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Original Research Paper

Performance of parthenocarpic and non-parthenocarpic grafts of cucumber

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ABSTRACT

Effect of rootstock on yield and quality of cucumber scion was studied at Department of Vegetable Science, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala during February-May, 2021. Parthenocarpic and non-parthenocarpic cucumber scions were grafted onto five different cultivated cucurbit species i.e. pumpkin, bottle gourd, oriental pickling melon, culinary melon and ash gourd. Significant variations were observed for all the traits under this study. The highest vine length (4.37 m) was observed in Heera scion grafted onto *Lagenaria siceraria* rootstock followed by Heera scion grafted onto *Cucurbita moschata* rootstock (4.13 m). The diameter of rootstock hypocotyl was higher in case of KPCH-1 grafted onto bottle gourd (1.48 mm) and Heera grafted onto bottle gourd (1.43 mm). KPCH-1 grafted on bottle gourd (29.33 days) and culinary melon (31 days) rootstocks showed early female flower initiation. The greater number of fruits was observed in graft combination of KPCH-1 and bottle gourd (32) followed by parthenocarpic grafts with pumpkin (30.33) and ash gourd (30.33) rootstocks. A greater fruit weight was observed in graft combination of Heera and bottle gourd (7.51 kg) followed by Heera grafted onto pumpkin (7.38 kg). Results of this experiment suggest that these graft combinations can be employed in sustainable vegetable cultivation.

Keywords: Cucumber, grafts, non-parthenocarpic, parthenocarpic, rootstock and scion

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is a popular and second important cucurbit grown throughout tropical and sub-tropical region. Due to the rising demand for salad cucumber in off-season, protected cultivation can be followed to increase the yield and quality (Singh *et al*., 2012). Parthenocarpy along with gynoecious sex expression is an asset for protected cultivation of cucumber. Cultivation of parthenocarpic hybrids is gaining attention of the growers as it is a reliable and profitable venture. The major factors limiting cucumber cultivation are soil-borne root knot nematodes and soil salinity. To overcome the problems in cucumber cultivation, an eco-friendly technique exploited is vegetable grafting with resistant rootstocks.

Grafting was confined to woody perennials but now vegetable grafting has gained importance to combat biotic and abiotic stress. Though cultivated area of grafted cucubitaceous plants has increased tremendously in foreign countries, but the commercial use of vegetable grafting is a relatively recent innovation in India and scientific information is meagre. Sakata *et al*. (2008) showed that cucumber could be grafted onto different wild and cultivated rootstocks, including *Cucurbita* interspecific hybrids, *Cucumis* spp., bottle gourd, wax gourd, fig-leaf gourd, African horned cucumber, sponge gourd and ridge gourd. However, survival, growth and yield of grafted plants depend on stock-scion compatibility, grafting method and post-grafting management. Due to change in root system, the physiology and metabolic process of plants are affected in grafted plants. The studies on use of parthenocarpic variety as scion in grafting is limited.

Grafting can also increase yield since grafted plants are resistant to soil borne diseases, have strong root systems and increased photosynthesis (Davis *et al*., 2008). Cucumber adapts well to grafting and has few compatibility problems with the usual rootstocks

(Echebarria, 2001). Edelstein *et al*. (2004) observed that number of leaves, stem length, and fresh weight of melon plants increased when grafted onto other cucurbitaceous rootstocks. Chao and Yen (2013) observed that cucumber grafted onto *Cucumis* rootstock showed good rootstock scion combination, better tolerance to soil-borne diseases, better growth, yield and quality. Hang *et al*. (2005) observed that when scion and rootstock have hollow hypocotyls as in cucurbits, the hole insertion and one cotyledon grafting methods are preferred.

