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Performance of Grafted Bitter Gourd (*Momordica charantia* L.) with Scion taken from Plant Sources of Different Maturity

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ABSTRACT

Bitter gourd (*Momordica charantia* L.*)* is a very important high vegetable crop grown in Asia especially in the Philippines. Nowadays, application of grafting with scion sources of different maturity is gaining interest as for the solution for high cost of hybrid seeds. This study was conducted to determine the graft compatibility of bitter gourd scions taken from sources of different maturity grafted onto sponge gourd rootstock; compare the growth and yield performance of the grafts produced; assess the effects of plant sources of different maturity on the post-harvest quality of grafted bitter gourd. The treatments were: non-grafted, Scion from 10, 21, 30, 45, and 60 days old plant source. Different maturity of scions was obtained from healthy and disease free sources and grafted onto a 14 day old sponge gourd rootstock. Results showed that grafted bitter gourd with scion from younger sources had higher percentage graftake compared with scion from older sources. In addition, younger sources had higher fruit yield per plant compared to grafted bitter gourd with scion from older sources.

Keywords: bitter gourd, grafting, scion, rootstock, non-grafted

INTRODUCTION

Vegetables are an important agricultural crop. Vegetables are even more valuable than all root crops and cereals in terms of production value (Brickel 1992 as cited by Garcelazo 2000). Bitter gourd (*Momordica charantia* Linn.) is locally named *ampalaya* in the Philippines. In other countries, it is also known as a tropical fruit, balsam pear, or bitter melon (Anbarasan & Tamilmani 2013). It is one of the most widely economically planted cucurbitaceous vegetables in the Philippines, and is considered a high-value commodity due to its higher market price. Despite bitter gourd's rising popularity and potential as a natural treatment, there are still a few production problems to be addressed. These are bacterial wilt (*Ralstonia solanacearum*) infestation and expensive hybrid seeds. Bacterial wilt caused by *Ralstonia solanacearum* has the potential to impair fruit yield and quality (Abawi et

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al 2000; Nisini et al 2002), furtheremore, killing a wide range of plants in tropical, subtropical, and mild temperate climates (Nishiyama et al 2012; Yabuuchi et al 1995)

Disease control is an important aspect of vegetable farming (Koike et al 2006). Vegetable grafting is another potential strategy for controlling bacterial wilt (*Ralstonia solanaciarum*) infestation and is also known to boost bitter gourd yield and promote prolonged output. A finding reported by Davis et al (2008) indicated that grafting cucurbits boosts plant vigor, yield in the presence of illness, tolerance to abiotic stresses, and resistance to soil-borne plant diseases. Furthermore, grafted plants provide higher yields by extending the economic harvest period (Mohamed et al 2012). More than half of the world's biggest watermelons and cucumbers (*Cucumis sativus* Linn.) are grown in China, with around 20% of them being grafted (Davis et al 2008). Another study found that grafting had an impact on cucurbitaceous vegetable plant growth and fruiting characteristics under both normal and stressful settings (Mohamed et al 2012).

In vegetable grafting, there are two types of procedures and these are tube grafting and cleft grafting. The grafting method used in bitter gourd was cleft grafting because of the diameter of the stem of bitter gourd which was not fit for tube grafting. Graft union failure was characterized by mismatched scion and rootstock, a lack of competence and knowledge, or bad environmental conditions ailments, illnesses, and incompatibilities (Hartman & Kester 2011).

Grafting also aids in the acceleration of plant development and the reduction of nursery production time. There have been no reports in the field of employing scions from different age levels in bitter gourd. By doing so, the farmers' problem of high cost and limited supply of hybrid seedlings of bitter gourd could be solved because the scion material needed in bitter gourd grafting is readily available in the field.

This study was conducted to determine the graft compatibility of bitter gourd scions taken from sources of different maturity grafted onto sponge gourd rootstock and compare the growth and yield performance of the grafts produced.

