The Bioscan 10(3): 1331-1334, 2015 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

AGRONOMIC EVALUATION OF GRAFTED BITTER GOURD (*MOMORDICA CHARANTIA* L.) CULTIVARS FOR GROWTH AND YIELD

N. A. TAMILSELVI*[1] AND L. PUGALENDHI[2]
[1]Department of Vegetable Crops, Horticulture College and Research Institute,
Tamil Nadu Agricultural University, Coimbatore - 641 003, INDIA
[2]Tapioca and Castor Research Station, Yethapur, Salem - 636 119, INDIA
e-mail: tamilaaru@gmail.com

KEYWORDS
Grafting
Bitter gourd
Rootstocks
Yield
Cucurbita moschata
Luffa cylindrica

Received on :
13.05.2015

Accepted on :
26.08.2015

***Corresponding author**

ABSTRACT
The experiment was conducted during the year 2012-13 to study the effect of cucurbitaceous rootstocks on bitter gourd growth and yield (*Momordica charantia* L.) by comparing grafted bitter gourd plants with non-grafted plants under field conditions. The bitter gourd cultivars viz., Palee F_1 and CO 1 were grafted on to two cucurbit rootstocks *viz.,* pumpkin (*Cucurbita moschata)* and sponge gourd (*Luffa cylindrica*). The grafting method adopted in this study was side grafting. The result revealed that the grafted plants had better vegetative growth and yield than the non-grafted plants (check). Highest vegetative growth (856.66 cm), least node number to first female flower appearance (25.80), narrow sex ratio (17.8) and fruit number (28.02 fruits) and fruit yield per vine (3.55 kg/vine) were observed in Palee F_1 scion grafted onto 'pumpkin *(Cucurbita moschata)'* rootstock than other graft combinations and non-grafted plants. The differences recorded for growth and yield of the tested cultivars might be due to different growth characteristics, graft affinity and compatibility. This evidence indicates that grafting bitter gourd scions onto specific rootstock significantly influences growth and yield without deterioration in the fruit quality.

INTRODUCTION

Even though grafting has been practiced in fruit trees for thousands of years vegetable grafting has been recently and widely adopted on a commercial scale (Sakata *et al.*, 2007). The early use of grafted vegetables was associated with protected cultivation which involves successive cropping. Fortunately, seed companies have been able to select and/or breed well-adapted scion cultivars for intensive growing. Although the benefits of using grafted seedlings are widely recognized, many other factors must be carefully considered to ensure successful cultivation and satisfactory income with this new technology, especially in developing countries such as India. It has been well known that the use of proper rootstocks can minimize the problems associated with successive cropping and stress tolerance (Huang *et al.*, 2010). Grafts were used to induce resistance against low and high temperature, enhance nutrient uptake, increase synthesis of endogenous hormones, improve water use efficiency, improves alkalinity and salt tolerance, increases photosynthesis and land use efficiency (Huang *et al.*, 2010).

Bitter gourd (*Momordica charantia* L.) is one of the important cucurbitaceous vegetables grown in India. Depending on location, bitter gourd is also known as bitter melon, Karela or Balsam pear. The immature fruits and tender vine tips are used in a variety of culinary preparations. It is a most common vegetable cultivated throughout India during warm season (Satkar *et al.*, 2013). Bitter gourd has been used in various herbal medicine systems for a long time because of its disease preventing and health promoting phyto chemical compounds like dietary fiber, minerals, vitamins, flavonoids and antioxidants. It is also used for reduction of blood sugar levels in the treatment of type-2 diabete (Singh *et al.*, 2013). Due to limited availability of cultivable land and high market demand for bitter gourd, they are cultivated intensively in larger areas. One of the possible approaches for achieving the targeted production is to identify suitable hybrids/varieties with biotic and abiotic stress tolerance, high yield with good quality and finding suitable technology (Grafting technique) of cultivation.

Effect of grafting on plant growth and fruiting characteristics of cucurbits under normal as well as stress conditions have been conducted in various places. But, very scanty reports exist on bitter gourd grafting. With this point of view, the present study was undertaken to evaluate the growth and yield of bitter gourd scions grafted with pumpkin and sponge gourd as rootstocks.

