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Effects of Compost Type and Rootstock Length on Fruit and Vegetable Seedlings Growth in the Nursery

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History Article

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Abstract

The study was conducted to develop local fruit plants and to improve vegetable production at the Plant Germplasm Garden of RC for Biotechnology-LIPI. Carambola (*Averrhoa carambola*), durian (*Durio zibethinus*) and guava (*Psidium guajava*) were propagated vegetatively (grafting and budding) and were grown on the media containing grass compost (K-1), spent compost of paddy straw mushroom (K-2) or oyster mushroom (K-3) in combination with rootstock length of 45-55 cm (TB-1), 65-75 cm (TB-2) and 75-90 cm (TB-3). Tomato (*Lycopersicum esculentum*) and *kangkung* (*Ipomoea reptans*) were grown on the same media in the screen house. The highest survival rate of grafted durian (71.56%) was obtained from TB-3 grown on K-1 by budding technique. Meanwhile, the highest survival rate of carambola (68.89%) was obtained from TB-1 by grafting technique. The budding technique was not appropriate for guava (0 % of survival). Application of K-3 of 3 kgs on tomato plants resulted in the highest fresh weight, length, and diameter of the fruit, and the highest of plant height, total leaves, and biomass of *kangkung*. The study is expected to be applied to improve fruit plant growth and survival rate as well as a high production of organic vegetable.

How to Cite

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INTRODUCTION

Vegetative propagation (grafting and budding) technique of fruit plant species was done at the Plant Germplasm Garden of Research Center for Biotechnology-LIPI in order to develop local fruit plant species. Eight carambola varieties have been characterized to assess their genetic variability and relationship (Priadi, et. al., 2016). It was known that new plant produced by this technique is identical to scion traits. It has been reported that vegetative propagation can reduce the heterogeneity of star fruit trees (Gonzalez et. al., 2006) and other fruit plant species. There are some requirements for successful grafting such as compatibility between rootstock and scion, the cambial region of the scion must be placed in intimate contact with that rootstock, the grafting operation must be done at a time when the rootstock and scion are in the proper physiological stage (Hartmann et al., 1990), in addition, organic materials used for seedling growth post-grafting or budding is also important.

Organic wastes such as grass cuttings and spent compost of paddy straw and oyster mushroom and cow dung were used to produce quality compost. Compost is organic materials that contain essential nutrients that plants need. Compost has the ability to improve the chemical, physical, and biological characteristics of soils (Coperband, 2002). Therefore, such compost was used for growing media of fruit and vegetable plants. Plant growth was affected by several factors such as duration of composting and the addition of N prior to composting (Prasad & Charlie, 2007). Recently more people have started to consume healthy food such as organic vegetable from the organic farming system that using organic fertilizer. Tomato (*Lycopersicum esculentum*) is a fruit vegetable, originated from the South America. It can be consumed directly as a condiment, salad or processed into sweets, dried fruit or canned fruit. Tomato fruit has a good nutritional content; therefore it used to improve community nutrition (Siemonsma & Piluek, 1994). Meanwhile, *kangkung* (*Ipomoea reptans*) is an important leafy vegetable in Indonesia. This species is native to Africa and has been widely cultivated in the tropics (Wiersema & Leon, 2013).

The objective of the study was to investigate the effects of rootstock length, propagation techniques and growing media containing compost on growth and survival rate of fruit plant seedling in order to develop local fruit plant species in the nursery and to improve organic vegetable production in the screen house .

METHODS

Source of plant and compost

Both of scions and rootstock of star fruit (*Averrhoa carambola*), durian (*Durio zibethinus*) and guava (*Psidium guajava*) were obtained from the registered mother plant at the Plant Germplasm Garden of Research Center for Biotechnology-LIPI. The combination of fruit plant rootstock and scion variety used in this study was presented in Table 1.

