Current Horticulture 12(1): 64–68, Januray–April 2024 DOI: 10.48165/chr.2023.12.1.02

Effect of growing environment on graft compatibility and its success in cucurbits

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Received: 2 May 2021; Accepted 12 December 2022

ABSTRACT

The experiment was conducted to evaluate the effect of growing environment on graft compatibility and its success in cucurbits, at Kittur Rani Channamma College of Horticulture, Arabhavi, Belagavi district, Karnataka, during *kharif* 2018-19 and *rabi* 2019-20 seasons. Among both growing environments (open field and shade net condition), field transplanted grafted plants did not survive 20 days after grafting, hence study was continued to know the performance of grafted plants under shade net condition. Graft compatibility and its success was significantly influenced by different cucurbitaceous rootstocks and scions. Significant and maximum graft success (89.33 and 96.33 %), maximum vine length (227.30 and 269.91cm 40 DAG), minimum number of days to first and 50 % sprouting, final girth of graft union (16.36, 20.04, 13.37, 16.39 at 60 & 90 DAG), node number to first female flower appearance (19.14, 8.28) and days to first female flower appearance (33.15, 45.62) were noticed in *Momordica charantia* L. and *Luffa acutangula* L. scions grafted on *Cucurbita moschata* L. and *Trichosathes cucumerina* L. rootstocks during both seasons and there was non-significant difference between two seasons.

Key words: Cucurbits, Graft compatibility, Graft success, Growing environment, Wedge grafting method,

The family cucurbitaceae includes about 118 genera and 825 species, many of which are economically important crops (Saroj and Choudary, 2020). Continuous cropping can cause abiotic and biotic stresses (incidence of cucurbit pest and soil-borne diseases. Chemical pest control is expensive and is not effective and can harm environment (Davis *et al*., 2008). To overcome many of these problems an alternative technology is grafting. Therefore, an experiment was conducted at Kittur Rani Channamma College of Horticulture, Arabhavi, UHS, Bagalkot, Karnataka, to find out the effect of growing environment on graft compatibility and its success in cucurbits using wedge grafting method.

MATERIALS AND METHODS

The experiment was conducted at Kittur Rani Channamma College of Horticulture (KRCCH), Arabhavi, Belagavi district, Karnataka, during *kharif* 2018-19 and rabi 2019-20 seasons. Two growing environments (open field and shade net condition), five cucurbitaceous species as a rootstocks, *viz.* bottle gourd *(Lagenaria siceraria* L.*)*, pumpkin (*Cucurbita moschata* L.*)*, ivy gourd (*Coccinia indica* L.) sponge gourd *(Luffa cylindrical* L.*)*, snake gourd (*Trichosanthes cucumerina* L.) and five different cucurbitaceous species as scions, *Viz.* watermelon (*Citrullus lanatus L.*), cucumber (*Cucumis sativus* L.), muskmelon *(Cucumis melo* L.), bitter gourd (*Momordica charantia* L.) and ridge gourd *(Luffa acutangula* L.*)*. Grafting was performed by using wedge grafting in a factorial randomized block design with three replications.

RESULTS AND DISCUSSION

There was significant difference among rootstocks on number of days taken for first and 50 % sprouting. Significant and minimum number of days to first sprouting were noticed when snake gourd (R_3) (3.17 4.67, 4.17 6.50 days) was used as a rootstock, followed by pumpkin (R_2) (4.33 6.50 8.00 days). The significant and maximum number of days to first sprouting were observed in bottle gourd (R_1) (5.83

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6.67, 9.50 9.67 days) as a rootstock during both the seasons. The pooled data recorded least number of days to first and 50 % sprouting (3.92, 5.33 days) when snake gourd (R_3) was used as a rootstock. Maximum number of days to first and 50 % sprouting (6.25, 9.58 days) was recorded in bottle gourd (R_1) as a rootstock. These results may be due to early callus formation and wound healing due to faster cell multiplication and cell division at graft portion, resulting in early sprouting and vice-versa for delayed sprouting.