MATERIALS AND METHODS

The experiment were carried out at the Department of Vegetable Crops, Tamil Nadu Agriculture University, Coimbatore 641103 during the year 2012-2013 to evaluate the effect of grafting on growth and yield of bitter gourd on to

pumpkin and sponge gourd rootstocks. Seedlings of rootstocks and scions were raised in protrays. In general, protrays composed of 50 cells were filled with nutrient enriched coir pith. Seeds were sown one seed per cell and watered as needed, normally twice a day. For obtaining same diameter of scion and rootstocks, bitter gourd seeds were sown five days earlier than rootstocks seeds. The grafting was done in green house during morning and evening hours. Side grafting method was followed in this study. Grafting is performed 20-25 days old seedlings. The best time for side grafting is when the rootstock and scion stems have the same diameter. The grafted plants were transferred immediately to the mist chamber and maintained there for five to seven days at >95%, 25-30ºC and darkness. Relative humidity was reduced for acclimatization. After acclimatization, the plants were transferred to shade house seven to ten days later. Watering is done by just wetting the tray by submerging with water (mixed with Chlorpyriphos 2ml / lit and Copper oxychloride 2 gm/lit) as needed. The clips are removed once the graft portion gets united. By this time grafting union was completed and the bitter gourd scions were able to get water and nutrients through the rootstocks. Stock growth and cotyledonary leaves are removed before planting in field. Four graft combinations *viz.,* Palee F_1 grafted on to pumpkin rootstock, CO 1 grafted on to pumpkin rootstock, Palee F_1 grafted on to sponge gourd rootstock and CO 1 grafted on to sponge gourd rootstock were raised along with two bitter gourd scions (Palee F_1 and CO 1) at 2 x 1.5 m spacing. The experimental design consists of randomized block design (RBD) with four replication. During the growing season, the following vegetative and yield traits were recorded for each plant; vine length, number of primary branches, days to first male and female flower appearance, node number to first male and female flower appearance, sex ratio, days to first harvest, fruit number per vine, fruit weight, flesh thickness, fruit yield per vine. Recommended package of practices was followed to grow a successful crop of bitter gourd (Anon, 2009). The data from the experiments were analyzed statistically following Panse and Sukatme (1989).

RESULTS AND DISCUSSION

Growth and flowering behaviour of bitter gourd grafts and scions were presented in Table 1. The results of this study revealed that vine length was significantly higher in grafted plants than that of non grafted plants. Among the four graft combinations, Palee F_1 grafted on to pumpkin rootstock recorded highest vine length (Table 1). Similar vigorous plant growth in grafted watermelon plants was observed by Yetisir *et al.* (2007) and Mohammed *et al.* (2012). Promoted plant growth in grafted plants can be explained by the interaction of some or all of the following phenomena: increased water and plant nutrient uptake due to stronger and more extensive root growth of the rootstock, augmented endogenous hormone production, enhanced scion vigour (Leoni *et al.*, 1990) and tolerance to salinity. Ioannou (2001) found that grafted watermelon plants were more vigorous than self-rooted ones and had a larger central stem diameter. Additional effects of other processes could also play an important rolein enhancement of plant growth (Yetisir *et al.*, 2007). Salam *et al.* (2002) observed 32 per cent higher main vine length in grafted plant than that of non-grafted counterpart. The number of primary branches per plant is yet another yield contributing trait in bitter gourd. Palee F_1 grafted on to pumpkin rootstock significantly gave the highest number of primary branches. Alan *et al.* (2007) reported that the grafted watermelon plants produced more lateral vines (9 lateral vines / vine) than non grafted plants (4 lateral vines / vine).

Earliness is one of the main attributes which is measured in terms of days to first male and female flower appearance and is preferred for commercial cultivation when high yield is coupled with earliness. The results of this study indicated that grafted plants showed seven to ten days delay in flowering (both male and female) than non-grafted plants due to heavy stress during graft union process in the grafted plants. The graft combination Palee F_1 grafted on to pumpkin rootstock exhibited greatest number of days to flowering and least number of days observed in non-grafted plants. But Palee F_1 grafted on to pumpkin rootstock exhibited earliness with least number of days to first flowering when compared to other graft combinations. Similar trend of delayed flowering in grafted plants were also reported by Sakata *et al.* (2007) and Hamed *et al.* (2012) in watermelon who reported a delayed flowering up to one week in grafted watermelons, resulting in an equal delay in fruit maturity.