MATERIALS AND METHODS

The experiment was conducted in rain shelter during February-May, 2021 at Department of Vegetable Science, College of Agriculture, Vellayani, Kerala. The experimental site was located at 8.5°30' North latitude and 76.9°54' East longitude at an altitude of 29 m above mean sea level. Predominant soil type of the experimental site was red loam of Vellayani series, texturally classified as sandy clay loam.

In this experiment, two different scions were used: a parthenocarpic hybrid KPCH-1 and a non-parthenocarpic variety, Heera. Five rootstocks were used, namely, pumpkin (*Cucurbita moschata*) var. Ambili, bottle gourd (*Lagenaria siceraria*) var. Arka Bahar, ash gourd (*Benincasa hispida*) var. KAU Local, culinary melon (*Cucumis melo* var. acidulus) var. Mudicode local and oriental pickling melon (*Cucumis melo* var. conomon) var. Vishal.

Considering the early germination of cucumber (scion) compared to rootstocks, rootstocks were sown four days earlier than scions. Depending on the result of standardization, ten days old scion was grafted onto fourteen days old rootstocks. Alar and cycocel 20 ppm each were used to control height of rootstocks. Based on the stem grith of rootstocks and scion, grafting methods were employed. For culinary melon, oriental pickling and ash gourd where the stem size were similar to scion, one cotyledon grafting was used. In case of pumpkin and bottle gourd whose stem girth is higher than that of cucumber, hole insertion method was employed. The protrays were shifted to graft healing chamber (e"85 % humidity) immediately after grafting. Graft union formation was noticed within seven days and thereafter the grafts were shifted to 75 % shaded net house. The grafted plants were planted in the main field (rain shelter) after twelve days of grafting. The experiments were laid in a randomized complete block design with three replications of ten plants each at a spacing of 1.5 m × 0.5 m on raised beds. Standard cultural practices were followed to raise a healthy crop under protected condition.

Diameter of rootstock hypocotyls was recorded using vernier calliper. The vine length of each graft was measured using a scale after final harvest. For determining earliness, the node number and days at which the first pistillate flower appeared was recorded for each plant. The number of fruits per plant and yield per plant was recorded as an average of all ten plants in each replication. For quality assessment, five random fruits were selected from each replication. Fruit length and diameter were measured. The total soluble solids (TSS) content was measured using a handheld refractometer (ERMA, Japan). The data obtained in evaluation trial was analyzed using WASP (Web Agriculture Statistical Package) 2.0 software through ANOVA techniques.

RESULTS AND DISCUSSION

The present study revealed that the vegetative and yield parameters of the grafted plants were significantly affected by scion-rootstock combinations (Table 1 and 2). Significant difference was observed in vine length with respect to rootstocks and scions used in this study. Among the ten graft combinations, the highest vine length (4.37 m) was observed in Heera scion grafted onto bottle gourd rootstock followed by Heera scion grafted onto pumpkin rootstock (4.13 m). Generally, vigorous rootstocks increase the vine length of scions. However, the root and shoot vigour imparted by these rootstocks did not reflect in higher yield. This is confirmed by a lack of correlation between yield and root parameters. Similar differences in vine length were also obtained by Mohamed *et al*. (2012) who stated that grafted watermelon plants were more vigorous than self-rooted ones and had a larger central stem diameter and recorded 32 per cent higher main vine length than that of non-grafted counterpart. Selvi and Pugalendhi (2018) also observed the increase in vine length through grafting in bitter gourd. Improved plant growth of grafts is measured by phenomena of stronger and more extensive root growth, increased water and plant nutrient uptake as well as endogenous hormone production (Islam *et al*., 2013).

The diameter of rootstock hypocotyl reflects the vigor of the grafts. The diameter of rootstock hypocotyl was higher in case of KPCH-1 grafted onto bottle gourd (1.48 mm) and Heera grafted onto bottle gourd (1.43 mm). Growth and development of grafted plants was better than that of non-grafted plants throughout the growing period. High vigor was noticed in grafts with high diameter of rootstock hypocotyl. Similar results were observed by Aishwarya (2019).