Table 1. Combination of rootstock and scion variety of three fruit plant species for vegetative propagation

Species	Variety	
	Rootstock	Scion
Carambola (*Averrhoa carambola*)	Demak	Dewabaru
Durian (*Durio zibethinus*)	Local durian	Sitokong
Guava (*Psidium guajava*)	Local guava	Kristal

Two species of vegetable plants used in this study i.e. tomato (*Lycopersicum esculentum*) and *kangkung* (*Ipomoea reptans*) were obtained from a local market in Bogor, West Java. Soil amendments used in this study was grass and spent mushroom compost. Grass compost was obtained from RC for Biotechnology-LIPI, whereas both of spent compost of paddy straw and oyster mushroom were obtained from RC for Biology-LIPI (Table 2).

Table 2. Compost type and fruit plant rootstock length for vegetative propagation

Type of compost	Raw material of compost	Code of rootstock	Rootstock length (cm)
K1	Grass	TB-1	45-55
K2	Spent of paddy straw mushroom	TB-2	65-75
K3	Spent of oyster mushroom	TB-3	75-90

Procedures

This study was conducted from April to October 2015 at the Germplasm Garden of RC for Biotechnology-LIPI, Cibinong, West Java. The average temperature and rainfall in this area

from April to October 2015 was 27.5-27.7°C and 305-228 mm respectively. The predominant soil type in this region (Cibinong) is latosol (Tan, 2008). The fruit plants were propagated vegetatively using either grafting or budding technique and were grown on media in the polybag (15 x 20 cm) containing grass compost (K-1) at least in triplicates up to 3 weeks for survival observation. Grafting was made at 25-30 cm above the base. The plants were then transferred to soil media in the polybag (20 x 30 cm) containing various type of compost (1:1) i.e. grass compost (K-1), spent compost of paddy straw mushroom (K2), and spent compost of oyster mushroom (K-3) in combination with rootstock plant lengths i.e. 45-55 cm (TB-1), 65-75 cm (TB-2) and 75-90 cm (TB-3) for 10 weeks. A study on apple trees propagation conducted by Karlidag & Esitken (2012) showed a positive relationship between the length of the rootstock trunk and the number of lateral shoots. The propagated plants were maintained in the paranet shade with the light intensity of 70% until the union was established. Watering and pest eradication of the plants were done as needed. The tomato seeds were sown manually on growing media containing top soil, rice husk charcoal and spent compost of paddy straw mushroom (1:1:1) in polystyrene trays prior to transfer to soil beds (6 x 1 m) in the screen house. In order to produce organic vegetables of tomato and *kangkung* the same compost type was applied to soil beds with a dosage of 3 or 5 kg each plant**.** The tomato was cultivated in soil beds with a spacing of 60 x 60 cm for 9 weeks. Whereas the *kangkung* was cultivated for 5 weeks in soil beds with a spacing of 20 x 20 cm. The individual tomato plant was supported by a bamboo stick when fruiting start. The plants were watered as needed. Meanwhile, pest and disease of the plants were controlled with organic pesticides.

Statistical analysis

The experiments were arranged in Completely Randomized Design (CRD) with 3 replications. Obtained data was analyzed statistically using Analysis of Variance (ANOVA) followed by Duncan's Multiple Range Test (DMRT) using statistical software of SPSS 16.0.

RESULTS AND DISCUSSION

Fruit plant

Survival rates of grafted fruit plants of those three species were varied. The highest percentage of survival of carambola (68.89%) was obtained by the rootstock length of 45-55 cm using grafting technique. Meanwhile**,** the highest percentage of survival of durian (75.56%) was obtained by the rootstock length of 75-90 cm using the budding technique (Figure 1). A study on apple tree grafting conducted by Karlidag & Esitken (2012) showed that a higher level of cytokinin production may occur in longer rootstock trunks. Consequently, the amounts of cytokinin transported from rootstock to scion may be greater, and higher levels of cytokinin in the scion shoot can promote lateral bud growth. All compost type applied to grafted fruit plant was not significantly different in majority growth parameters observed (Table 3).

