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The Engineering Of Planting Media And Ab Mix Nutritional Concentration To Improve Tomato Agronomic Characteristics Hydroponically

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Abstract

The decline in tomato production in Indonesia in recent years has become an obstacle in its cultivation. Unstable soil and climate problems can reduce the quality and quantity of this crop. Efforts to increase production have been made through the improvement in the hydroponic cultivation system. The study was conducted to determine the effect of planting media and nutrient concentration of AB Mix to improve the agronomic characteristics of tomatoes by hydroponic wick system. The study used a factorial completely randomized design (CRD) consisting of 2 treatment factors, namely the planting medium combined with the nutrient concentration of AB mix. The planting medium consists of: M1 = 50% baglog waste + 50% sand, M2 = 100% baglog waste and M3 = 100% sand, while the concentration of AB mix nutrients consists of: K1 = 1000ppm, K2 = 2000 ppm and K3 = 3000 ppm. The research results showed that the best combination of planting media and nutrient concentration of AB mix at plant height variables was on the planting medium addition of 50% baglog waste + 50% sand with a nutrient concentration of AB mix of 3000 ppm. The addition of 100% sand and 3000 ppm AB mix nutrient concentration each can increase plant growth variables. While the addition of 1000 ppm AB mix nutrient concentration can increase the number of fruit by 24,89/plant and can increase fruit weight from around 103g/plant to 648,30 g/plant for 3 harvests.

Keywords: Lycopersicumesculentum Mill., Planting media, Agronomic characteristics, Hydroponics

Introduction

Indonesia faces the challenge to produce food and other agricultural products in order to meet the needs of a rapidly growing human population. Tomatoes are one of the most widely consumed agricultural products. Apart from being a vegetable, the fruit can be used as raw material for medicines, the processed materials for food and cosmetic industries so that it has a high economic value(Esparza, Jiménez-Moreno, Bimbela, Ancín-Azpilicueta, & Gandía, 2020; Gowe, 2015; Osorio, Flórez-López, & Grande-Tovar, 2021; Sagar, Pareek, Sharma, Yahia, & Lobo, 2018; Wijayanti & Susila, 2013)

National tomato production has decreased in recent years. National tomato production data in 2015 reached 962.845 tonnes but in 2016 it decreased to 883.242 tonnes (8,26%) and in 2017, the production

decreased again by 877.801 tonnes (0.61%) (Central Bureau of Statistics, 2018). The narrowing of fertile agricultural land and the conversion of agricultural land to non-agricultural land is one of the causes of the decline in tomato production in Indonesia.

An increase in production can be done through intensification and expansion of areas on potential marginal lands (Cassman, 1999; Dimithe et al., 2000; Kibret, Marohn, & Cadisch, 2016; Lewis & Kelly, 2014; Lotze-Campen et al., 2010; Pagiola & Holden, 2001; Shahid & Al-Shankiti, 2013; Strijker, 2005; Zeleke & Hurni, 2001). The main limitation for marginal land use among others are low soil fertility with high acidity and low nutrient availability. In addition, erratic climatic conditions can reduce the quality and quantity of tomatoes as well as the high proliferation of pests and plant diseases (Di Gioia et al., 2016; Tugiyono, 1999; Wai, Naing, Lee, Kim, & Chung, 2020). The consequence is that it requires the engineering of planting media by utilizing baglog waste of oyster mushrooms and sand combined with the concentration of AB mix nutrients to create a suitable growing environment through modification of the wick system hydroponic technology. Planting fruit vegetables hydroponically is more profitable because the quality of the product produced has higher quality and safer from pesticide residues and chemicals (Allen et al., 2015; Hasan et al., 2018; Indriasti, 2013; T. Liu, Yang, Han, & Ow, 2016; Ntatsi et al., 2021; Swain, Chatterjee, Viswanath, Roy, & Biswas, 2021; Tao et al., 2021). Some of the advantages of hydroponic cultivation are: 1) controllable plant growth, 2) high production quantity and quality, 3) effective and efficient provision of irrigation water and nutrient solutions, 4) independent of season, 5) relatively permanent planting media, 6) can be applied in narrow areas, and 7) reduce pests and diseases (Margiwiyatno & Sumarni, 2011).

The use of oyster mushroom baglog waste as an alternative planting medium in hydroponic cultivation because it is locally available and has porous properties, which is easy to absorb and store water and drain large amounts of water. While the benefits of sand media are easy to obtain, affordable prices, can be used repeatedly after being cleaned again, easily absorb nutrients, water and oxygen and support plant roots so that they can function like soil.

