

RESEARCH ARTICLE

Growth and Development of Potted Ornamental Chilli (*Capsicum annuum* L.) with Different Types of Fertilizer and Growing Media

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Abstract

Chilli has great potential to be marketed as ornamental potted plants due to their diversity in colours and shape of the fruits. The purpose of this research was to determine the optimum growing media and fertilizer to improve the performance of three varieties of potted ornamental chilli, "Syakira", "Lembayung", and "Ayesha". This research was conducted in Cikabayan greenhouse, Bogor Agricultural University, from December 2016 until May 2017. The experiment was arranged in a split plot design with fertilizer as the main factor (without fertilizer, P0; AB mix; P1, and NPK + Gandasil D, P2) and growing media as sub plots, i.e. charcoal husk : soil : manure (M1), perlite: soil : manure (M1), and cocopeat : soil: manure (M3) with proportion of 2:1:1 (v/v). NPK fertilizer and foliar fertilizer Gandasil D showed the maximum plant height, number of branches, number of flowers and fruits. "Ayesha" treated with AB mix fertilizer had the largest fruit diameter whereas "Syakira" and "Ayesha" had the longest fruit under the same treatment. Ornamental chilli grown on charcoal husk and cocopeat had the maximum number of branches and flowers per plant. "Syakira" grown on charcoal husk with AB mix and NPK + Gandasil D, "Lembayung" using cocopeat with AB mix fertilizer, and "Ayesha" varieties using charcoal husk with AB mix fertilizer were the most preferred by the consumers.

Keywords: fertilizer, fruit set, ornamental plant, performance, preference test

Introduction

Chilli is one of the most recognized horticultural crops in Indonesia and in the world and is commonly

grown for its pungent fruits. Utilization of chilli as an ornamental plant was only developed in recent years. Bosland and Votava (1999) reported that planting chilli on pot can provide advantages, such as including ease in maintenance and transportation. Due to its fruit colour variation, such as green, yellow or purple when young and red, orange or yellow when red, chilli has become an attractive ornamental potted plant (Rubatzky and Yamaguchi, 1999)

A number of research have reported consistent plant breeding activities in Indonesia to develop ornamental chilli (Desita et al. 2015; Kurniawan et al., 2015; Sirojuddin et al., 2015; Setiyoko et al., 2015; Hapshoh et al., 2016). Chilli which is planted as an ornamental plant should have aesthetical values (Cayanti, 2006). The unique shape and colour of the fruits, lush canopy and proportional shape make the chilli plants more attractive. The denser the plant the more number of generative branches, resulting in more flowers and fruits.

A study in ornamental chilli production was conducted to improve the overall plant quality. Application of fertilizers and growth regulators can control the size and shape of plants. Nurlaelia (2007) reported that 30 ppm paclobutrazol can produce proportional ornamental chilli plants. A more recent study by Sari and Suketi (2013) showed that 100 and 200 ppm GA₃ can increase vegetative growth of the plant but had no effects on fruit drops. The best NPK fertilizer dosage that can support the growth and quality of ornamental chilli is 1.5 g per plant (Shofiana and Suketi, 2015). Furthermore, Shofiana and Suketi (2015) reported that application of 1, 2 or 3 g.L⁻¹ foliar fertilizers resulted in a proportional plant and more number of branches per plant.

Growing media is one of the most important factors in plant growth and development. According to Soepardi (1983) growing medium must be able to support the plants, have good aeration, can hold water and nutrients. Mixing the soil with other materials such as compost, sand and fertilizer is intended to obtain these physical properties. Studies have depicted the benefits of adding composts (Kamaliah, 1999), cocopeat and manure (Cayanti, 2006) in a potting mix in improving vegetative and generative growth while enhancing good quality of ornamental chilli. The objective of this study was to evaluate and determine the optimum growing media and types of fertilizers to improve the growth and performance of ornamental potted plant chilli "Syakira", "Lembayung" and "Ayesha".