Earliness coupled with high yield is an important trait for commercial cultivation of vegetable crops. A significant influence of the rootstocks was observed on earliness in terms of the appearance of pistillate flower at the lower nodes and also number of days to female flower initiation. Early flowering was observed in grafts than the control. KPCH-1 grafted on bottle gourd (29.33 days) and culinary melon (31 days) rootstocks showed early female flower initiation whereas, Heera grafted onto pumpkin took greater number of days (48.33 days). These results are similar to Pal *et al*. (2020) and Bigdelo *et al*. (2017). However, a reverse trend of delayed flowering in grafted plants was observed by Hamed *et al*. (2012) and Selvi and Pugalendhi (2018). In cucurbits, node at which first female flower appears is also considered as important trait to measure earliness. The number of nodes of female flower initiation was lower for the graft of KPCH-1 on bottle gourd (3.33) and oriental pickling melon (3.67) than the non-grafted control (4th node). Parthenocarpic gynoecious hybrid bears only female flowers and in case of Heera, the graft combinations of Heera on ash gourd (8) and culinary melon (8.33) showed female flowers at lower nodes (Table 1).

Significant difference was observed for traits like number of fruits per vine, fruit yield, average fruit weight and days to first fruit harvest. Number of fruits were higher in case of parthenocarpic grafts than the non-parthenocarpic graft combinations. The greater number of fruits was observed in graft combination of KPCH-1 and bottle gourd (32.00) followed by parthenocarpic grafts with pumpkin (30.33) and ash gourd (30.33) rootstocks. In non-parthenocarpic graft combination, the grafts with oriental pickling melon (27.67) followed by ash gourd (26.33) and bottle gourd (26.00) produced a greater number of fruits than the control (25.67). These graft combinations produced 5 to 10 per cent higher fruits per plant. In cucumber,

Table 1. Vegetative and flowering parameters of grafts

Graft combinations	Diameter of rootstock hypocotyl (cm)	Vine length (m)	Days to 1st female flower	Node of 1st female flower
KPCH-1 on culinary melon	1.20	1.77	31.00	4.00
Heera on culinary melon	1.21	4.00	47.30	8.33
KPCH-1 on oriental pickling melon	1.24	1.91	32.00	3.67
Heera on oriental pickling melon	1.23	2.30	47.00	11.00
KPCH-1 on pumpkin	1.36	2.53	31.67	4.67
Heera on pumpkin	1.37	4.13	48.33	9.00
KPCH-1 on ash gourd	1.34	2.63	31.67	4.67
Heera on ash gourd	1.26	2.27	45.33	8.00
KPCH-1 on bottle gourd	1.48	2.46	29.33	3.30
Heera on bottle gourd	1.43	4.37	44.33	9.00
KPCH-1	0.90	2.73	33.67	4.00
Heera	0.97	3.60	46.00	10.00
CD (0.05)	0.10	0.34	3.17	1.50
SEm	0.05	0.25	2.27	0.81
SD	0.17	0.89	7.86	2.82
CV	4.94	7.10	4.84	13.34

'Shelper' rootstock provided increase in the number of marketable fruits and 35.5 and 39.5 % increase in yield, compared to non-grafted plants (Kohatsu *et al*., 2013).

A greater fruit weight was observed in graft combination of Heera and bottle gourd (7.51 kg) followed by Heera grafted onto pumpkin (7.38 kg). However, in case of KPCH-1, higher fruit yield was observed in the graft combination of bottle gourd (5.25 kg), followed by ash gourd (Table 2). Fruit yield depends on number of fruits and average fruit weight. In the present study, fruit yield was directly proportional to the average fruit weight. Higher number of fruits was noticed in parthenocarpic grafts whereas higher fruit yield was observed in non-parthenocarpic grafts, which is due to high average fruit weight of non-parthenocarpic grafts (Fig.1).