MATERIALS AND METHODS

Production of Grafted Planting Materials

The seeds of sponge gourd (rootstock) and bitter gourd (scion) were ragdoll in moist cloth. When the radicle emerged, seedlings were transferred individually in seedling trays filled with the prepared sterilized mixture of garden soil, vermicast, and carbonized rice hull (1:1:1) ratio. For 60, 45, 30 and 21 day's old scion source, they were collected at farmer's field and were grown in open field. Scions taken from young lateral shoots were harvested at the desired age. There are 30 scions in every treatment per replication were collected and was graft to sponge gourd rootstock.

Bitter gourd scions were cleft grafted to the sponge gourd rootstock. The remaining shoots of the sponge gourd seedlings were removed using a sharp blade to allow stem to harden. The stem of sponge gourd was sliced in the middle longitudinally approximately 6-8 mm deep using a sharp blade. The lower edge of the scion stem was carefully sliced by two diagonal cuts to form a blunt wedge or V shape approximately 6-8 mm long. The wedge end of the scion was inserted into the sliced root stock. After placing the scion on the rootstock, the graft junction was immediately clipped with a grafting clip to fix the grafted position tightly together. Right after grafting, the seedlings were transferred to the improvised healing chamber maintaining >85% relative humidity to facilitate faster healing of wounds. Four days after grafting, the healing chamber was opened in 1 to 2 hours during early in the morning and late in the afternoon to replenish carbon dioxide and air pollutants. This condition was maintained for 2 to 3 days. The grafted plants were removed out of the chamber and placed in the nursery in 80% shaded area. Nine days after grafting, starter solution was applied (0.5 kg of 16-16-16 dissolved in 50 L water). The plants were held in the nursery for seven days for further development and hardening.

Land Preparation

An experimental area of 240 m^2 was used in the setup of this study. The experimental area was thoroughly plowed and harrowed twice at a weekly interval to loosen the soil and pulverize soil clods, level the area, and remove weeds for the soil ready for planting. After final harrowing, three plots which measured 1 m x 48 m and separated by 2.5 m alley way were constructed.

Experimental Design and Treatments

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications, with every treatment containing 10 sample plants in each replication. Each treatment plot had a planting distance of 80 cm between hills. An alleyway of 2.5 m between replications was provided to facilitate farm operations, management, and data gathering.

The following were the treatments:

T_1 – Non-grafted bitter gourd (control)
T_2 – Scion from 10 days old plant source
T_3 – Scion from 21 days old plant source
T_4 – Scion from 30 days old plant source
T_5 – Scion from 45 days old plant source
T_6 – Scion from 60 days old plant source

Transplanting

One week after grafting, graft of different maturity were hardened for two weeks by gradual exposure to direct sunlight while withholding water to acclimatize them to field conditions. The hardened grafts were transplanted during late in the afternoon to each plot measuring 8 m x 1 m with plastic mulch. Starter solution was applied after planting to facilitate early recovery of transplanted seedlings.

Fertilizer Application

For basal fertilizer application, 10 g/hill of complete fertilizer (16-16-16) was thoroughly mixed with vermincast at 250 g/plant and was applied during planting.

Trellising

Trellising was constructed to provide enough support one week after transplanting. Bamboo was used to serve as post and placed in line to each row of growing ampatola in each plot. Tie wires were tied along each row from post to post and the plants were secured by tying them to the tire wire using plastic straw. Trellising net was placed 2 meters above the ground.

Pruning

Pruning was employed when plants reached 1-2 meters tall using sharp pruning shears. Pruning of undesirable shoots was done in the afternoon to allow the wounds to dry up and heal faster and to make them clean to reduce the possibilities of the plant diseases infection.

Irrigation

Drip irrigation system was installed manually. Drip irrigation hose with minute holes at 0.5 m distance enough to make a single drip was installed in every row of plants in every replication.