There were significant differences among scions for days taken to first sprouting. Significant and least number of days to first sprouting were observed when ridge gourd (S_2) (4.11 5.33 days) was used as a scion, whereas maximum number of days to first sprouting was noted in bitter gourd (S_1) (4.77 5.89 days) as a scion during both seasons. The pooled data recorded least number of days to first sprouting (4.72 days) in ridge gourd (S_2) and maximum number of days to first sprouting (5.33 days) in bitter gourd (S_1) scion. Similar results were also observed for days to 50 % sprouting. Among different scions, bitter gourd (S_1) took minimum number of days to 50 % sprouting (6.11, 7.67 and 6.89 days) compared to ridge gourd (S_2) during both seasons and mean respectively. This is logically due to physiological conditions of juvenile and younger scions which favored early callus formation due to higher cellular activity.

The interaction effects of different rootstock and scion was also significant during both seasons. Significant and least number of days to first and 50 % sprouting (3.00 4.33, 4.00, 6.33 days) was recorded in ridge gourd scions grafted on snake gourd rootstock using wedge grafting method (R_3S_2) and it was at par with bitter gourd scions grafted on snake gourd (R_3S_1) (3.33 5.00, 4.33 4.33 days) rootstock. This may be attributed due to synergistic effects of higher temperature and relative humidity inside healing chamber and also high compatibility of scion and rootstock which ultimately helps in early callus formation due to higher cellular activity and early wound healing.

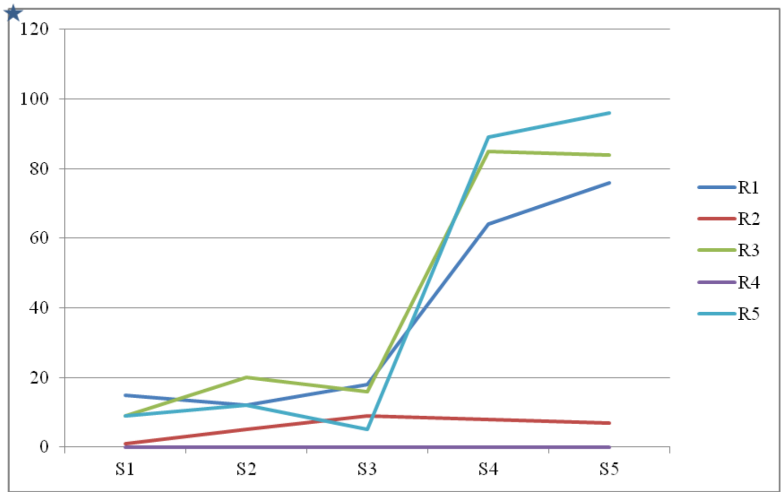
These findings are in line with these of Kavya (2017), and Khandekar *et al.* (2006). Maximum number of days to first sprouting (6.67 7.33, 9.67 9.67 days) was observed in bitter gourd scions grafted on bottle gourd (R_1S_1) as a rootstock. The pooled data recorded minimum number of days to first and 50 % sprouting (3.67 5.17 days) in ridge gourd scions grafted on snake gourd (R_3S_2) and maximum number of days to first sprouting in bitter gourd scions grafted on bottle gourd (R_1S_1) (7.00 9.67 days) rootstock.

The percentage of graft success was assessed in bottle gourd, *Coccinia*, pumpkin, sponge gourd and snake gourd and five different cucurbitaceous scions (watermelon, cucumber, muskmelon, bitter gourd and ridge gourd). Among these combinations, only bitter gourd and ridge gourd scions grafted on bottle gourd, pumpkin and snake gourd rootstocks were found compatible while other all combinations were incompatible. It may be attributed to environmental factors, lack of skill of grafter or premature death of either rootstock or scion due to incompatibility (Fig.1). Further more than 50 % graft success combinations were used for further investigation.