Materials and Methods

The research was conducted in Cikabayan greenhouse, Bogor Agricultural University, from January to May 2017. Growing media tested were soil, manure, charcoal husk, perlite and cocopeat, combined with AB mix fruit, NPK (16-16-16) and Gandasil D fertilizers. Abamectin and mankozeb at recommended dosage were used to control insect pests and disease respectively when required. The experiment was arranged in a split plot design with fertilizer as the main plot, consist of three types of fertilizers, i.e P0 (without fertilization) as control, P1 (AB mix), and P2 (NPK + Gandasil D). The subplot was growing media consisting of 2: 1: 1 (v/v/v) of charcoal husk: soil: manure (M1), perlite: soil: manure (M2), and cocopeat: soil: manure (M3) using three chilli ornamental varieties, "Syakira", "Lembayung" and "Ayesha". Each experimental units consist of five plants, so there were 405 plants in total.

The seeds were planted in a tray, and 4-week-old seedlings were transplanted into 20 cm pots containing the different medium with one seedling per pot. Fertilizer solution at 250 mL was applied weekly to each plant starting week one to week 12. The concentration of AB mix fertilizer used in each stock A and B was 5 ml.L⁻¹ water (P1) and NPK 5 g.L⁻¹ water + Gandasil D 2 g.L⁻¹ water (P2).

Scoring was conducted on plant height, number of branch per plant, number of flower per plant, number of fruit per plant, fruit length (cm), fruit diameter (mm), ratio of fruit length and diameter. Consumer preference test was conducted three times at 8, 10, and 12 weeks after planting (WAP). The test was conducted by ten panelists (female and male students). Assessment criteria consisted of plant proportion, physical appearance of plants, the appearance of leaf and fruit colour, and crop overall performance using scale of one to four: highly dislike (1), dislike (2), like (3) and really likes (4). Data were tested by F-test. Significant values were tested further using Duncan Multiple Range Test (DMRT) at α 5%.

Results and Discussion

Plant height

Types of fertilizers affected the height of ornamental plants of "Syakira", "Lembayung" and "Ayesha" at 2-12 WAP. Plants treated with NPK + Gandasil D were taller than those with AB mix fertilizer or without fertilizer (Figure 1, 2 and 3). This confirmed the studies by other researchers that ornamental chilli was the tallest when supplied with NPK (Sari and Suketi, 2013; Prasetya, 2014; Shofiana and Suketi, 2015).

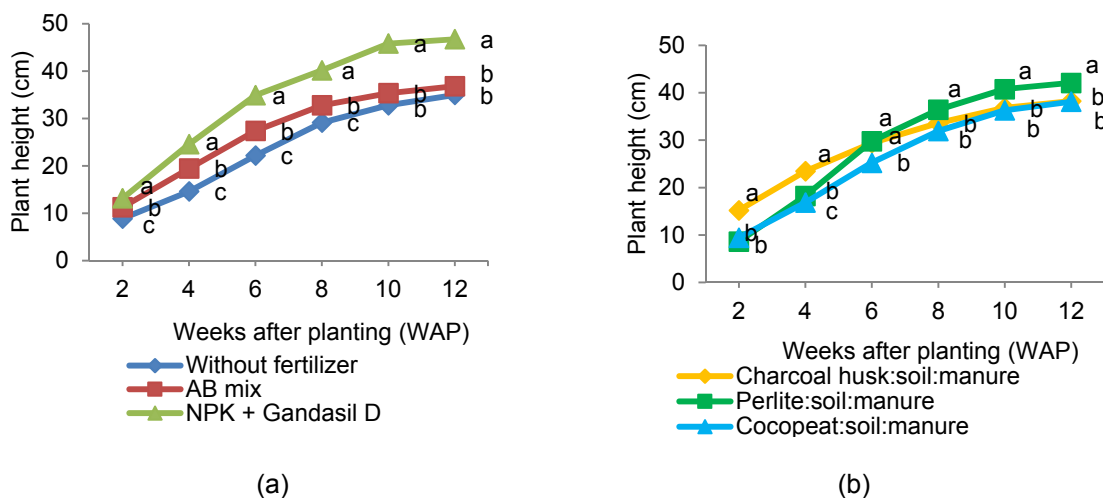


Figure 1. Plant height of ornamental chilli "Syakira" with different fertilizer treatments (a) and growing media (b).