Control of Insect Pests and Diseases

The plants were monitored for any pest invasion and appropriate measure was taken as much as possible following Integrated Pest Management (IPM) and Good Agricultural Practices (GAP). Manual picking of the disease plants leaves, sanitation, and fruit bagging were also done to prevent and control further insect pest infestation caused by fruit fly and disease infection.

Harvesting

Harvesting was done by manually picking the fruits two (2) to three (3) weeks after flowering and when the fruits turned to dark green. After harvesting, the fruits were classified as marketable and non-marketable. Marketable fruits were those fruits in standard sizes and free from diseases, insect damage, and mechanical injuries. Non-marketable fruits were those small fruits damaged by diseases, insects, and mechanical injuries.

Data Gathering

Yield and yield components were fruit size such as length of fruits, diameter of fruits, weight of fruits, number of fruits/plant, yield per plant (Kg), and total yield per hectare (tons). Grafting success of the grafted plant was assessed by counting the number of plants that survived within 14 days after grafting while grafting survival of the grafted plant was assessed by counting the number of plants that survived within 30 days after grafting.

RESULTS AND DISCUSSION

Yield and Yield Components

Number of fruits, total yield per plant, and total yield per hectare of grafted bitter gourd affected with scion taken from plant sources of different maturity are shown in Table 1. Results showed that there were significant difference in number of fruits, total yield per plant, and total yield per hectare. Number of fruits, total yield per plant, and total yield per hectare were recorded highest in grafted bitter gourd with scion from young scion sources compared to old scion sources and in non-grafted bitter gourd. However, 10 days old scion sources (T2) were numerically comparable with 21 days old scion sources and 30 days old scion sources in number of fruits, total yield per plant and total yield per hectare.

Table 1. Yield and yield components and Percent plant survival of grafted bitter gourd (a graft between bitter gourd, *Momordica charrantia* L. and sponge gourd, *Luffa anguculata* L.) with scion taken from plant sources of different maturity

TREATMENT	NUMBER OF FRUITS/PLANT	YIELD/PLANT (Kg)	TOTAL YIELD/HA (Tons)
T1-Non-grafted	5.00 cd	1.07 cd	1.71 cd
T2-10 DOSS	13.67 a	3.27 a	12.69 a
T3-21 DOSS	9.00 b	2.00 b	6.96 b
T4-30 DOSS	7.67 b	1.82 b	6.11 b
T5-45 DOSS	7.00 bc	1.30 bc	3.85 bc
T6-60 DOSS	3.00 d	0.52 d	1.19 d
% CV	12.00	15.03	15.18

Means within the same column in a block followed by a common letter designation are not significantly different from each other at 5 % level of significance
DOSS – day old scion source

Increased yield in bitter gourd with scion from younger sources was due to high productivity, higher survival rate, and quality of scion as shown in their vegetative parameters. Most of non-grafted bitter gourd per replication were infected by bacterial wilt. Hu (2016) found that grafted plants had more total and marketable fruit, as well as a higher marketability percentage, than ungrafted plants. Another study conducted by Romero et al (1997) revealed that the increase in yield is most likely due to the rootstock's strength, which significantly improves the vegetative growth of the grafted plant and, as a result, strengthens the rate of water and nutritive element absorption at vigorous rootstocks with a well-developed root system. Moreover, researchers discovered that rootstocks can boost root system vitality and increase water and mineral intake (Lee 1994). As a result, phosphorus, calcium, and sulphate absorption is improved in grafted melon (Ruiz et al 1996). The result was supported by the study of Yoder et al (1994) in which lower photosynthetic rates in older douglas-fir trees are caused by reduced stomatal conductance, which results from lower hydraulic conductivity in their longer (or more complex) hydraulic pathways.