Rootstock selection and its interaction with scion is an important factor in vegetative propagation. Goncalves et al. (2005) found that the rootstock genotype affected all physiological parameters of sweet cherry (*Prunus avium*). It is also affected the yield of grafted apple trees (D'yakov et al., 2014). A study on carambola grafting conducted by Bhadra (2012)**,** using a combination of time grafting operation and carambola varieties showed that the highest graft success and survival were recorded in a non-hybrid star fruit (BAU Carambola-1 variety), while the lowest were in hybrid carambola which was conducted in May in Bangladesh. A study on durian propagation conducted by Sudjijo (2009)**,** showed that rootstock diameter of 0.55-0.60 cm resulted in bigger union diameter. On the other hand, the rootstock diameter of 0.45-0.55 cm grafted with a scion of durian (cv. Hepe) resulted in higher grafted plant length at 3 months after grafting. Budding technique seems to be not appropriate for guava propagation which is indicated by 0% of survival (Figure 1)**.** A study conducted by Singh et al., (2007) showed that temperature range of 20-26°C and relative humidity of 69-78% were the most conducive for maximum graft union in guava.

Graft union formation was affected by compatibility between rootstock and scion. A study on apple propagation conducted by Dolgun et al. (2009) found that the formation of a mechanically strong graft union depends on differentiation of wound vessel members and new vascular elements. Successful graft union was represented by survival grafted plants and may vary between the species. In this study, it was found that the best graft union was obtained by durian compared with carambola and guava in both grafting and budding technique. Those grafted fruit plants growth seems to be affected by the growing media used. In general, the highest growth parameter value of carambola, durian