Node number for first male and female flower appearance is also considered as an important biometric trait to measure the earliness in cucurbits. The graft Palee F_1 grafted on to pumpkin rootstock followed by Palee F_1 grafted on to sponge gourd rootstock male flowers at the early nodes than the other grafts combinations and scions. This was line with the findings of Reyes, (1990) when grafting bitter gourd scions on to bottle gourd and sponge gourd rootstocks than non-grafted plants. Grafted bitter gourd plants tend to give higher female flowers and lower male flowers comparing to non-grafted plants. Sex expression and flowering is controlled by plant hormones. Narrow sex ratio is the favourable trait in cucurbits. In the present investigation, the graft combinations, Palee F_1 grafted on to pumpkin rootstock followed by CO1 grafted on to pumpkin rootstock had the narrow sex ratio than that of non-grafted plants. This result was in agreement with Heidari *et al.* (2010) and Shahidul Islam *et al.* (2013) in watermelon.

Observation on days to first harvest is yet another indicator of the earliness of any crop especially in vegetables which could fetch premium price and catch the early market. It is directly influenced by earliness in flowering. This is also one of the yield determining characters, when number of days is reduced, it is expected to give more number of harvests. Non-grafted plants or scions recorded lowest value for days to first harvest than grafted plants. Among the four graft combinations, Palee F_1 grafted on to pumpkin rootstock showed earliness in the first harvest which recorded high fruit yield. Delayed harvesting in grafted plants was mainly due to delayed flowering because of heavy stress during graft union process.

Fruit and fruit yield attributes of bitter gourd grafts and scions were presented in Table 2 and it is differed significantly between grafted and non-grafted plants. Number of fruits produced by any kind of vegetable is a direct indicator of high yield. Higher the fruit number more will be the yield. The highest fruit number was observed in Palee F_1 grafted on to pumpkin

Table 1: Growth and flowering behaviour of bitter gourd graft combinations and scions

Graft combinations and scions	Vine length	Number of primary branches	Days to first male flower appearances	Days to first female flower appearances	Node no. to first male flower appearances	Node no. to first female flower appearances	Sex ratio (No. of Male/ female flower)	Days to first harvest
Palee F_1 grafted on to pumpkin *(Cucurbita moschata)* rootstock	844.26	12.97	66.02	69.32	22.75	25.80	17.89	78.72
CO 1 grafted on to Pumpkin *(Cucurbita moschata)* rootstock	619.42	10.30	75.87	81.70	28.10	31.21	23.05	85.90
Palee F_1 grafted on to Sponge gourd *(Luffa cylindrica)* rootstock	511.97	11.01	71.72	77.47	27.90	33.17	20.67	88.10
CO 1 grafted on to Sponge gourd *(Luffa cylindrica)* rootstock	393.20	9.74	79.70	87.70	31.03	34.12	28.97	93.07
Palee F1	647.67	11.02	60.27	63.30	29.42	30.12	19.02	69.12
CO 1	543.76	10.27	63.97	68.47	30.72	34.02	23.09	72.02
Grand mean	594.25	10.88	69.59	74.66	28.32	31.41	22.11	81.15
SEd	6.12	0.70	1.12	1.31	1.25	1.02	0.98	1.07
CD (p = 0.05)	13.05	1.50	2.39	2.79	2.67	2.18	2.10	2.30

Table 2: Yield and yield attributes of bitter gourd graft combinations and scions

Graft combinations and scions	Fruit number per vine	Individual fruit weight (g)	Flesh thickness (cm)	Fruit yield per vine (kg)
Palee F_1 grafted on to Pumpkin *(Cucurbita moschata)* rootstock	28.02	182.20	0.85	3.55
CO 1 grafted on to Pumpkin*(Cucurbita moschata)* rootstock	20.93	134.22	0.70	2.20
Palee F_1 grafted on to Sponge gourd*(Luffa cylindrica)* rootstock	19.40	137.32	0.75	2.27
CO 1 grafted on to Sponge gourd*(Luffa cylindrica)* rootstock	18.80	101.82	0.66	1.70
Palee F1	21.22	164.55	0.73	2.90
CO 1	18.07	92.14	0.68	1.79
Grand mean	21.07	135.37	0.73	2.40
SEd	0.71	2.06	0.03	0.23
CD (p = 0.05)	1.53	4.40	0.06	0.50

rootstock than other graft combinations. Chouka and Jebari (1999) obtained the greatest fruit number of watermelon cv. 'Sugar baby' on 'RS841' (hybrid like 'Shintoza' and 'Bottle gourd' rootstocks. These results was coincide with those obtained by Nisini *et al*. (2002) in muskmelon and Hamed *et al.,* (2012) in water melon.