There was highest percentage of graft success (10 DAG) by snake gourd (R_3) (92.50 and 90.50 %), followed by pumpkin (R_2) (87.83 and 85.50 %) and in bottle gourd (R_1) (71.00 and 68.00 %) as a rootstock during both seasons. The pooled mean showed highest percentage of graft success in snake gourd (R_3) (92.25 %), followed by pumpkin (R_2) (87.00 %) and lowest in bottle gourd (R_1) (70.00 %) rootstock. Oda *et al*. (1993) also revealed that maximum percentage of graft success in pumpkin. Similarly, ridge gourd (S_2) recorded maximum percentage of graft success (86.00 and 84.67 %) compared to bitter gourd (S_1) (81.56 and 78.00 %) scion during both seasons. Pooled mean recorded maximum percentage of graft success in ridge gourd (S_2) (85.39%) compared to bitter gourd (S_1) (80.78 %) scion. This may be due to survival rate of grafted plants was inversely correlated with difference in diameters of scion and rootstock and number of vascular bundles (Yetsari and Sari, 2004).

Interaction effects were also found to be significant during both seasons. Ridge gourd scions grafted on snake gourd (R_3S_2) recorded maximum percentage of graft success (97.00, 95.33 %), followed by bitter gourd scion grafted on pumpkin (R_2S_1) (90.67, 86.33 %) and lowest in bitter gourd scions grafted on bottle gourd (R_1S_1) (66.00, 62.00 %) rootstock during both seasons. The pooled data showed maximum percentage of graft success in ridge gourd scions grafted on snake gourd rootstock (R_3S_2) (96.33 %), followed by bitter gourd scions grafted on pumpkin rootstock (R_2S_1) (89.33 %) and lowest in bitter gourd scions grafted on bottle gourd rootstock (R_1S_1) (64.83 %).

Among two seasons the highest percentage of graft success and minimum number of days to 50 % sprouting was noticed during *kharif* (2018-19) than



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Rootstocks: R_1, bottle gourd; R_2, coccinia; R_3, pumpkin; R_4, sponge gourd; R_5, and snake gourd;

Scions: S_1, watermelon; S_2, cucumber; S_3, muskmelon; S_4, bitter gourd; and S_5, ridge gourd;

Fig. 1: Compatibility of cucurbitaceous rootstocks and scions on graft success

Table 1: Effect of cucurbitaceous rootstock and scion on scion length, girth of graft union and number of nodes 20 days after grafting

Treatment	Length (cm)			Initial girth of graft union (mm)		Number of nodes/graft
	10 DAG	15 DAG	20 DAG	10 DAG	20 DAG	15 DAG
R_1	16.22	20.73	15.90	4.83	4.22	1.95
R_2	16.18	20.53	16.52	5.53	5.08	2.28
R_3	20.23	24.21	19.89	5.28	4.62	3.23
SEm±	0.89	1.35	1.15	0.05	0.08	0.34
CD at (5 %)	2.80	NS	NS	0.17	0.25	NS
S_1	18.52	21.60	18.12	5.01	4.33	2.48
S_2	16.56	22.03	16.75	5.42	4.95	2.48
SEm±	0.73	1.10	0.94	0.04	0.06	0.28
CD at (5 %)	NS	NS	NS	0.14	0.20	NS
$R_1 S_1$	15.49	20.55	16.45	4.62	3.92	1.89
$R_1 S_2$	16.95	20.90	15.34	5.04	4.52	2.00
$R_2 S_1$	20.94	20.91	18.45	5.47	5.03	3.22
$R_2 S_2$	11.41	20.14	14.58	5.58	5.12	1.34
$R_3 S_1$	19.14	23.35	19.45	4.93	4.03	2.34
$R_3 S_2$	21.32	25.06	20.34	5.63	5.20	4.11
SEm±	1.26	1.1	1.62	0.07	0.11	0.48
CD at 5 %	3.96	NS	NS	0.24	0.35	1.51
CV (%)	12.41	15.12	16.10	2.49	4.13	33.31