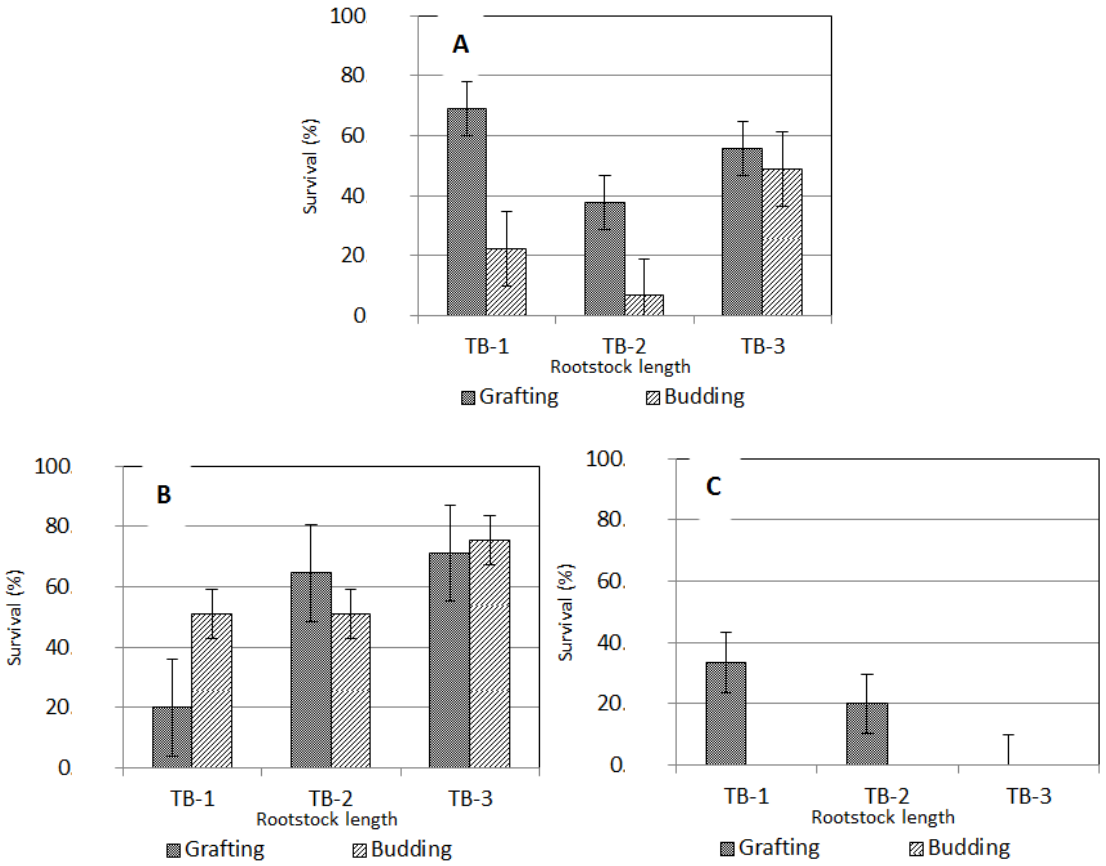

Figure 1. Effects of rootstock length on the survival of grafted fruit plant of A. carambola, B. durian and C. guava for 6 weeks on growing media containing grass compost.

Table 3. Effects of compost type and propagation technique on growth of grafted fruit plants after growing for 10 weeks in the nursery

Compost Type	Grafting				Budding			
	Plant height (cm)	Rootstock Diameter (cm)	Scion Diam-eter (cm)	Leaves Num-ber	Plant height (cm)	Rootstock Diameter (cm)	Scion Diameter (cm)	Leaves Number
				Carambola				
K-1	81.0 a	6.6 a	6.2 a	23.3 a	82.2 a	7.6 a	6.0 a	17.3 b
K-2	75.9 a	5.8 b	5.9 a	21.3 a	78.0 a	7.5 ab	6.4 a	21.7 a
K-3	82.0 a	6.0 ab	5.9 a	22.7 a	76.3 a	6.9 b	5.7 a	19.7 ab
				Durian				
K-1	51.2 a	6.0 a	4.3 a	17.3 a	50.3 a	6.8 a	4.5 a	14.3 a
K-2	49.5 a	6.2 a	4.5 a	16.7 a	56.5 a	7.5 a	4.5 a	13.0 a
K-3	44.3 a	5.8 a	4.1 a	12.7 a	47.1 a	7.1 a	4.2 a	12.7 a
				Guava				
K-1	69.9 a	5.3 a	5.5 a	28.3 a				
K-2	55.5 b	5.1 a	5.4 a	27.3 a				
K-3	66.9 a	4.4 a	4.6 a	21.7 a				

Note: Means followed by the different letter within the same column are significantly different ($p<0.05$) according to DMRT

K-1= Grass compost. K-2= Spent compost of paddy straw mushroom. K-3= Spent compost of oyster mushroom

and guava was obtained by grass compost and spent compost of paddy straw mushroom (Figure 2).

Vegetable plant

Although each tomato plant produced 8 fruits per plant (420 g per plant) in average, the tomato plants fertilized with spent compost of oyster mushroom of 3 kg resulted in higher fruit fresh weight, length, and diameter compared to those plants fertilized with the others compost used (Figure 3).

per plant was lower than the result of the study by Lopes et al. (2015) using 100% of spent compost of almond mushroom (*Agaricus subrufescens*). A study conducted by Hernandez et al. (2014), showed the lower yields observed in the soils treated only with compost is probably due to nutrient limitation, mainly N. Combination use of organic and mineral fertilization improved the effect on yield compared to the use of mineral fertilization alone, although differences were not always statistically significant. Another study conducted by Adil et al. (2006) showed

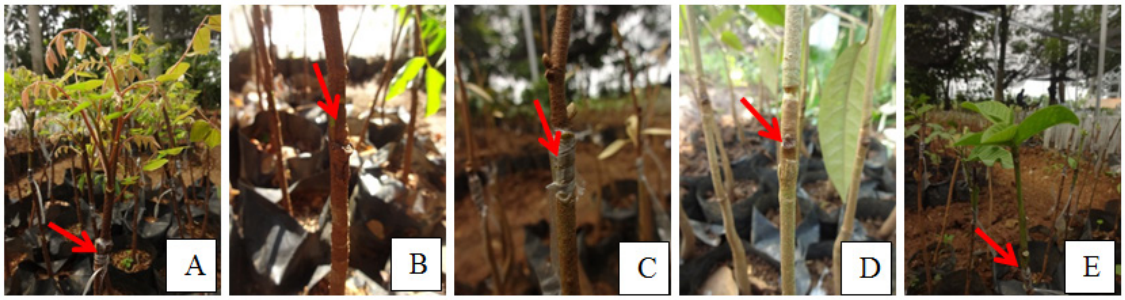

Figure 2. Survival grafted plant of carambola by grafting and budding (A-B), durian by grafting and budding (C-D) and guava by grafting (E) technique. Red arrows indicated that the grafting union was established.