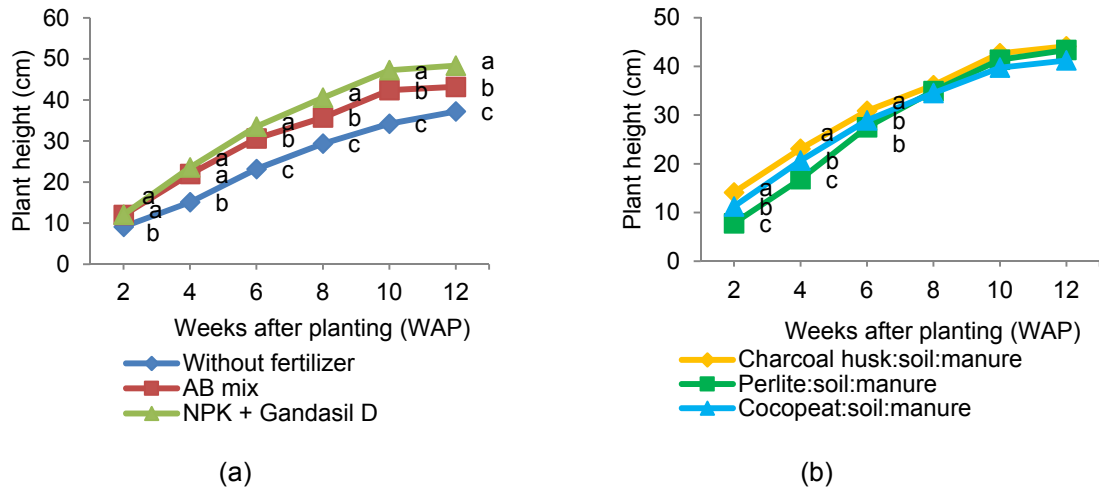


Figure 2. Plantheight of ornamental chilli ““Lembayung”” with different types of fertilizer treatments (a) and growing media (b).

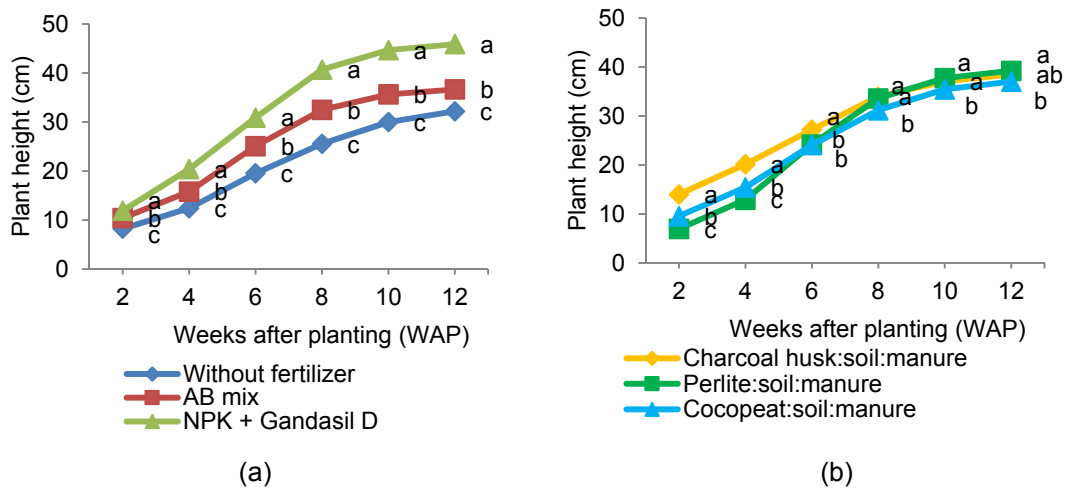


Figure 3. Plant height of ornamental chilli ““Ayesha”” with different fertilizer treatments (a) and growing media (b).

Types of growing media affected “Syakira” and “Ayesha” height at 2 to 12 WAP, and “Lembayung” at 2 to 6 WAP. Plants grown on perlite medium were the shortest in the first week; however, “Lembayung” grown in perlite was the tallest at 8 to 12 WAP, although not significantly different from those grown in the other media. Similar results were reported by Maloupa et al. (1993) that gerbera plants grown in perlite were taller and had more flowers compared to those grown in rockwool.