Early fruit harvesting was noticed in case of parthenocarpic graft combinations with bottle gourd (40 days) followed by ash gourd (41 days) and culinary melon (41 days) than the control (43 days). The graft combination of Heera with bottle gourd (54 days) and ash gourd (54.67 days) rootstock showed early fruit harvesting than that of non-parthenocarpic control (Table 2). Earliness of any vegetable crop is directly measured through days to first harvest which could fetch premium price and catch the early market. Days to first harvest had the positive direct effect with days to female flower initiation and node of pistillate flower appearance. Five to ten per cent increase in yield

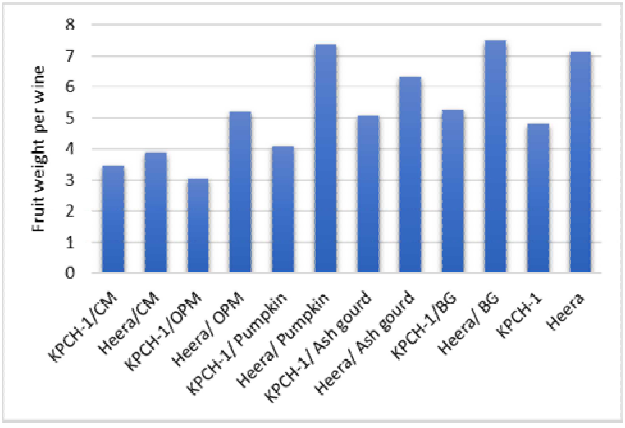

Fig. 1. Graphical representation of average fruit yield per vine
CM - Culinary melon, OPM - Oriental pickling melon, BG - Bottle gourd

Table 2. Fruit yield parameters of cucumber grafts

Graft combinations	Fruits per vine	Fruit yield (kg)	Days to first harvest	Fruit TSS (°B)
KPCH-1 on culinary melon	28.00	3.48	41.00	2.20
Heera on culinary melon	25.00	3.89	57.00	3.60
KPCH-1 on oriental pickling melon	25.67	3.06	40.67	2.07
Heera on oriental pickling melon	27.67	5.20	56.67	2.20
KPCH-1 on pumpkin	30.33	4.09	41.33	2.27
Heera on pumpkin	24.67	7.38	57.67	2.97
KPCH-1 on ash gourd	30.33	5.09	41.00	2.17
Heera on ash gourd	26.33	6.33	54.67	1.97
KPCH-1 on bottle gourd	32.00	5.25	40.00	2.03
Heera on bottle gourd	26.00	7.51	54.00	2.27
KPCH-1	29.00	4.82	43.00	2.07
Heera	25.67	7.14	55.67	2.00
CD (0.05)	3.63	0.89	2.66	0.63
SEm	0.69	0.44	2.25	0.13
SD	2.40	1.52	7.80	0.48
CV	7.78	10.06	3.24	16.12

was observed in grafted plants than the non-grafted control. Fruit TSS was observed to be higher with non-parthenocarpic scion combined with culinary melon rootstock (3.6 °B) and pumpkin (2.96 °B) against the control (2.0 °B). Parthenocarpic non-grafted cucumber has total soluble solids of 2.06 °B which was lower than that of grafts with rootstock pumpkin (2.26 °B) and culinary melon (2.20 °B). Quality parameters are not affected by rootstock-scion combination as previously reported by Selvi and Pugalendhi (2018) in bitter gourd.

CONCLUSION

It can be concluded that grafted plants performed better than non-grafted control in cucumber. Grafting can be commercialized in protected cultivation of cucumber for parthenocarpic and non-parthenocarpic cultivars. According to this study, both scions, KPCH-1 and Heera performed better with the bottle gourd rootstock for almost all vegetative and yield attributing traits. Therefore, this graft combination can be used in sustainable horticulture with higher yield. Further, grafting can be utilized to combat biotic and abiotic stress in cucurbitaceous vegetables.

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