Effects Of Various Planting Media On Growth Performance Of Melon Plants Grafted With Squash Rootstock

Yusup Bahrul Ulum, Arifah Rahayu, Yanyan Mulyaningsih

Abstract— Java region, excluding West Java, is a production center of melon (*Cucumis melo* L.). Efforts including the application of grafting method should be done in order to make the plant grow well in West Java region. Squash (*Cucurbita maxima*) is an appropriate plant to be used as roostock for melon grafting as squash has a close kinship with melon and grows well in West Java region. Planting medium composition is known to have significant effects on the growth of melon plants. This study was aimed at assessing the combination effects of squash accession as rootstock and various planting media on the growth of grafted melon plants. A factorial completely randomized design with two factors was used. The first factor was planting media compositions including 100% soil (control), 25% compost + 75% soil, 50% compost + 50% soil, 25% rice husk charcoal + 75% soil, and 50% rice husk charcoal + 50% soil. The second factor was squash accessions as rootstock including Bogor, Cianjur, and Sukabumi accessions. Grafting was conducted by using slanting technique. Results showed that the use of Sukabumi accession rootstock resulted in more successful grafting, higher rootstock diameter, plant height, number of leaves, number of internodes, and leaf area than that of Bogor and Cianjur accessions. Compared to the use of rice husk charcoal, the use of compost in planting media resulted in plants with higher diameter of rootstock, plant height, number of leaves, number of internodes, and leaf area.

Index Terms— melon, squash, grafting, planting media.

1 INTRODUCTION

Melon (*Cucumis melo*) is fruit that can be eaten directly or in processed forms. In Indonesia, melon production center is in Java (90%) with a production of 134,656 tons out of total national production of 150,347 tons. East Java had the highest annual melon production (57,681 tons), followed by Central Java (42,979 tons), Special Region of Yogyakarta (33,063 tons), and Banten (889 tons). Meanwhile, total melon production in West Java was only 44 tons. Melon farm productivity in West Java was only 1.33 tons/hectare while in other provinces in Java Island, it was 16-20 tons/hectare [1]. Melon plant is known to be susceptible to the attack of pathogens growing well in areas with high humidity including Bogor area in West Java which has a considerable wet tropic climate with average rainfall rates of 2,500-5,000 mm/year [2][13]. Base stem rot caused by *Mycophaerekka melonis* P. fungus is one of the most common diseases found in melon [3]. Using seeds produced by grafting method is a way to avoid this disease. Grafting is aimed at improving the quality of melon plants by using rootstocks from plants which are more tolerant to the environmental condition of the area where the plants are grown. The success of grafting is also affected by botanical kinship of the plants to be grafted. Melon (*Cucumis melo*) and squash (*Cucurbita maxima*) belong to the same family of Cucurbitaceae. Studies showed that the two species were compatible in grafting [4][5]. National squash production in 2011 was 352,300 tons with the highest contribution came from West Java (155,310 tons), followed by Central Java (121,630 tons), Bengkulu (38,374 tons), Lampung (22,375 tons), and East Java (14,611 tons). West Java had been the biggest producer since 2007 with total production of squash ten times higher than that of the other provinces. This indicated that squash had good tolerance and grew well in West Java area. Planting medium is another factor affecting the growth of melon plants. Compost and rice husk charcoal are among the common media used for melon planting. Studies showed that the use of compost medium was found to profoundly support the growth and production of melon [6][7]. In some studies, the use of rice husk charcoal as a single planting medium did not give significant effect on the growth of melon so that it needed to be mixed with compost or cocopeat [8]. The use of rice husk charcoal as a single medium or a mixed medium in some studies (Pangestu 2004 and Sesanti 2018)[14] was focused on melon planting so that it could not yet be used as a benchmark in this study. However, it was expected that grafted melon plants be able to give good response to the use of rice husk charcoal as a planting medium. This study was aimed at assessing the response of melon plants to the use of squash of Bogor, Cianjur, and Sukabumi accessions as rootstocks and planting medium compositions.