The research of (Wijayanti & Susila, 2013) showed that the use of organic growing media (bamboo leaf compost) as a hydroponic growing medium gave better results on growth parameters and the number of tomatoes of the Permata varieties. While the use of oyster mushroom baglog waste and the type of nutrition shows an interaction with the number of leaves, leaf area, wet weight and dry weight of pakcoy leaves (Anwar, 2016; Hardiansyah, Nurjanah, & Widodo, 2019; Purba, Tobing, & Setyono, 2019; Salim & Firgiyanto, 2021; Zakariya, Rivai, & Aini, 2017). Likewise, the use of hydroponic beach sand media on tomatoes provides higher root and canopy growth than husk charcoal (J. Liu et al., 1993; Mullinix, Phatak, & Cooper, 1993; Sakya, Harjoko, & Ferdyana, 2017; Sherif, Loretan, Trotman, Lu, & Garner, 1993; Snyder, 1993; Suthar et al., 2018; Trotman, Hill, Mortley, David, & Loretan, 1993).

Based on these results, the use of organic waste (oyster mushroom baglog waste) and sand has good prospects as a hydroponic growing medium in an effort to increase tomato production.

Similarly, the giving of AB mix nutrient concentration is expected to increase the nutrient content needed by tomatoes to support optimal growth and production. The focus of this study are: 1) knowing the interaction between the planting medium and the concentration of AB mix nutrients on the agronomic characteristics of tomatoes, 2) knowing the effect of the composition of the planting medium, and 3) knowing the right concentration of AB mix nutrients to improve the agronomic characteristics of tomatoes.

Materials and Methods

The research was carried out from January to March 2019, at the Experimental Garden Installation Laboratory, Department of Agricultural Cultivation, Faculty of Agriculture, Palangka Raya University. The materials used are Servo varieties tomato seeds, 8 L ice cream box for the place of nutrient solution and as a growing medium, net pole, Rockwool 2cm x 2 cm as seed media, glass of mineral water and husk charcoal as a nursery medium, flannel cloth, nutrient solution using AB mix nutrition consisting of stock A and stock B, 5 L jerry cans as a nutrient solution container, baglog waste from oyster mushroom cultivation and sand as a planting medium and a tray as a nursery place.

Experiments were arranged using a completely randomized design (CRD) with two factors and three replications. The first factor is the planting medium (M1 = 50% baglog waste + 50% sand, M2 = 100% baglog waste, and M3 = 100% sand) and the second factor is the nutrient concentration of AB (K1 = 1000 ppm, K2 = 2000 ppm and K3 = 3000 ppm). The experiment consisted of 9 treatment combinations so that there were 27 experimental units.

The preparation of planting media includes: the provision of sand and baglog waste that has been cleaned and sterilized (inserting baglog waste into plastic and then the steaming process is carried out into the sterilizer for 5-6 hours at a temperature > 100oC). Creating a wick system hydroponic installation by perforating the lid of the ice cream box with a hole diameter of 10 cm. Then make a hole in the bottom of the pot with a diameter of 12 cm to insert a 2 x 30 cm flannel cloth. The making of growth media according to treatment with a dose based on volume units. The making of AB mix nutritional solution by preparing 2 jerry cans (5 L) containing 5 L of water then input the nutritional solids A 1059 g and B 1059 g to each jerry can then stir until dissolved and give the label A (macronutrient) and B (micronutrients). Tomato seeds are sown in 30 x 30 cm plastic trays with 2 cm x 2 cm Rockwool seedling media. 7 days after the nursery, the seeds are transferred to a glass of mineral water using husk charcoal media. At the age of 14 days, the plants are transferred to a pot containing nutrient media with a concentration according to treatment and 4 L of water (1/2 volume of ice cream box). In the ice cream box, a pot containing sand and baglog waste is placed in the composition according to the treatment. One-pot contains 1 tomato seed. The provision of AB mix nutrition according to treatment (1000 ppm, 2000 ppm and 3000 ppm) is given to plants aged 7, 14, 21, 28, 35, 42 and 49.