Number of branches per plant

Lushiousness is one of the important qualities of potted plants. Dense plants would have more generative branches that potentially produce more fruits. Branch number per plant was influenced by the fertilizer treatment (Figure 4, 5, and 6). NPK +

Gandasil D applied weekly produced the greatest number of branches in “Syakira”, “Lembayung” and “Ayesha” varieties at two weeks after planting until week 12. Good vegetative growth of the plants in this study showed that providing additional nutrients were beneficial to the chilli plants, indicated by more number of branches per plants compared to those without fertilization. A similar result was reported by Sari and Suketi (2013) and Khan et al. (2014).

The types of growing media affected the number of branches in the ornamental chilli. The use of charcoal husk and cocopeat medium in all varieties resulted in more branches per plant than those grown in perlite medium at 12 WAP. Cayanti (2006) reported that chilli grown on charcoal husk and cocopeat medium had more branches than those grown on sawdust medium. The use of growing medium with organic materials

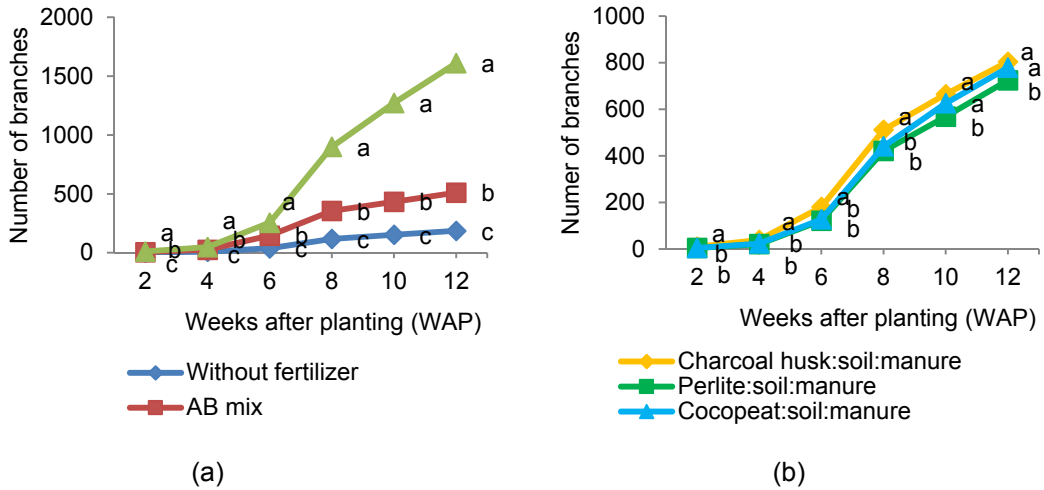


Figure 4. Number of branches per plant of ornamental chilli "Ayesha" with different fertilizer treatments (a) and growing media (b).

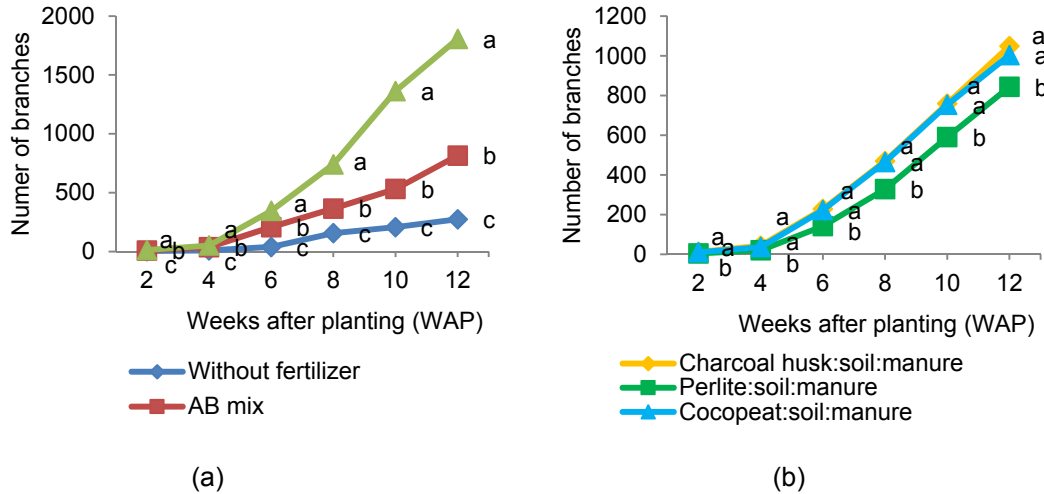


Figure 5. Number of branches per plant of ornamental chilli "Lembayung" with different fertilizer treatments (a) and growing media (b).