Fruit Size of Bitter Gourd

Length of fruits, diameter, and fruit weight of grafted bitter gourd with scion taken from plant sources of different maturity are presented in Table 2. The fruit size of bitter gourd differed significantly as presented on the length, diameter, and weight of fruit per plant. Results showed that there were significant difference in length of fruits, fruit diameter, and fruit weight. Longest length of fruit was consistently recorded in grafted bitter gourd with scion taken from young source (Table 2). Fruits from non-grafted and in grafted bitter gourd with scion from older source were significantly shorter. On the other hand, largest size was significantly observed in grafted bitter gourd with 10 days old scion source (T2) compared to other treatments this is because of high chlorophyll content of younger seedlings compare to the older seedlings. Fruits from bitter gourd with scion from older source were significantly smaller in their size. Moreover, grafted bitter gourd with 10 days old scion source (T2) resulted to heaviest fruit weight per plant (301.43 g) when compared to bitter gourd with 60 days old scion source (161.45 g) and bitter gourd with 45 days old scion source (218.63 g) respectively.

Table 2. Fruit size of grafted bitter gourd (a graft between bitter gourd, *Momordica charrantia* L. and sponge gourd, *Luffa anguculata* L.) with scion taken from plant sources of different maturity

TREATMENT	FRUIT SIZE		
	LENGTH (cm)	DIAMETER (mm)	WEIGHT (grams)
T1-Non-grafted	25.19 bc	44.45 b	223.61 c
T2-10 DOSS	30.67 a	50.30 a	301.43 a
T3-21 DOSS	28.26 ab	48.77 ab	254.67 b
T4-30 DOSS	26.43 abc	47.85 ab	236.81 bc
T5-45 DOSS	28.73 ab	44.99 b	218.63 c
T6-60 DOSS	21.98 c	37.44 c	161.45 d
% CV	6.08	3.63	4.25

Means within the same column in a block followed by a common letter designation are not significantly different from each other at 5 % level of significance
DOSS – day old scion source

Bitter gourd with 21 days old scion source (T3) and bitter gourd with 30 days old scion source showed comparable results with bitter gourd with 10 days old scion source in fruit length, diameter, and weight. The smallest and lightest fruits were obtained in grafted bitter gourd with scion taken from 60 days old source (T6) which only had 21.98 cm long, 37.44 cm width and 161.45 Kg fruit weight respectively (Table 2). Similarly, Day et al 2001 reported that significant decrease of fruit size in *Kamlong* with scion from older source could be attributed to its slow growth potential due to lower photosynthetic rates. In addition, lower photosynthetic rates in older douglas-fir trees are caused by reduced stomatal conductance, which results from lower hydraulic conductivity in their longer (or more complex) hydraulic pathways Yoder et al 1994).

Graft-tale and Graft Quality

Grafted bitter gourd with scion from younger sources (T2 and T3) had significantly higher percent graftake (97.33 %, 91.33 %, respectively) and percent field survival (100%, 90%, respectively) compared to older scion (T6) which percent graftake was range to (66.67 %) and percent field survival (56.67 %). According to the result of study by Goldschmidt (2014) young seedling cells have high potential for division and differentiation (Flaishman et al, 2008). Moreover, the result of this study was supported by the study of Pompeu Junior (2005) as cited Fadel et al (2019) that reported that graft incompatibility is due to biochemical and anatomical factors that leads to a senescence process. In addition, it may instead be considered as just the inability of a scion and a rootstock to form a grafting union.

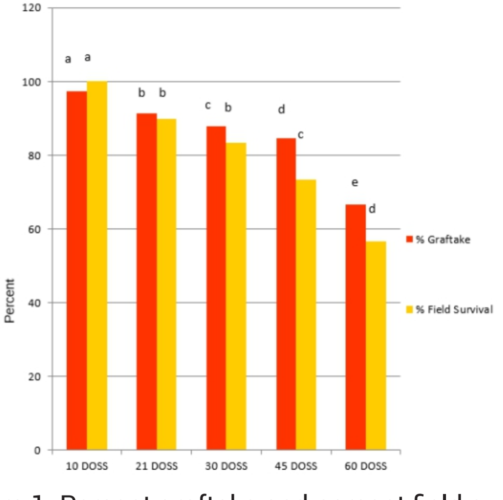

Figure 1. Percent graftake and percent field survival of grafted bitter gourd with scion taken from plant sources of different maturity
*DOSS-days of old scion source

CONCLUSION AND RECOMMENDATION

Based from the results of the study, bitter gourd graft compatibility is higher in 10 days old scion as compared with other treatments and bitter gourd in 10 days old scion source responded well in terms of yield.