- *Yusup Bahrul Ulum, Agrotechnology Program Study, Faculty of Agriculture, Djuanda University, Bogor, Indonesia, E-mail:*
- *Arifah Rahayu, Agrotechnology Program Study, Faculty of Agriculture, Djuanda University, Bogor, Indonesia, E-mail: arifah.rahayu@unida.ac.id*
- *Yanyan Mulyaningsih, Agrotechnology Program Study, Faculty of Agriculture, Djuanda University, Bogor, Indonesia, E-mail: yanyan.mulyaningsih*

2 MATERIALS AND METHODS

2.1 Time and Site

The study was conducted at Kampung Balandongan, Ciherang Pondok Village, Caringin District, Bogor Regency, West Java Province from November 2018 to February 2019.

2.2 Equipment and Materials

The equipment used included gillette, pruning shears, watering can, balance, measuring tape, caliper, pesticide sprayer, and soil loosening tools. Materials used included polybags, seed sowing trays, melon seeds (Amanta F1), squash seeds (Bogor, Cianjur, and Sukabumi accessions), planting media (soil, compost containing sheep manure, and rice husk charcoal), synthetic fertilizers (urea, TSP, and KCl), and pesticide.

Squash seeds were obtained from Ciapus Village, Ciomas District, Bogor Regency (Bogor accession), Pasawahan Village, Takokak District, Cianjur Regency (Cianjur accession), and Tegal Laya Village, Lembur Situ District, Sukabumi City (Sukabumi accessions).

2.3 Methods

A factorial completely randomized design with two factors was used. The first factor was planting medium composition (volume-based ratio) and the second was squash accession as rootstock.

The planting media consisted of five levels including 100% soil (control, A1), 25% compost + 75% soil (A2), 50% compost + 50% soil (A3), 25% rice husk charcoal + 75% soil (A4), and 50% rice husk charcoal + 50% soil (A5). Squash accessions included Bogor accession (B1), Cianjur accession (B2), and Sukabumi accession (B3). There were 15 treatments combinations and 3 replicates making up 45 experimental units. A total of 450 observation units were used as 10 observation units were allocated on each experimental unit. Data were subjected to an analysis of variance and a Duncan Multiple Range Test (DMRT) at a significant level of 5%.

2.4 Research Execution

Scion and rootstock were grown by sowing the seeds on seed sowing trays. Scion seeds were sown five days earlier than rootstock seeds. Sowing media were the mixtures of made of soil (1 part), compost (1 part), and rice husk charcoal (1 part). Grafting was conducted when the rootstocks aged 7 days after sowing (DAS). A slanting technique of grafting was applied. Slanting cuts were made on the apical bud of rootstocks leaving a cotyledon and 2 cm above the stem base of scions. Scion and rootstock cuts were bound by using grafting clips. Grafted seedlings were placed under a plastic shade with high humidity in order to avoid death caused by transpiration that might occur as scion and rootstock were not tightly bound. The seedlings were then grown in ploybags containing planting medium compositions. Plants were watered twice day in the morning and afternoon when there was no rain. Control of pests and diseases was done twice a month through pesticide spraying. Weed control was done manually. Fertilizer was administered gradually. Basic fertilizers including urea, TSP, and KCl were given at the time of medium preparation. Supplementary fertilization was administered twice on 10 days after planting (DAP) (urea and TSP) and 20 DAP (urea, TSP, and KCl). Measurements were taken on percentage of grafting success, stem diameter, plant height, number of leaves, number of internodes, and average leaf area.

3 RESULTS AND DISCUSSION

3.1 Percentage of Grafting Success

It was found that melon grafting by using squash of Sukabumi accession as the rootstock had the highest percentage of grafting success. Observation was conducted for 2 weeks on 200 plants of in each accession. The percentages of grafting success were 98.5% (197 plants), 95% (190 plants), and 93.5% (187 plants in Sukabumi, Bogor, and Cianjur accessions, respectively.

3.2 Rootstock Diameter

Rootstock diameter was affected by accession and planting medium combinations (2-3 WAP) but not by any interaction between accession and planting media. Rootstock diameter in planting medium of 50% compost + 50% soil was higher than that in control and planting medium of rice husk charcoal + soil at 2-3 WAP but not different from that in planting medium of 25% compost + 75% soil. Rootstock diameter of Sukabumi accession was higher than that of Bogor and Cianjur accessions in 2-3 WAP (Table 1).