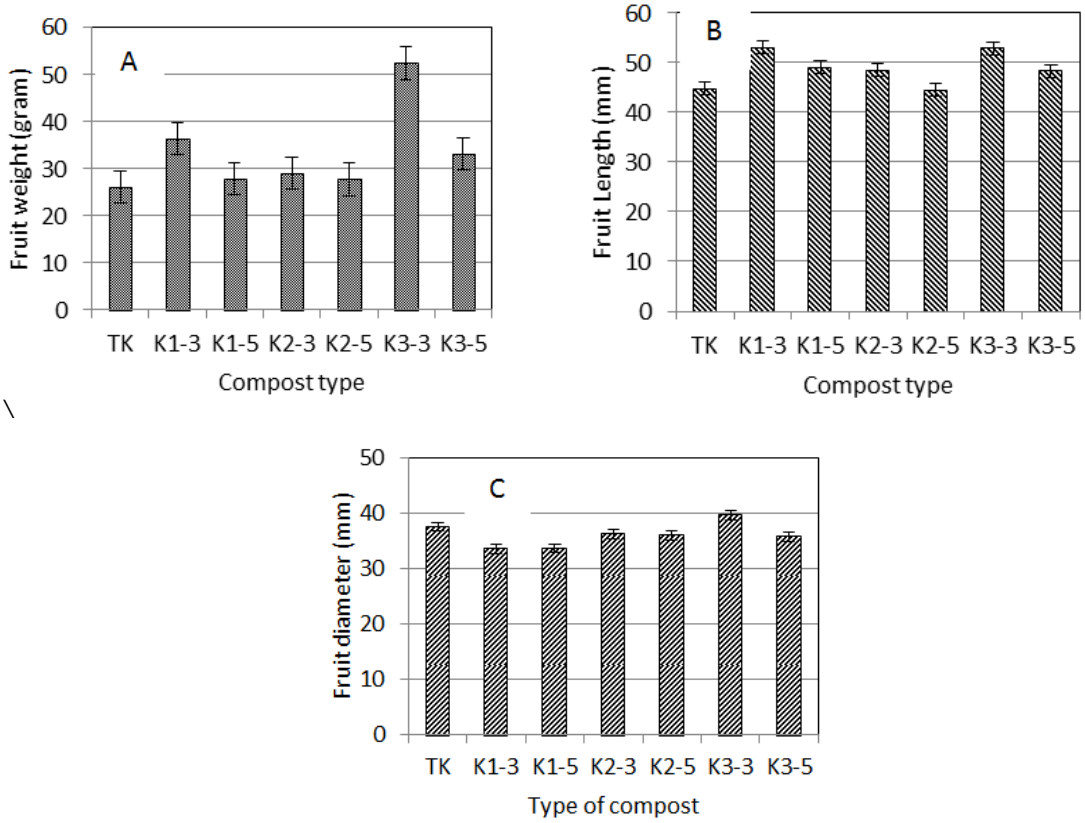

Figure 3. Effects of compost on fresh weight (A), length (B), and diameter (C) of tomato fruit
Note: TK=without compost, K1-3 grass compost of 3 kg, K1-5= grass compost of 5 kg, K2-3=spent compost of paddy straw mushroom of 3 kg, K2-5= spent compost of paddy straw mushroom of 3 kg, K3-3= spent compost of oyster mushroom of 3 kg, K3-5= spent compost of oyster mushroom of 5 kg.