The checking of the measurement of pH and EC solution, the pH value ranges from 6,5-6,8 and the EC value 2,1 - 2,5. The checking of the nutrient concentration using TDS (Total Dissolved Solids) conducted every 7 days followed by cleaning the box from dirt / moss when it has disturbed the plant. The addition of the nutrient solution was carried out every 7 days until harvesting with the concentration according to the treatment. Pest control is done manually by removing and killing and making traps from the used mineral water bottles (1 L) that are painted yellow and smeared with mouse glue. Disease control is carried out by spraying vegetable pesticides made from garlic extract with a concentration of 60 ml + 940 ml aquadest sprayed in the afternoon. Harvesting is started on plants aged 60-70 days after planting at intervals of 4 days as many as 3 harvests times. Harvesting is done on fruit that has yellowish and reddish color with dried leaf edges.

Observations were made on the following variables. Plant height, measured from the base of the stem to the apical growth point of the stem from 1 week after planting to 4 weeks after planting. The number of leaves, counted on the fully opened leaves from 1 week after planting to 4 weeks after planting. Stem diameter, measured 5 cm stem diameter from stem and root boundaries from 1 week after planting to 4 weeks after planting. The number of ripe fruits, calculated the number of ripe fruits at harvest (for 3 harvests). The total weight of ripe fruit, weighing the ripe tomatoes in each treatment. Performed for three (3) harvests. The effect of planting media and nutrient concentration of AB mix on the agronomic characteristics of tomatoes can be determined by the variance analysis (F test). If the results of the analysis of variance show a significant or very significant effect, then followed by the mean test using the Honestly Significant Difference (Tukey) test at the α 5% and α 1% levels.

Results and Discussion

1. Plant Height

The combination treatment of planting media and nutrient concentration of AB mix showed an interaction on the plant height aged 3 and 4 weeks after planting. The best treatment combination is found in the media of 50% baglog waste + 50% sand + 3000 ppm (Table 1).

Hydroponic cultivation In addition considering the nutrition, the planting media must also have good porosity so that air and nutrients can be absorbed optimally (Perwitasari, Tripatmasari, & Wasonowati, 2012). Whereas oyster mushroom baglog waste has porous properties, namely easy to absorb and store water, and to drain large amounts of water (Anwar, 2016)

The nutrient content found in Ab mix nutrients are macro and micro nutrients. Nitrogen is a macro nutrient. The higher the nutrient concentration given, the greater the amount of nitrogen nutrients provided as long as it does not exceed the plant requirement threshold. According to (Iqbal, 2016), the provision of nutrition in a hydroponic system is very important because the medium does not contain sufficient nutrients to

support plant growth. Tomato plant hydroponics usually uses nutrients around 1400 -3500 ppm. Nitrogen is needed by plants in relatively large quantities for each growth, especially vegetative growth of plants because it is a building block for proteins, nucleic acids, enzymes, and alkaloids (Abdallah et al., 2010; Below, 2001; Bobbink, Hornung, & Roelofs, 1998; Chapman & Barreto, 1997; Kleijn, Treier, & Müller-Schärer, 2005; Lawlor, Lemaire, & Gastal, 2001; Mae, 1997; Sumiati & Gunawan, 2007). The maximum plant height growth besides influenced by nitrogen is also influenced by other elements such as P and K (Harbianto, Armaini, & Idwar, 2015).

Table 1. The effect of planting medium and AB mix concentration on the height of tomato plants.

Treatment	Plant height (cm)			
	1 MST	2 MST	3 MST	4 MST
Planting media:				
50% baglog waste + 50% sand	11,86	27,32ab	51,31	75,86
100% baglog waste	11,74	24,88a	48,48	72,43
Pasir 100%	12,32	28,02b	52,91	75,97
F Test	Ns	*	ns	*
AB mix concentration:				
1000 ppm	12,28	25,18ab	49,31	73,39
2000 ppm	11,19	25,94a	49,16	73,63
3000 ppm	12,46	29,10b	54,23	77,23
F Test	Ns	*	*	*
Interaction	ns	ns	*	*

Information: ns = no significant effect at the 5% test level

* = significant effect on the test level of 5%,

** = significant effect on the 1% test level, the numbers in each column followed by the same letter are not significantly different based on the 5% Honestly Significance Difference (BNJ) test.

2. Number of Leaves

The treatment of the planting medium showed a very significant effect on the number of leaves of plants aged 1 and 3 weeks after planting (mst) and had a significant effect on the age of 2 and 4 weeks after planting (mst). The use of AB mix nutrient concentrations had a very significant effect on the age of 2 and 3 weeks after planting (mst) and had a significant effect on the age of 4 weeks after planting (mst) (Table 2).