Table 1
Rootstock Diameter

Treatment	Rootstock diameter			
	0 WAP	1 WAP	2 WAP	3 WAP
Planting Medium	---------- cm ----------			
100% soil (control)	0.40	0.42	0.44^{a}	0.48^{ab}
25% compost + 75% soil	0.40	0.42	0.46^{ab}	0.49^{bc}
50% compost + 50% soil	0.40	0.42	0.47^{b}	0.51^{c}
25% rice husk charcoal + 75% soil	0.40	0.42	0.45^{a}	0.48^{ab}
50% rice husk charcoal + 50% soil	0.40	0.42	0.44^{a}	0.47^{a}
Accession				
Bogor	0.40	0.42	0.45^{ab}	0.49^{ab}
Cianjur	0.39	0.41	0.44^{a}	0.48^{a}
Sukabumi	0.40	0.42	0.46^{b}	0.50^{c}

Remark: Different superscripts in the same column indicate differences (P<0.05)

3.3 Plant Height

Planting media, accessions and their interaction gave significant effects on plant height at 1-3 WAP. Height of plants with Sukabumi accession as rootstock was significantly higher than that of Bogor and Cianjur accessions in various planting medium composition except in 50% compost + 50% soil. Melon plants grafted by using rootstock of Bogor and Cianjur squash accessions and grown in planting medium of 50% compost + 50% soil had the highest plant height. Meanwhile, melon plants having squash of Sukabumi accession as rootstock did not have different plant height from those in control, 25% compost + 75% soil, and 25% rice husk charcoal + 75% soil planting media (Table 2).

Table 2
Height of plants at 1-3 WAP in planting media and accession combinations

Age	Treatment	Accession		
	Planting Medium	Bogor	Cianjur	Sukabumi
1 WAP	100% soil (control)	15.28^{bcd}	14.14^{a}	17.36^{e}
	25% compost + 75% soil	15.45^{cd}	14.97^{abcd}	17.47^{e}
	50% compost + 50% soil	16.72^{e}	15.86^{e}	17.23^{e}
	25% rice husk charcoal + 75% soil	15.27^{bcd}	14.45^{ab}	16.96^{e}
	50% rice husk charcoal + 50% soil	14.52^{abc}	14.11^{a}	15.23^{bcd}
2 WAP	100% soil (control)	21.90^{bc}	19.34^{a}	25.94^{f}
	25% compost + 75% soil	22.35^{cd}	21.26^{bc}	26.27^{f}
	50% compost + 50% soil	25.17^{ef}	23.70^{de}	26.16^{f}
	25% rice husk	21.76^{bc}	20.26^{ab}	25.28^{ef}

	charcoal + 75% soil			
	50% rice husk charcoal + 50% soil	21.32^{bc}	20.46^{ab}	22.60^{cd}
3 WAP	100% soil (control)	30.33^{bc}	26.78^{a}	36.54^{f}
	25% compost + 75% soil	30.91^{cd}	29.58^{bc}	36.90^{f}
	50% compost + 50% soil	35.47^{ef}	33.23^{f}	37.25^{f}
	25% rice husk charcoal + 75% soil	30.19^{bc}	27.87^{ab}	35.41^{ef}
	50% rice husk charcoal + 50% soil	29.24^{abc}	28.98^{abc}	30.84^{cd}

Remark: Different superscripts in the same column indicate differences (P<0.05)

3.4 Number of Leaves

Number of leaves was significantly affected by planting medium, accession, and their interaction at 1 and 2 WAP but not at 3 WAP (Table 3). Number of leaves of melon plants grafted with squash of Sukabumi accession as rootstock was higher than that of melon plants grafted with squash of Bogor and Sukabumi accessions as rootstock. However, no different number of leaves was found in plants grown in 50% compost + 50% soil planting medium at 2 WAP. The lowest number of leaves was found in plants grown in rice husk charcoal + soil planting media (Table 4).