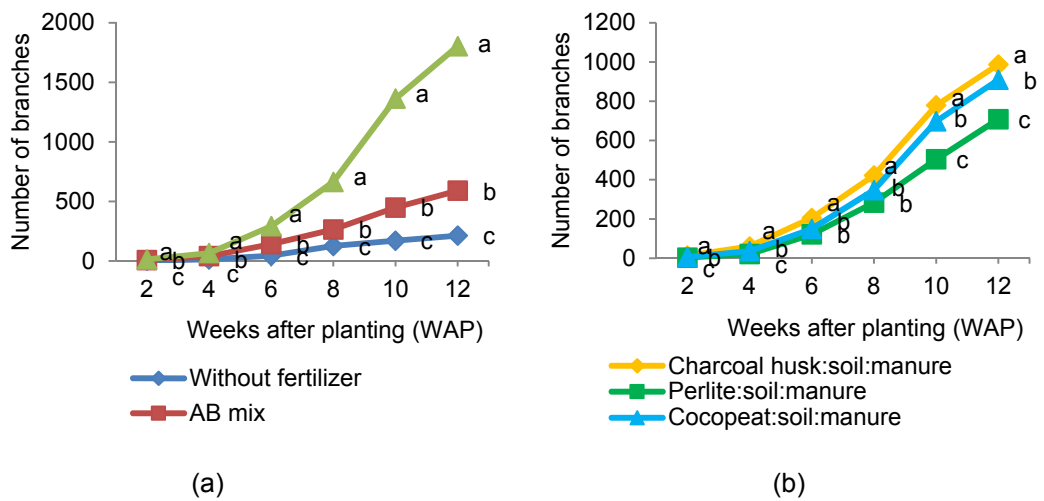


Figure 5. Number of branches per plant of ornamental chilli "Lembayung" with different fertilizer treatments (a) and growing media (b).

such as charcoal husk and cocopeat possibly provided better medium physical properties. As reported by Soepardi (1983) that organic material in the growing medium, previously bound in the organic materials, decomposed and became available for plants hence enhances their vegetative growth

Number of flowers and fruits per plant

Plant fertilized with NPK + Gandasil D had the greatest number of flowers compared to other treatments (Table 1). "Syakira" and "Lembayung" grown in charcoal husk medium had the greatest number of flowers, even though it was not significantly different from those grown on cocopeat medium. Plants grown in charcoal husk media had the greatest number of flowers than those grown in other media. Composition of charcoal husk and cocopeat media may have had better aeration and water holding capacity as compared to other media. Gunadi et al. (2007) reported that pH of charcoal husk medium was higher than perlite medium on paprika and the plant root system was the best on this type of media.

Total number of fruits per plant was not affected by growing medium, but was affected by types of fertilizers. NPK + Gandasil D (P2) resulting in the most of number of fruits in "Syakira" (123) and "Lembayung" (66) (Table 1). Fertilizing with AB mix resulted in the greatest number of fruits in "Ayesha" (72).

A study by Alviana and Susila (2009) showed that increasing the doses of fertilizer up to 453 kg.ha⁻¹

N, 207 kg.ha⁻¹ P₂O₅, 360 kg.ha⁻¹ K₂O increased fruit number per plant in chilli "Prabu".

Plants fertilized with NPK + Gandasil D had the greatest total number of fruits per plant at 12 WAP, but fruit formation in this treatment was seven days later than those with AB mix fertilizer. It is possible that the Nitrogen levels from AB mix was too high and delayed fruit formation, as reported by Rubatzky and Yamaguchi (1999).