R_1S_1, bitter gourd scions grafted on bottle gourd rootstock; R_1S_2, ridge gourd scions grafted on bottle gourd rootstocks; R_2S_1, bitter gourd scions grafted on pumpkin rootstock; R_2S_2, ridge gourd scions grafted on pumpkin rootstocks; R_3S_1, bitter gourd scions grafted on snake gourd rootstock; and R_3S_2, ridge gourd scions grafted on snake gourd rootstocks

DAG, Days after grafting; NS, Non -significant

rabi (2019-20). Similar findings were also noticed in standardization of grafting in bitter gourd (Akhila and George, 2017). The probable reasons may be the fact that temperature and humidity play important role that influence graft healing by callus formation (Hartmann *et al.*, 2000.

Successful graft combinations were transplanted under open field and shade net condition 8 days after

Table 2: Graft success and vegetative parameters as influenced by cucurbitaceous rootstock and scion under protected environment (shade net)

Treatment 2018-19		Graft success (%) 10 DAG		Vine length (cm) 40 DAG		No. of nodes/graft 60 DAG		Girth of graft union (mm) 60 DAG		Girth of graft union (mm) 90 DAG		Node number to first female flower appearance		Days to first female flower appearance
		2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Rootstock	R_1	71.00 (57.48)	70.00 (56.85)	207.11	198.90	81.84	80.94	10.92	11.55	12.79	13.10	18.60	18.92	45.77
	R_2	87.83 (69.71)	87.00 (68.92)	227.62	224.63	90.90	93.02	12.91	13.11	14.96	15.21	14.70	14.61	41.50
	R_3	92.50 (74.94)	92.25 (74.45)	250.26	248.60	92.73	94.85	14.96	14.87	18.13	18.21	13.68	13.71	39.94
	SEm±	**0.40**	**0.47**	**2.36**	**1.71**	**1.03**	**1.25**	**0.33**	**0.21**	**0.34**	**0.36**	**0.93**	**0.91**	**1.25**
	CD at (5 %)	**1.26**	**1.49**	**7.43**	**5.39**	**3.23**	**2.61**	**1.04**	**0.67**	**1.06**	**1.16**	**2.95**	**2.88**	**3.95**
Scion	S_1	81.56 (65.43)	80.78 (64.80)	221.08	212.53	126.78	126.62	13.60	13.96	16.32	16.45	21.87	22.42	45.36
	S_2	86.00 (69.31)	85.39 (68.68)	235.58	235.56	50.19	52.58	12.26	12.38	14.26	14.56	9.46	9.08	39.44
	SEm±	**0.33**	**0.38**	**1.92**	**1.40**	**0.84**	**1.02**	**0.27**	**0.17**	**0.27**	**0.30**	**0.77**	**0.74**	**1.02**
	CD at (5 %)	**1.03**	**1.22**	**6.06**	**4.04**	**2.64**	**2.13**	**0.85**	**0.54**	**0.86**	**0.95**	**2.41**	**2.36**	**3.23**
Interaction	R_1S_1	66.00 (54.32)	64.83 (53.61)	206.50	197.97	124.45	122.43	11.03	11.83	13.73	13.76	27.00	28.18	45.94
	R_1S_2	76.00 (60.65)	75.17 (60.09)	207.73	199.83	39.23	39.45	10.81	11.26	11.85	12.45	10.20	9.65	45.60
	R_2S_1	90.67 (72.22)	89.33 (70.92)	229.87	212.32	130.45	130.29	13.40	13.72	15.36	15.55	19.64	19.93	45.00
	R_2S_2	85.00 (67.19)	84.66 (66.93)	225.37	236.94	51.34	55.75	12.43	12.51	14.55	14.87	9.77	9.30	38.00
	R_3S_1	88.00 (69.75)	88.17 (69.86)	226.87	227.30	125.45	127.15	16.39	16.36	19.88	20.04	18.97	19.14	45.13
	R_3S_2	97.00 (80.09)	96.33 (79.04)	273.65	269.91	60.00	62.56	13.53	13.37	16.37	16.39	8.40	8.28	34.74
	SEm±	**0.56**	**0.66**	**6.39**	**2.42**	**1.45**	**1.77**	**0.46**	**0.30**	**0.47**	**0.52**	**1.33**	**1.29**	**1.77**
	CD at 5 %	**1.78**	**2.11**	**10.50**	**7.63**	**4.57**	**3.69**	**1.48**	**0.94**	**1.50**	**1.65**	**4.18**	**4.08**	**5.59**
	CV (%)	**1.16**	**1.39**	**2.53**	**1.87**	**2.81**	**2.26**	**6.28**	**3.92**	**5.38**	**5.83**	**14.66**	**14.24**	**7.25**