Table 3
Number of leaves

Treatment	Number of leaves			
	0 WAP	1 WAP	2 WAP	3 WAP
Planting Medium				
100% soil (control)	2.00	3.68	6.18	8.53^{c}
25% compost + 75% soil	2.00	3.57	6.10	8.68^{cd}
50% compost + 50% soil	2.00	3.30	6.43	8.94^{d}
25% rice husk charcoal + 75% soil	2.00	3.53	5.48	7.97^{b}
50% rice husk charcoal + 50% soil	2.00	3.30	4.89	7.41^{a}
Accession				
Bogor	2.00	3.33	5.70	8.15^{a}
Cianjur	2.00	3.18	5.50	8.06^{a}
Sukabumi	2.00	3.19	6.25	8.71^{b}

Remark: Different superscripts in the same column indicate differences (P<0.05)

Table 4
Number of leaves of grafted melon plants at 1-2 WAP in planting media and accession combinations

Age	Treatment	Accession		
	Medium	Bogor	Cianjur	Sukabumi
1 WAP	100% soil (control)	3.50^{bc}	3.27^{abc}	4.27^{d}
	25% compost + 75% soil	3.40^{abc}	3.17^{abc}	4.13^{d}
	50% compost + 50% soil	3.30^{abc}	3.13^{ab}	3.47^{abc}
	25% rice husk charcoal + 75% soil	3.33^{abc}	3.10^{a}	4.17^{d}
	50% rice husk charcoal + 50% soil	3.13^{ab}	3.23^{abc}	3.53^{c}
2 WAP	100% soil (control)	6.00^{de}	5.73^{cd}	6.80^{f}
	25% compost + 75% soil	5.83^{cd}	5.70^{cd}	6.77^{f}
	50% compost + 50% soil	6.43^{ef}	6.43^{ef}	6.43^{ef}
	25% rice husk charcoal + 75% soil	5.43^{bc}	4.93^{ab}	6.07^{de}
	50% rice husk charcoal + 50% soil	4.80^{a}	4.70^{a}	5.17^{ab}

Remark: Different superscripts in the same column indicate differences (P<0.05)

3.5 Number of Internodes

Number of internodes was significantly affected by planting medium, rootstock accession, and their interaction in 2 WAP but not in 1 and 3 WAP (Table 5). The highest number of internodes was found in melon plants grafted using squash of Sukabumi accessions as rootstock. However, no differences were found in plants grown in 50% compost + 50% soil planting medium. The lowest number of internodes was found in grafted melon plants grown in 50% rice husk charcoal + 50% soil planting medium (Table 6).

Table 5
Number of internodes

Treatment	Number of internodes			
	0 WAP	1 WAP	2 WAP	3 WAP
Planting medium				
100% soil (control)	1.00	3.14^{b}	5.77	7.97^{c}
25% compost + 75% soil	1.00	3.12^{b}	5.56	8.20^{c}
50% compost + 50% soil	1.00	2.82^{a}	6.00	8.39^{c}
25% rice husk charcoal + 75% soil	1.00	3.00^{ab}	4.90	7.40^{b}
50% rice husk charcoal + 50% soil	1.00	2.78^{a}	4.40	6.91^{a}
Accession				
Bogor	1.00	2.83^{a}	5.23	7.61^{a}
Cianjur	1.00	2.69^{a}	5.04	7.53^{a}
Sukabumi	1.00	2.39^{b}	5.71	8.17^{b}

Remark: Different superscripts in the same column indicate differences (P<0.05)

Table 6
Number of internodes of grafted melon plants at 2 WAP in planting media and accession combinations

Age	Treatment	Accession		
	Planting medium	Bogor	Cianjur	Sukabumi
2 WAP	100% soil (control)	5.47^{cde}	5.40^{cd}	6.43^{f}
	25% compost + 75% soil	5.40^{cd}	5.10^{bc}	6.17^{f}
	50% compost + 50% soil	6.10^{ef}	6.07^{ef}	5.83^{def}
	25% rice husk charcoal + 75% soil	4.90^{abc}	4.33^{a}	5.47^{cde}
	50% rice husk charcoal + 50% soil	4.27^{a}	4.30^{a}	4.63^{ab}

Remark: Different superscripts in the same column indicate differences (P<0.05)

3.6 Average Leaf Area

Planting medium, rootstock accession, and their interaction were found to significantly affect average leaf area. Highest average leaf area was shown by grafted melon plants using squash of Sukabumi accession grown in 50% compost + 50% soil planting medium. The lowest average leaf area was found in melon plants grown in rice husk charcoal + soil planting media (Table 7).