The same study may be conducted during dry season which is the best season for bitter gourd production.

REFERENCES

Abawi G and Widmer T. 2000. Impact of soil health management practices on soilborne pathogens, nematodes and root diseases of vegetable crops. *Applied soil ecology* 15(1): 37-47

Anbarasan A and Tamilmani C. 2013. Effect of calcium pectate on the physiochemical changes during the ripening of bitter gourd fruit (*Momordica charantia* L Var-Co-1). *Asian Journal of Plant Science and Research*, 3(4), 51–58

Brickil C. 1992. Encyclopedia of gardening. Furling Kindersly publisher. Henrietta St. London. pp 322

Davis AR, Perkins-Veazie P, Hassell R, Levi A, King SR & Zhang X. 2008. Grafting effects on vegetable quality. *HortScience*, 43(6),1670–1672

Davis AR, Perkins-Veazie P, Sakata Y, López-Galarza S, Maroto JV, Lee SG & Lee JM. 2008. Cucurbit grafting. *Critical Reviews in Plant Sciences*, 27(1), pp 50–74

Hartmann HT, Kester DE, Davies FT & Geneve RL. 2002. Hartmann and Kester's plant propagation: Principles and practices, 8th ed.; PrenticeHall: Upper Saddle River, NJ, USA

Hartmann HT, Kester DE, Davies, FT & Geneve RL. 2011. Plant propagation: principles and practices. Eight edition. New York: Prentice Hall

Hu B. 2016. Improved tomato grafting technologies (PhD dissertation). The Ohio State University, USA

Goldschmidt EE. 2014. Plant grafting: New mechanisms, evolutionary implications. Frontiers in Plant Science, 5, 1-9

Koike ST, Gladders P & Paulus A. 2006. Vegetable diseases: A colour handbook, CRC Press

Lee JM. 1994. Cultivation of grafted vegetables I, current status, grafting methods and benefits. *HortScience* 29:235–239

Mohamed FH, El-Hamed KEA, Elwan MW & Hussien MA. 2012. Impact of grafting on watermelon growth, fruit yield and quality. *Veg. Crops Res. Bulletin,* 76: pp 99-118

Romero L, Belakbir A, Ragala L & Ruiz JM. 1997. Response of plant yield and leaf pigments to saline conditions: effectiveness of different rootstocks in melon plants (*Cucumis melo* L.). *Soil Science of Plant Nutrition* 43: 855–862

Ruiz JM, Belakbir A & Romero L. 1996. Foliar level of phosphorus and its bioindicators in Cucumis melo grafted plants. A possible effect of rootstocks. *Journal of Plant Physiology* 149: 400-404

Yabuuchi E, Kosako Y, Yano J, Hotta H & Nishiuchi Y. 1995. Transfer of two Burkholderia and an Alcaligenes species to Ralstonia gen. nov.: Proposal of Ralstonia pickettii (Ralston, Palleroni and Doudoroff 1973) comb. nov., *Ralstonia solanacearum* (Smith 1986) comb. nov. and *Ralstonia eutropha* (Davis 1969) comb. nov. *Microbial. Immunol.,* 39, 897-904

Yoder BJ, Ryan MG, Waring RH, Schoettle AW & Kaufmann MR. 1994. Evidence of reduced photosynthetic rates in old trees*. For. Sci.* 40:513–527