Fruit formation was fewer than the total number of flowers due to a large number of flowers that dropped, most likely due to high day temperatures during the course of this study. The average daily temperature in the greenhouse of 29°C was acceptable for chilli, but the maximum day temperature in the greenhouse could reach 44.1 °C in some days, resulting in the rapid drying out of growing media. The optimum temperature for chili growth is between 21-30°C; temperatures above 35°C could reduce the rate of fruit formation, especially in low humidity environment, and resulting in non-viable and sterile pollens (Pinto et al., 2016; Bosland and Votava, 1999). The period from pollination, anthesis, to the beginning of fruit formation is a critical phase in chilli; water deficiency at this stage could cause flower drops, falls of young fruits, and will be affecting the final size of the fruits.

Fruit Characteristics

Based on our results different types of growing media did not affect the length and diameter of the fruits (Table 2). The longest fruit was from the plants

Table 1. The effects of types of fertilizer and growing media on the number of flowers and fruits of ornamental chilli

Treatment	Number of flowers per plant			Number of fruits per plant		
	"Syakira"	"Lembayung"	"Ayesha"	"Syakira"	"Lembayung"	"Ayesha"
Fertilization						
P0	179.29 c	263.41 c	201.66 c	17.82 c	7.92 c	18.07 b
P1	488.51 b	797.87 b	572.13 b	67.22 b	40.27 b	72.29 a
P2	1567.25 a	1756.89 a	1736.50 a	123.53 a	66.36 a	63.78 a
F-test	**	**	**	**	**	**
Growing media						
M1	771.42 a	1021.51 a	963.11 a	74.35	41.11	55.86
M2	705.20 b	818.16 b	684.49 c	71.43	32.84	51.51
M3	758.43 a	978.51 a	862.70 b	62.79	40.59	46.78
F-test	*	**	**	ns	ns	ns
Interaction	*	ns	**	ns	ns	ns

Note: Values followed by different letters in the same column are significantly different according to Duncan's multiple range test (DMRT) at $\alpha = 5\%$, ns = not significantly, * = significant (at $\alpha = 5\%$), ** = very significant ($\alpha = 1\%$), P0 = without fertilization, P1 = AB mix, P2 = NPK + Gandasil D, M1 = charcoal husk : soil : manure, M2 = perlite : soil : manure, M3 = cocopeat : soil : manure

fertilized with AB mix in “Ayesha” and “Syakira”, whereas “Lembayung” fruit length was not affected by types of fertilizer treatment. AB mix fertilizer increased the fruit diameter in “Ayesha”; this was in line with a study by Samanhudi and Harjoko (2010) where charcoal husk medium with AB mix standard Joro produced a larger diameter of tomato fruits. A similar study by Widyanti and Susila (2015) showed a significant increase in the length and diameter of the large red chilli. Nitrogen and potassium fertilizer has been shown to increase the length of chilli fruit (Khan et al, 2014) and they are the most important elements in the biochemical and physiological processes that affect plant growth and metabolism (Wang et al, 2014).

Table 2. The effects of types of fertilizer and growing media on ornamental chilli fruit length, fruit diameter, and ratio of fruit length to fruit diameter

The growing media and fertilizer did not affect the ratio of fruit length to diameter; a character that varies with cultivar. “Syakira” had high ratio of length to diameter (5.5) whereas in “Ayesha” it was lower (2.25), resulting in more rounded fruits. These results are similar to those reported by Sari and Suketi (2013) and Cayanti (2006) that fertilization and growing media do not affect the ratio of length to diameter of the fruits.

Customer Preference Test

Preference test was conducted three times by ten panelists to evaluate the preference of consumersto

the ornamental chilli plantsat week 8, 10 and 12. Performance was based on plant to pot proportion, freshness, physical appearances, fruit and leaf colour (Table 3).

Plants with fertilization treatment were preferred over the treatment without fertilization. Eight-week-old chilli plants fertilized with NPK + Gendasil D were the most preferred by the panelists. All chilli plants treated with NPK + Gendasil D at 8 WAP had a good proportion, lushious green leaves, and attractive physical appearances. Proportional plant value decreased when plants were > 10-week-old due to the canopy that had become too dense and wide. In general, a proportion of plant height to diameter of 1.5 to 2 is ideal for potted plant (Rego and Rego, 2016).