Mean fruit weight is yet another yield contributing component. High values of mean fruit weight were recorded in the graft combination, Palee F_1 grafted on to pumpkin rootstock whereas among the scions, high values of mean performance were registered by the hybrid Palee F_1(Table 2) This finding falls in line with that of Heidari *et al*. (2010). In case of fruit length and girth, the graft Palee F_1 grafted on to pumpkin rootstock followed by CO1 grafted on to pumpkin rootstock registered higher values compared to other grafts and scions. The yield contributing characters *viz.,* fruit length girth and weight were somehow higher in grafted plants. This result was in agreement with Bekhradi *et al*. (2011), Hamed *et al*. (2012) and Shahidul Islam *et al*. (2013) in watermelon. Flesh thickness is a yet another important character that determines the market preference. The highest value for this trait were observed in fruits harvested from the graft, Palee F_1 grafted on to pumpkin rootstock which was significantly higher than other graft combinations and scions. This result was confirmed by previous reports of Bie *et al*. (2010) in muskmelon and Mohammed *et al*. (2012) in water melon.

In the present study, a higher fruit yield was obtained when Palee F_1 grafted on to pumpkin rootstock compared to other graft combinations and scions (Table 2). This might be resulted from different factor such as rootstocks vigorous root system increases the efficiency of water and nutrient consumption resulting in enhanced growth and yield, superior interaction between rootstock and scion and vigour of the root system which could have enhanced water and nutrient uptake enabling good supply of endogenous hormones leading to increased fruit yield (Sherly, 2010; Aloni *et al*., 2010), increase in absorption of water and nutrition with rootstock widespread root system, increases in endogenous plant growth regulator production (Salehi *et al*., 2010), tolerance to soil low temperature (Zhu *et al*., 2006), increased salinity tolerance (He *et al*., 2009; and Huang *et al*., 2010). In addition, many researchers also reported that superior interaction between rootstocks and scions resulting in high vigor of the root system and greater water and mineral uptake leading to increased yield and fruit enhancement. Similar trends of increased fruit yield in grafted plants were also reported by Huitron *et al*. (2011) and Shahidul Islam *et al*. (2013). The overall study indicated that Palee F_1 grafted on to pumpkin rootstock is potential graft combination to get higher yield and profit, to be valuable to the farming community.

REFERENCES

Alan, O., Ozdemir, N. and Gunen, Y. 2007. Effect of grafting on watermelon plant growth, yield and quality. *J. Agro.* **6(2):**

362-365.

Aloni, B., Cohen, R. Karni, L. Aktas, H. and Edelstein, H. 2010. Hormonal signaling in rootstock-scion interactions. *Sci. Hortic.* **127:** 119-126.

Anon 2009. Crop production manual. *Tamil Nadu Agric. Univ.,* Coimbatore.

Bekhradi, F. Kashi, A. and Delshad, M. 2011. Effect of three cucurbits rootstocks on vegetative and yield of 'Charleston Gray' watermelon. *International J. Plant production*. **5(2):** 105-110.

Bie, Z., Han, X., Zhu, Z., Tang, M. and Huang, Y. 2010. Effect of nine rootstocks on the plant growth and fruit quality of melon. *Acta Hort*. **856:** 77-81.

Chouka, A. S. and Jebari, H. 1999. Effect of grafting on watermelon vegetative and root development production and fruit quality. Proceeding of 1st International Symposium on Cucurbits. *Acta Hort.,* pp. 492.

Hamed, H. K., Z. Ebrahim, S. Gholam and S. Gholamabbas. 2012. Evaluation of different rootstocks and grafting techniques on graft union percent, yield and yield components of watermelon cv. 'Crimson Sweet'. **World Appl. Sci. J., 18 (5):** 645-651.

He, Y., Zhu, Z. Yang, J. Ni, X. and Zhu, D. 2009. Grafting increases the salt tolerance of tomato by improvement of photosynthesis and enhancement of antioxidant enzymes activity. *Envi-ron. Exp. Bot*. **66:** 270-278.

