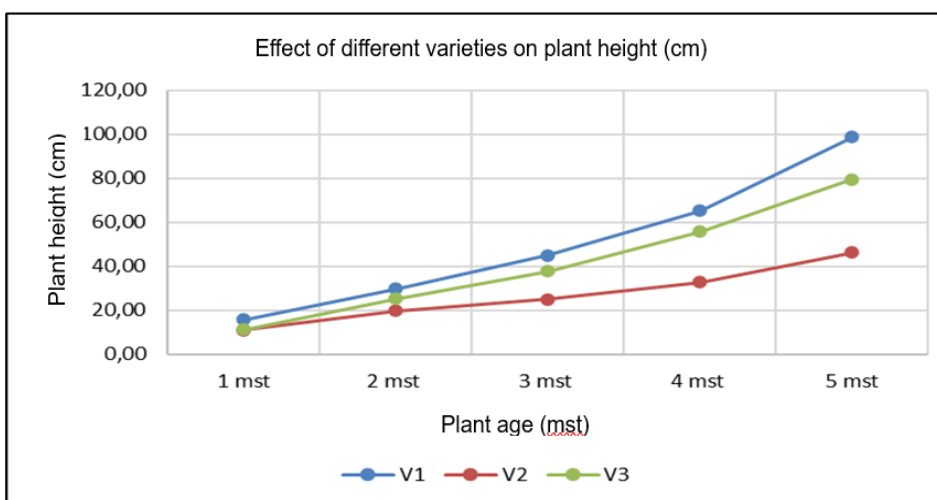


Figure 2. Graph of average plant height versus variety differences (V)

3.1.2 Number of Leaves (pieces)

The following are the results of the analysis of the number of leaves (strands) according to the treatment of AB Mix (AB) fertilizer which had a very significant effect on the 3 WAP observations, but had no real effect on the 1, 2, 4 and 5 WAP observations. It can be seen in the following table.

Table 3. Average number of leaves given AB Mix at ages 1, 2, 3, 4 and 5 wp

AB Mix (AB) Fertilizer	Number of Leaves (pieces)				
	1 mst	2 mst	3 mst	4 mst	5 mst
AB1	15,17	17,50	22,67 a	28,33	33,17
AB2	15,33	19,50	26,50 ab	29,33	36,17
AB3	15,50	18,83	26,50 b	28,67	34,50

Note: Numbers followed by different lowercase letters in columns indicate very significant differences at the 5% test level (DMRT)

Table 3 above can be seen that there was an increase each time AB Mix was given in the number of leaves at the ages of 1, 2, 3, 4 and 5 WAP. It can be said that administering AB Mix at the AB2 = 1,100 ppm level gave the highest average results at observations 2, 3, 4 and 5 WAP compared to AB1 = 900 ppm and AB3 = 1,300 ppm, but at 1 WAP observation it was given AB Mix with level AB3 = 1,300 ppm shows the highest treatment compared to levels AB1 = 900 ppm and AB2 = 1,100 ppm. The graph of the average number of leaves at the age of 1 WAP, 2 WAP, 3 WAP, 4 WAP, and 5 WAP can be seen in Figure 3. Meanwhile, the results of the treatment of different varieties (V) had a very significant effect on observations 1, 2, 3, 4, and 5. mst. Data on the average number of leaves for different varieties can be seen in table 4 and figure 4.

Table 4. Average number of leaves for differences in varieties at ages 1, 2, 3, 4 and 5 WAP

Varietal Difference (V)	Number of Leaves (pieces)				
	1 mst	2 mst	3 mst	4 mst	5 mst
V1	17,00 a	20,33 a	26,00 a	30,67 a	38,00 a
V2	14,00 ab	16,50 ab	22,50 ab	25,83 ab	30,33 ab
V3	15,00 a	19,00 b	27,17 b	29,83 b	35,50 b

Note: Numbers followed by different lowercase letters in columns indicate very significant differences at the 5% test level (DMRT)

Table 4 above shows an increase in each treatment of different varieties at ages 1, 2, 3, 4 and 5 WAP. It can be said that the difference in variety (V) in plant height at level V1 = Green Spinach Seeds gives the highest average yield compared to level V2 = Red Spinach Seeds and V3 = Striped Chicken B Seeds.