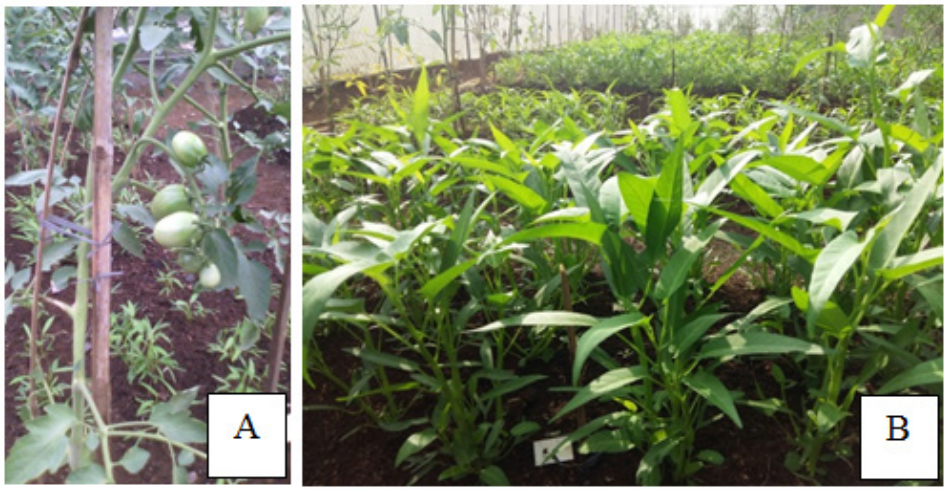

Figure 4. The cultivation of tomato (A) and *kangkung* (B) towards organic cultivation in the screen house of the Germplasm Garden

Table 4. Effects of compost type on growth of *kangkung* after growing for 5 weeks in the screen house

Compost type	Compost dosage (kg)	Plant height (cm)	Leaves number	Biomass/plant (gram)
Without compost	0	32.7 d	10.7 a	13.5 c
K-1	3	35.1 cd	9.8 b	18.9 ab
	5	37.8 b	10.0 b	16.0 bc
K-2	3	35.7 bc	9.0 c	15.4 c
	5	35.1 cd	9.2 c	13.5 c
K-3	3	34.6 cd	10.7 a	12.8 c
	5	42.5 a	10.9 a	19.7 a

Note: Means followed by the different letter within the same column are significantly different ($p<0.05$) according to DMRT. K-1= Grass compost, K-2= Spent compost of paddy straw mushroom, K-3= Spent compost of oyster mushroom

combination with urea resulted in significant total fruits than those control. A further study such as nutrient analysis on *kangkung* biomass and tomato fruit to determine the effect of various type of compost on nutrient content has to be done towards the organic farming (Figure 4).

The tallest *kangkung* plant (42.5 cm) was obtained by the plant grown on the media containing spent compost of oyster mushroom of 5 kg and it was significantly different with those grown on the other media used. The highest leaves number (10.9) was obtained by the same compost type and dosage. However, it was not significantly different with the plant grown on media containing spent compost of oyster mushroom of 3 kg or those grown on media without compost. The media containing spent compost of oyster mushroom of 5 kg has also resulted in the highest *kangkung* biomass (19.7 gram/plant), however, it was not significantly different with the plant grown on the media containing grass compost of 3 kg (Table 4).

CONCLUSION

The highest survival of grafted carambola (68.89%) was obtained from rootstock length of 45-55 cm grown on media containing grass compost by grafting technique. The highest survival of grafted durian (75.56 %) was obtained from the rootstock length of 75-90 cm by budding technique. The budding technique seems to be not appropriate for guava propagation which was indicated by 0% of survival. The application of compost on tomato plants showed that spent compost of oyster mushroom of 3 kg resulted in the highest of fruit fresh weight, length and diameter. In general, plant height, leaves number and total biomass of *kangkung* was higher when the plant has grown on the media containing compost. The study is expected to be applied to improve grafted fruit plant growth and survival in

order to develop local fruit plant species as well as a high production of organic vegetable in a screen house.

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