Table 7
Average leaf area of grafted melon plants at 3 WAP in planting media and accession combinations

Age	Treatment	Accession

	Planting medium	Bogor	Cianjur	Sukabumi
3 WAP	100% soil (control)	21.98^{abcd}	22.69^{abcd}	27.29^{cd}
	25% compost + 75% soil	40.27^{e}	30.53^{d}	54.95^{f}
	50% compost + 50% soil	48.24^{ef}	41.86^{e}	63.77^{g}
	25% rice husk charcoal + 75% soil	18.85^{abc}	17.65^{ab}	25.65^{bcd}
	50% rice husk charcoal + 50% soil	16.85^{ab}	15.79^{a}	22.53^{abcd}

Remark: Different superscripts in the same column indicate differences (P<0.05)

4 DISCUSSION

4.1 General Condition and Field Constraints

During the trial period from December 2018 to January 2019, there were, on average, high rainfall of 12.69 mm/hour, high humidity level of 88.49%, temperature of 21.22^{o}C, and photoperiod of 1.79 hours/day [9]. These climate constraints had not allowed the study to be conducted until the plants reached their reproductive phase. This climatic condition made the plants fragile and perishable as they had high water content. Consequently, observations were conducted only in vegetative phase.

4.2 The Growth of Grafted Melon Plants Grown in Various Planting Medium Compositions

4.2.1 Effects of Squash as Rootstocks

Melon plants grafted by using squash of Sukabumi accession as rootstock in this study were found to have better results than by using Bogor and Cianjur accessions. As rootstock, compared to other accessions, squash of Sukabumi accession had better characteristics in terms of their fruit weight, fruit flesh thickness, fruit perimeter, fruit height, number of seeds, seed viability, and percentage of grafting success. These characteristics were suspected to support the growth of melon plants. However further studies were required to support this notion.

4.2.2 Effects of Planting Medium Compositions

In their vegetative phase, grafted melon plants showed the best responses to compost + soil planting media while those to rice husk charcoal + soil were relatively lower than those to control. These differences might be caused by different content of nitrogen (N) in compost and rice husk charcoal. It is shown in Table 7 that compost (sheep manure) had higher N content than rice husk charcoal [10]. In plants, nitrogen is very important for the formation of chlorophyll which plays a role as an 'engine' that synthesizes carbohydrate to support the growth and new cell formation [11]. The use of Dekamon growth promoter in melon grown in compost medium was found to produce fruits with higher fruit weight and fruit diameter than melon grown in other planting medium (raw rice husk) [6]. Results of another study by Mustaqim [7] also showed that melon plants grown in compost medium had higher stem diameter, higher plant height, and faster flower formation. In this study, grafted melon grown in rice husk charcoal media had low production. This was in line with results of a study of Cunino and Taolin [12] who found that there was no significant vegetative growth shown by cucumber plants grown in rice husk charcoal medium. However, if the trial was conducted until the reproductive phase, some positive effects on melon production, similar to what was found in cucumber [12], would be observed.

Table 8
Nutrient contents of compost and rice husk charcoal planting media

Planting Medium	Nutrient content ---------- % --------- N	P	K	Reference
Compost (sheep manure)	1.28	0.19	0.93	Setyorini *et al.* 2006 [14]
Rice husk charcoal	0.05	0.23	0.06	Balittanah 2015 [10]

5 CONCLUSION

Melon plants (Amanta F1 variety) grafted by using squash as rootstock of various accessions and grown in various planting media were found to have different growth. As rootstock, squash of Sukabumi accession gave better results in several parameters measured than those of Bogor and Cianjur accessions. These findings indicated that squash of Sukabumi accession had potential characteristics supporting its use as rootstock for melon grafting. However, this notion needs to be proven further. Compost + soil was the planting medium which gave the best effects on the growth of grafted melon plants as it contained more N than rice husk charcoal. Higher composition of rice husk charcoal hampered the growth of grafted melon plants, even when it was compared with control.