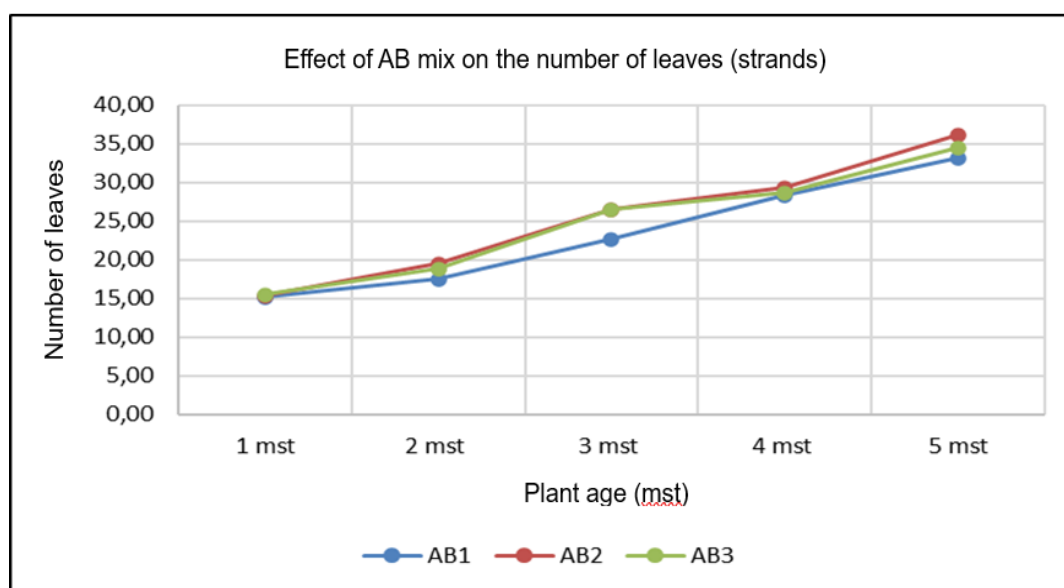


Figure 3. Graph of the average number of leaves on giving AB Mix (AB)

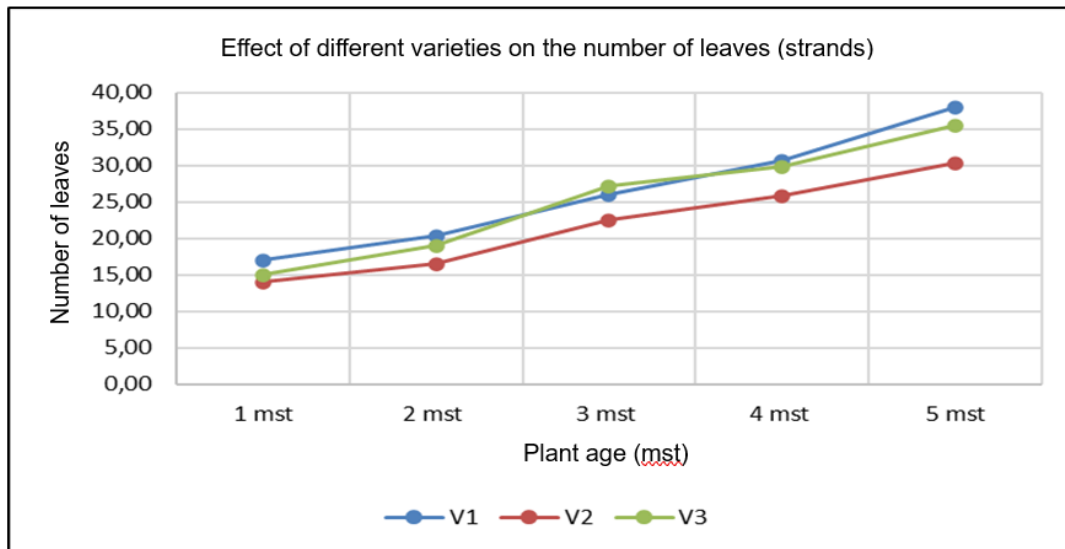


Figure 4. Graph of the average number of leaves against the difference in varieties (V)

3.1.3 Root Length (cm)

The following are the results of the root length analysis according to the AB Mix treatment, which did not have a significant effect on the observation of root length. It can be seen in the following table.

Table 5. Average root length when given AB Mix

AB Mix (AB) Fertilizer	Root Length (cm)
AB1	52.83
AB2	49.75
AB3	53.99

Table 5 above can be seen that there is an increase each time AB Mix is given in root length (cm). It can be said that administering AB Mix at the AB3 = 1,300 ppm level gave the highest average results in observing root length compared to the AB1 = 900 ppm and AB2 = 1,100 ppm levels. The graph of the average root length can be seen in Figure 5. Meanwhile, the results of the treatment of different varieties (V) had no significant effect on the observation of root length. Data on average root length for different varieties can be seen in table 6 and figure 6.

Table 6. Average root length versus variety differences

Varietal Difference (V)	Root Length (cm)
V1	61.92
V2	30.58
V3	64.08

Table 6 above can be seen that there is an increase in each treatment of varietal differences in observing root length. It can be said that the difference in variety (V) in plant height at level V3 = B Seeds for Loreng chickens gives the highest average yield compared to levels V1 = Green Spinach Seeds and V2 = Red Spinach Seeds. Steel and Torrie further stated in (Widodo *et al.*, 2016) that if the effect of different interactions is not significant, then it can be concluded that the treatment factors act independently or their influence is independent.

4. CONCLUSION

At a bokasi dose of 1:1 with a PGPR spraying frequency of 2 and 3 times, the height of pakcoy plants increases, while the combination of a bokasi dose of 1:1.5 with a PGPR spraying frequency of 4 times increases the number of leaves of pakcoy plants and is able to reduce the level of pest attacks and disease incidence.

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