* Rootstocks : R_1, Bottle gourd; R_2, Pumpkin; R_3, Snake gourd

Scion(S) : S_1,Bitter gourd; S_2,Ridge gourd

DAG, Days after grafting NS, Non-significant

* Figures in parentheses are arcsine transformation

grafting (after healing). Sudden wilting of grafted plants under open field condition was observed 20 days after grafting (DAG). This may be due to transplant shock or disease attack or climatic condition of the place which may not be suitable for cultivation of grafted plant under open field condition (Table 1).

Sprout length of scion under shade net condition recorded at 10 days after grafting was found to be non-significant, whereas at 15, 20, 25, 30 and 40 days after grafting it was significantly affected by different treatment combinations. Number of node/graft/vine at 15 DAG was also found to be non significant and at 30, 45 and 60 days after grafting found to significant. The initial girth of graft union recorded at 10, 20 and 30 DAG was also found to be non- significant.

Pooled data showed maximum vine length (248.60 cm), maximum number of nodes/graft (94.85) (93.02), final girth of graft union (14.87, 18.21 mm at 60 and 90 DAG) (13.11 15.21 mm at 60 and 90 DAG), least number of days to first sprouting (39.94) (41.50), appearance of first female flower at early node (13.68) (14.70) in snake gourd (R_3), followed by pumpkin (R_2) rootstock respectively compared to bottle gourd (R_1) as a rootstock (Table 2). This might be attributed to strong and vigorous root system of both pumpkin and snake gourd rootstocks which promoted growth and also wider diameter and strong stem of snake gourd and pumpkin compared to bottle gourd with more number of vascular bundles for strong stem girth.

Interaction effects were also found to be significant. Maximum vine length (269.91 cm) (227.30 cm), maximum number of nodes/graft (130.29) (62.56) in ridge gourd and bitter gourd scions grafted on snake gourd and pumpkin rootstock respectively, final girth of graft union (16.36, 20.04) (13.37, 16.39 mm at 60 and 90 DAG) in bitter gourd and ridge gourd scions grafted on snake gourd rootstock. Minimum number of days to first female flower appearance (33.15) (45.62) and appearance of first female flower at earliest node (19.14) (8.28) in both ridge gourd and bitter gourd scions grafted on snake gourd rootstock respectively. This may be due to strong and extended roots of both pumpkin and snake gourd which helps to absorb more water and nutrient elements leading to vigorous plant growth and flowering parameters. There was no difference between two seasons. This clearly indicates that the rootstocks were more stable under different environmental conditions, giving nearly the same vegetative and flowering parameters. A similar finding was also observed by Mohamed *et al*. (2012) in watermelon.

CONCLUSION

Thus the best rootstocks for both bitter gourd and ridge gourd are pumpkin and snake gourd with respect to graft compatibility and graft success and vegetative and flowering parameters. Open field cultivation grafted plants can be tried using mulching and drip irrigation systems for more yield.

ACKNOWLEDGEMENT

The authors acknowledge the help of the team of AVRDC (World Vegetable Centre) Taiwan, especially Dr Ravishankar Manickam, for guaidance.

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