“Syakira” fertilized with AB mix fertilizer and NPK + Gendasil D were the most preferred crop performances by panelists at 12 WAP. Generally, panelists preferred ornamental chilli plants that were given AB mix fertilizer at 10 and 12 WAP due to their good proportion and attractive fruits. However, the leaves of plants treated with AB fertilizer had started yellowing at 12 WAP. Leaf yellowing may be a clear indication of a nitrogen deficiency (Bosland and Votava, 1999) which was evident in plants treated with AB mix fertilizer treatment.

Fruit colour and overall shape of the ornamental chilli are the most important factors that determine the quality of ornamental chilli plants. “Syakira” and “Lembayung” varieties have a narrow triangular

Table 2. The effects of types of fertilizer and growing media on ornamental chilli fruit length, fruit diameter, and ratio of fruit length to fruit diameter

Treatment	Fruit length (cm)			Fruit diameter(cm)			Fruit length to diameter ratio		
	“Syakira”	“Lem-bayung”	“Ayesha”	“Syakira”	“Lem-bayung”	“Ayesha”	“Syakira”	“Lem-bayung”	“Ayesha”
Fertilization									
P0	3.93a	2.71	2.18 b	7.31	6.26	9.53 b	5.45	4.37	2.31
P1	4.34b	2.94	2.49 a	7.65	6.24	10.76 a	5.78	4.80	2.35
P2	4.28b	2.89	2.15 b	7.83	6.39	9.79 b	5.57	458	2.25
F-test	**	ns	**	ns	ns	*	ns	ns	ns
Growing Media									
M1	4.22	2.92	2.29	7.49	6.36	10.29	5.75	4.66	2.27
M2	4.14	2.83	2.30	7.66	6.37	10.25	5.49	4.50	2.27
M3	4.20	2.79	2.23	7.65	6.16	9.54	5.56	4.59	2.37
F-test	ns	ns	ns	ns	ns	ns	ns	ns	ns
Interaction	ns	*	ns	ns	ns	ns	ns	*	ns

Note: Values followed by different letters in the same column are significantly different according to Duncan’s multiple range test (DMRT) at $\alpha = 5\%$, ns = not significantly, * = significant (at $\alpha = 5\%$), ** = very significant ($\alpha = 1\%$), P0 = without fertilization, P1 = AB mix, P2 = NPK + Gendasil D, M1 = chorcoal husk : soil : manure, M2 = perlite : soil : manure, M3 = cocopet : soil : manure

Table 3. Result of preference test for performance ornamental potted chilli

Treatment	"Syakira"			"Lembayung"			"Ayesha"		
	Week after planting (WAP)								
	8	10	12	8	10	12	8	10	12
P0M1	2.4	2.3	2.6	2.8	2.5	2.5	2.6	2.7	2.9
P0M2	2.2	2.2	2.3	2.7	2.5	2.4	2.5	2.5	2.7
P0M3	2.3	2.3	2.2	2.7	2.6	2.6	2.2	2.2	2.4
P1M1	3.1	3.4	3.4	3.3	3.4	3.2	3.2	3.6	3.6
P1M2	3.1	3.0	3.1	3.1	3.3	3.2	2.9	3.3	3.6
P1M3	3.0	3.2	3.4	3.0	3.5	3.3	2.9	3.4	3.2
P2M1	3.2	3.1	3.4	3.2	2.9	2.8	3.3	2.7	2.8
P2M2	2.9	2.6	2.9	3.3	2.9	3.0	3.2	2.9	3.0
P2M3	2.7	2.7	3.0	3.2	3.0	2.9	3.0	2.7	2.6

Note : P0 = without fertilization, P1 = AB mix, P2 = NPK + Gandasil D, M1 = chorcoal husk : soil : manure, M2 = perlite : soil : manure, M3 = cocopeat : soil : manure

fruit shape whereas "Ayesha" fruits are triangular. All varieties have gradation of fruit colour during ripening. "Syakira" and "Ayesha" have yellow, orange and red ripe fruits, whereas "Lembayung" fruits are light purple, pale to dark orange fruits. The variation in the colours of fruits make the plants look attractive.

Conclusion

Planting different ornamental chilli varieties should take into account the selection of growing media and types of fertilizers to obtain the best performance. Charcoal husk media with AB mix fertilizer or NPK + Gandasil D was the best for "Syakira", cocopeat medium with AB mix fertilizer was the best for "Lembayung", and charcoal husk medium with AB mix fertilizer for "Ayesha".

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