6 RECOMMENDATIONS

In this study, only one grafting technique (slanting cut) was used. Studies on other grafting techniques and their effects on the success of grafting deserve to be conducted. Further studies on the effects of characteristics of seed sources (squash quality) on the growth of grafted melon plants were also recommended.

REFERENCES

[1] C. Arfah, F. Harun and M. Rahmawati, "Pengaruh media tanam dan konsentrasi zat pengatur tumbuh dekamon 22.43 l pada pertumbuhan dan hasil tanaman melon (Cucumis melo L.).," *Jurnal Kawista,* vol. 1, no. 1, pp. 10-14, 2016.

[2] Balittanah, "BIOCHAR Pembenah Tanah yang Potensial.," Balai Penelitian Tanah, Bogor, 2015.

[3] K. Bariyyah, S. Suparjono and Usmadi, "Pengaruh kombinasi komposisi media organik dan konsentrasi nutrisi terhadap daya hasil tanaman melon (Cucumis melo L.)," *Planta Tropika Journal of Agro Science,* vol. 3, no. 2, pp. 67-72, 2015.

[4] BPS [Badan Pusat Statistik] Kabupaten Bogor, Kabupaten Bogor dalam Angka 2015, Bogor: Katalog BPS: 1102001.3201., 2015.

[5] Kementan, Statistik Produksi Hortikultura Tahun 2014, Jakarta: Direktoran Jenderal Hortikultura, Kementerian Pertanian RI, 2015.

[6] I. Cunino and R. Taolin, "Pengaruh takaran arang sekam padi dan bokashi cair terhadap pertumbuhan dan hasil mentimun (Cucumis sativus L.)," *Savana Cendana,* vol. 3, no. 2, pp. 24-28, 2018.

[7] BMKG [Badan Meteorologi Klimatologi dan Geofisika], "Laporan iklim harian," BMKG [Badan Meteorologi Klimatologi dan Geofisika], 2019. [Online]. Available: http://dataonline.bmkg.go.id/data_iklim. [Accessed 5 May 2019].

[8] H. Hartmann, D. Kester, F. Davies and R. Geneve, Hartmann and Kester's Plant Propagation : Principles and Practice, Eighth Edition ed., New Jersey.: Prentice Hall, 2002.

[9] R. Mustaqim, Armaini and E. N. Yulia, "Pengaruh pemberian kompos tandan kosong kelapa sawit dan pupuk N, P, K terhadap pertumbuhan dan produksi tanaman melon (Cucumis melo L.)," *JOM FAPERTA,* vol. 3, no. 1, pp. 1-13, 2016.

[10] D. Setyorini, R. Saraswati and E. K. Anwar, Kompos, Bogor: Balai Penelitian Tanah., 2006.

[11] Suharno, I. Mawardi, Setiabudi, N. Lunga and S. Tjitrosemito, "Efisiensi penggunaan nitrogen pada tipe vegetasi yang berbeda di Stasiun Penelitian Cikaniki, Taman Nasional Gunung Halimun Salak, Jawa Barat," *Biodiversitas,* vol. 8, no. 4, pp. 287-294, 2007.

[12] DMBPPIPT, Melon (Cucumis melo L.). Tentang Budidaya Pertanian. 1-19., DMBPPIPT [Deputi Menegristek Bidang Pendayagunaan dan Pemasyarakatan Ilmu Pengetahuan dan Teknologi], 2000.

[13] E. Mavrona, M. Sotirioub and T. Pritsa, "Response of squash (Cucurbita spp.) as rootstock for melon (Cucumis melo L.)," *Scientia Horticulturae,* vol. 83, no. 1, pp. 353-362, 2000.

[14] BPS, Konsep dan Definisi Baku Statistik Pertanian 2012, Jakarta: BPS [Badan Pusat Statistik], 2012.