The best media treatment is on 100% sand media. Sand is very suitable for hydroponic cultivation because sand has good aeration, has porous properties so that excess water can be removed completely. The best AB mix nutrient concentration treatment is at a concentration level of 3000 ppm. The availability of N and P elements in sufficient quantities and optimal absorption of nutrients in accordance with the needs that plants needed can affect plant growth. Nitrogen is very important in relation to the vegetative phase of plants, because the element N plays a role in the formation of plant tissue, especially stems, branches and leaves. The function of nitrogen in the leaves is to form a green leaf substance which is useful for plant photosynthesis (Napitupulu & Winarto, 2010).

Table 2. The effect of planting media and AB mix concentration on the number of leaves of tomato plants.

Treatment	Number of leaves			
	1 mst	2 mst	3 mst	4 mst
Planting media:				
50% baglog waste + 50% sand	4,89ab	8,67ab	11,89a	16,56ab
100% baglog waste	4,67a	7,89a	11,22a	15,56a
Pasir 100%	5,44b	8,89b	13,00b	17,22b
F Test	**	*	**	*
AB mix concentration:				
1000 ppm	4,78	7,89a	11,11a	15,44a
2000 ppm	4,87	8,44ab	12,00ab	17,11b
3000 ppm	5,33	9,11b	13,00b	16,78ab
F Test	ns	**	**	*

Interaction	ns	ns	ns	ns

Information: tn = no significant effect at the 5% test level.

* = significant effect on the test level of 5%,

** = significant effect on the 1% test level, the numbers in each column followed by the same letter are not significantly different based on the 5% Honestly Significance Difference (BNJ) test

3. Stem Diameter

The treatment of the planting medium had a very significant effect at the ages of 1, 3 and 4 weeks after planting (mst) while the treatment of AB mix nutrient concentration had a very significant effect at the ages of 2, 3 and 4 weeks after planting (mst) (Table 3).

The treatment of 100% sand medium gives a better stem diameter than other growing media. Besides having a good aeration rate, easily absorbs nutrients, water and oxygen, sand media also has a texture and aeration that is suitable for root growth. This media can also provide the highest value for plant height and leaf area on hydroponic vegetables and the heavy sand weights will affect the uprightness of the plant stems (Mas' ud, 2009; Olagunju et al., 2019; Resh, 2012)

The best AB mix nutrient concentration treatment is at a concentration level of 3000 ppm. The availability of macro and micro nutrients in sufficient quantities and optimal absorption according to plant needs will affect growth. Nitrogen is very important in relation to the vegetative phase of plants, because the element N plays a role in the formation of plant tissues, especially stems, branches and leaves (Napitupulu&Winarto, 2010).

Table 3. The effect of the planting medium and AB mix concentration on the stem diameter of tomato plants.

Treatment	Stem diameter			
	1 mst	2 mst	3 mst	4 mst
Planting media:				
50% baglog waste + 50% sand	0,44ab	0,71	0,93b	0,99ab
100% baglog waste	0,42a	0,65	0,83a	0,93a
Pasir 100%	0,51b	0,51	0,92b	1,02b

F Test	*	tn	*	*
AB mix concentration:				
1000 ppm	0,45	0,58a	0,77a	0,84a
2000 ppm	0,44	0,62ab	0,94b	1,02b
3000 ppm	0,49	0,66b	0,97b	1,09b
F Test	ns	**	**	**
Interaction	ns	ns	ns	ns

Information: ns= no significant effect at the 5% test level.

* = significant effect on the test level of 5%,

** = significant effect on the 1% test level, the numbers in each column followed by the same letter are not significantly different based on the 5% Honestly Significance Difference (BNJ) test

4. Number of Fruits

The number of tomatoes per plant for 3 harvests showed that the composition of the growing medium had no significant effect on the number of fruits. However, the treatment of AB mix nutritional concentrations of 1000 ppm and 2000 ppm gave the highest results compared to the 3000 ppm treatment (Table 4).

This is because at concentrations of 1000 ppm and 2000 ppm the amount of nutrients has been fulfilled including the Ca content. The results of the analysis of the concentration of 1000 ppm have a Ca content of 192 ppm and a concentration of 2000 ppm has a Ca content of 384 ppm so that it can produce a large number of fruits.

According to (Resh, 2012) the need for Ca in hydroponic tomato plants is around 180 ppm. Plants will thrive if the nutrients needed by plants are sufficient and in a form suitable for plant absorption (Jones Jr, 2016). But at a concentration of 3000 ppm it contains too much Ca content of 576 ppm, besides that the pH of the water becomes alkaline at 7,9 so that the Ca elements available in the nutrients are not absorbed optimally therefore the number of fruits becomes less. This is following the opinion of (Wijayanti & Susila, 2013) that if the concentration is too low, the effect of the nutrient solution is not significant, while at concentrations that are higher or too high besides wasteful it will also cause plant cells to experience plasmolysis, namely the discharge of the cell because a more concentrated nutrient solution attracts it. At a concentration of 3000 ppm, many of the fruit are attacked by butt rot (blossom and root).