Heidari, A. A., Kashi, A. Saffari, Z. and Kalatejari, S. 2010. Effect of different cucurbita rootstocks on survival rate, yield and quality of greenhouse cucumber cv. Khassib. *Plant Ecophysiology*. **2:** 115-120.

Huang, Y., Bie, Z., He, S., Hua, B., Zhen, A. and Liu, Z. 2010. Improving cucumber tolerance to major nutrients induced salinity by grafting onto *Cucurbita ficifolia*. *Environ. Exp. Bot*. **69:** 32-38.

Huitron, M. V., Ricardez, M. G. and Camacho, F. 2011. Influence of grafted watermelon plant density on yield and quality in soil infested with melon necrotic spot virus. *Acta Hort. (ISHS)* **917:** 265-268.

Ioannou, N. 2001. Integrating soil solarization with grafting on re-sistant rootstocks for management of soil-borne patho-gens of eggplant. *J. Hortic. Sci. Biotechnol*. **76:** 396-401.

Leoni, S., Grudina, R. Cadinu, M. Madeddu, B. and Garletti, M.C. 1990. The influence of four rootstocks on some melon hybrids and cultivar in greenhouse. *Acta Hort*. **287:** 127-134.

Mohammed, F. H., El-Hamed, K. E. A. Elwan, M. W. M. and Hussien, M. A. N. E. 2012. Impact of grafting on watermelon growth, fruit yield and quality. *Veg. Crops Res. Bulletin* **76:** 99-118.

Nisini, P. T., Colla, G. E. Granati, O. Temperini, P. Crino and Saccardo, F. 2002. Rootstock resistance to fusarium wilt and effect on fruit yield and qulaity of two muskmelon cultivars. *Scientia Hort*. **93:** 281-288.

Panse, V. G. and Sukhatme, P. V. 1957. Statistical Methods for Agricultural Workers, *ICAR,* New Delhi.

Reyes, M. E. C. 1990. A preliminary study of graft compatibility of bittergourd scion on spongegourd and bottlegourd rootstocks. *ARC Gourd training report*. pp. 1-5.

Sakata, Y., Takayoshi, O. and Mitsuhiro, S. 2007. The history and present state of the grafting of cucurbitaceous vegetables in *J. Acta Hort*. **731:** 159-170.

Salam, M. A., Masum, A. S. M. H. Chowdhury, S. S. Dhar, M. Saddeque, M. A. and Islam, M. R. 2002. Growth and yield of watermelon as influenced by grafting. *J. Biol. Sci*. **2(5):** 298-299.

Salehi, R., Kashi, A. Babalar, M. and Delshad, M. 2010. Identification of cytokinin in xylem sap of grafted and ungrafted melon under different train treatments. *Proceeding of the 6th Iranian Horticulture Science congress. Guilan University*. pp. 239.

Shahidul Islam, M., Bashar, H. M. K. Howlader, M. I. A. Sarker, J. U. and Al-Mamun, M. H. 2013. Effect of grafting on watermelon growth and yield. *Khon Kean. J.* **41:** 284-289

Sherly, J. 2010. Studies on grafting of brinjal accessions (S*olanum melongena* L.) with wild s*olanum* rootstocks. *PhD (Hort.) Thesis,* TNAU, Coimbatore.

Yetisir, H., Kurt, S. Sari, N. and Tok, F. M. 2007. Rootstock potential of Turkish *Lagenaria siceraria* germplasm for watermelon: Plant growth, graft compatibility and resistance to *Fusarium*. *Turk J. Agric. For*. **31:** 381-388.

Zhu, J., Bie, Z. L., Huang, Y. and Han, X. Y. 2006. Effects of different grafting methods on the grafting work efficiency and growth of cucumber seedlings. *China Veg*. **9:** 24-25.

Satkar, K. P. Kulthe, A. A. and Chalke P. R. 2013. Preparation of bitter gourd ready to serve beverage and effet of storage temperature on its keeping quality. *The Bioscan*. **8(1):** 115-117.

Singh, K. Pan, R. S. and Bhavana, P. 2013. Heterosis and combining ability analysis in bitter gourd. (Supplement on Genetics & Plant Breeding, *The Bioscan*. **8(4):** 1533-1536.