Table 4. The effect of planting medium and AB mix concentration on the number of fruits per plant.

Treatment	Number of fruit per plant (3 times harvest)
Planting media:	
50% baglog waste + 50% sand	20,78
100% baglog waste	23,11
Pasir 100%	23,22
F Test	ns
AB mix concentration:	
1000 ppm	24,89[b]
2000 ppm	24,89[b]
3000 ppm	17,33[a]
F Test	**
Interaction	ns

Information: ns = no significant effect at the 5% test level.

* = significant effect on the test level of 5%,

** = significant effect on the 1% test level, the numbers in each column followed by the same letter are not significantly different based on the 5% Honestly Significance Difference (BNJ) test

5. Fruit Weight

The fruit weight per plant showed that the treatment of the planting medium did not have a significant effect so that there was no difference in fruit weight in all treatments of the growing media. The treatment of AB mix concentration of 1000 ppm gave the highest yield on fruit weight per plant for 3 harvests (Table 5).

At a nutrient concentration of 1000 ppm AB mix, the amount of nutrients needed by plants has been fulfilled, this can be seen from the large tomatoes. Fulfilling the right amount of macro and micro nutrient needs will result in good growth and yields.

Table 5. The effect of planting medium and AB mix concentration on tomato fruit weight per plant.

Treatment		Fruit weight per plant (3 times harvest)
Planting media:		
50% baglog waste + 50% sand		462,21
100% baglog waste		455,57
Pasir 100%		474,14
F Test	ns	
AB mix concentration:		
1000 ppm		648,30[b]
2000 ppm		457,08[ab]
3000 ppm		286,53[a]
F Test		**
Interaction	ns	

Information: ns = no significant effect at the 5% test level.

* = significant effect on the test level of 5%,

** = significant effect on the 1% test level, the numbers in each column followed by the same letter are not significantly different based on the 5% Honestly Significance Difference (BNJ) test

Increasing crop yield is an important indicator to determine the effect of planting media and nutrient concentration of AB mix on the agronomic characteristics of tomato plants. The number of fruit and fruit weight per plant can be increased by increasing the concentration of nutrients AB mix 1000 ppm, namely the number of tomatoes amounted to 24,89/plant and fruit weight amounted to 648,30 g/plant. While the

planting medium of sand 100% able to increase plant height, number of leaves and stem diameter. The combination of 50% baglog waste planting media and 50% sand with a nutrient concentration of AB mix 3000 ppm can increase plant height by 80,90 cm.

These findings suggest that tailoring planting media by the inclusion of baglog waste of oyster mushrooms and sand, as well as a nutrient content of 1000 ppm of AB mix, has the potential to boost tomato plant growth and productivity. Previous research found that the addition of bamboo leaf compost resulted in tomato fruit weights of 103 g/plant for three harvests (ages 9, 10, and 11 weeks after planting) (Wijayanti & Susila, 2013).

The results of this study indicated that the treatment of baglog waste and sand growing media was able to increase the growth of tomato plants. While the addition of 1000 ppm AB mix nutrient concentration was able to increase fruit weight by 648.30 g/plant for 3 harvests.

The concentration of 3000 ppm has too much Ca content amounted to 576 ppm, besides that the pH of the water becomes alkaline at 7,9 so that the Ca elements available in the nutrients are not absorbed optimally so that the number of fruits becomes less. At a concentration of 3000 ppm, many fruits were attacked by butt rot (blossom and root). Blossom and root occurred due to the lack of fulfillment of the nutrient Ca in plants (BPTP of East Kalimantan, 2014).

Conclusion

Based on the research results it can be concluded that :

1. The combination treatment of planting media of 50% baglogwaste + 50% sand and 3000 ppm AB Mix nutrient concentration can increase plant height by 80,90 cm.
2. The treatment of 100% sand planting media was able to increase the planting height by 75,97 cm, the number of leaves by 17, 22 stalks and a stem diameter of 1,02 cm.
3. The concentration of AB Mix nutrients at 3000 ppm can increase plant growth while the concentration of 1000 ppm can increase the number of fruit by 24,89 g/plant and fruit weight of 648,30 g/plant for 3 harvests.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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