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RESEARCH ARTICLE

GRAFTING COMPATIBILITY OF TOMATO (*SOLANUM LYCOPERSICUM*), BRINJAL (*SOLANUM MELONGENA*) AND CHILLI (*CAPSICUM ANNUM*) THROUGH CLEFT GRAFT METHOD

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ABSTRACT

The study on Grafting compatibility of tomato (*Solanum lycopersicum*), brinjal (*Solanum melongena*) and chilli (*Capsicum annum*) through cleft graft method was carried out under the mist chamber conditions at college orchard, Department of Horticulture, Agricultural College and Research Institute, Madurai during 2019 - 2020 with the aim to identify the best grafting compatibility between the crops through cleft grafting method. 9 level of crossing among the crops viz., Tomato X Tomato, Tomato X Brinjal, Tomato X Chilli, Brinjal X Brinjal, Brinjal X Tomato, Brinjal X Chilli, Chilli X Chilli, Chilli X Brinjal and Chilli X Tomato were grafted with cleft grafting method. Tomato var. PKM-1, Chilli var.K-2 and Brinjal var.PKM-1 used for this study. These grafting of rootstocks and scions were done in polybags and kept under mist chamber for compatible graft union. The study was laid out in Randomized Block Design (CRD) with 9 treatments (crossing) and ten replications and analyzed statistically. The results revealed that the plants are compatible with the grafting through cleft grafting method viz., For Tomato x Chilli, survival rate (95.47%), days taken for graft union (10.40days), number of leaves (26.75), plant height (56.65cm), number of sprouts per grafted plant (4.80), shoot length of the plant (43.30cm), root length (52.67cm), fresh weight of roots (20.13g) and dry weight of roots (18.32g). For Brinjal x Tomato, survival rate (67.35%), days taken for graft union (11.20days), number of leaves (25.25), plant height (53.42cm), number of sprouts per grafted plant (2.35), shoot length of the plant (41.50cm), root length (49.87cm), fresh weight of roots (20.12g) and dry weight of roots (18.50g). For Chilli x Tomato, survival rate (77.35%), days taken for graft union (10.60days), number of leaves (24.35), plant height (55.87cm), number of sprouts per grafted plant (4.30), shoot length of the plant (43.90cm), root length (52.10cm), fresh weight of roots (19.89g) and dry weight of roots (17.40g) and this is the best method of grafting in tomato, brinjal and chilli for graft compatibility.

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INTRODUCTION

Tomato (*Solanum lycopersicum*), chilli (*Capsicum annum*) is a warm season vegetable. It belongs to the family Solanaceae. It was originated from South America and it was introduced to India by portuguese. It is universally treated as 'Protective food'. it is a No.1 processing vegetable in the world. It is a self-pollinated and day neutral crop. Tomato contains red pigmentation due to lycopene. Excessive rains adversely affect its fruit set causing flower drop. Tomato fruit juice contains vitamin C, vitamin C and potassium. Breaker stage of tomato is suitable for long distance transport.

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Genetically modified tomatoes are resistant to Alzheimer's disease. Major producing states in India are Karnataka, Maharashtra and Madhya Pradesh. Important varieties cultivated in India are Pusa Sadabahar, Roma, Pusa Gaurav, Pusa early dwarf and PKM-1. Brinjal (*Solanum melongena*) is also known as egg plant. It belongs to the family solanaceae. It was originated from Indo-burma.dry fruit contain goiterogenic principle. it is often-cross pollinated and day neutral crop. Bitterness in egg plant is due to the presence of glycoalkaloid. It has been reported that on an average, the oblong-fruited egg plant cultivars are rich in total soluble sugars, whereas the long-fruited cultivars contain a higher content of free reducing sugars, anthocyanin, phenols, glycoalkaloids (such as Solasodine), dry matter and amide proteins. Heterostyly and anthocyanin pigment are present in brinjal and it also good source of vitamin B.

White brinjal is preferred by diabetic patient. West Bengal, Maharashtra and bihar are the largest producing state in India. Important varieties cultivated in India and Tamil Nadu is Pusa Purple Long, Pusa Barsati, Arka Navneet, Annamalai, Co1 and PKM-1. Chilli (*Capsicum annum*) is richest source of vitamin C. It belongs to the family solanaceae. It was originated from Mexico. It has bidirectional root system. It is a often-cross pollinated crop. Capsicin is a pungent principle and Capsanthin is a coloring agent present in chilli. It is used as an analgesic in tropical ointments and dermal patches to relieve pain. India is a major producer, consumer and exporter of chilli in the world. Major producing states in India are Andhra Pradesh, Maharashtra, Karnataka and Orissa. Important varieties cultivated in India and Tamilnadu are Arka Lohit, Punjab Lal, Andhra Jyoti, Pusa Jwala, KKM (CH1), PLR 1, K 1 and K 2.

PKM-1 variety of tomato is a green shoulder, determinate, non stacking and suitable for long distance transport and good keeping quality.PKM-1 variety of brinjal is adapted for rainfed condition and fruits are small with green stripes. K 2 variety of chilli is suitable to grown in rainfed condition. These are the varieties are used in this experiment because in this area mostly depending on rainfall to cultivate the crops thus we chosen the varieties that are suitable to cultivate under rainfed condition. In solanaceous crops are grafting through different grafting methods. They are Hole insertion grafting (HIG), Tongue approach grafting (TAG),Splice grafting (SG), tube grafting (TG), and one cotyledon splice grafting (OC-SG), Cleft grafting (CG), Pin grafting (PG). The most common technique for solanaceous grafting was cleft grafting, a process which involves cutting the stem of the scion into a wedge and fitting it into a cleft cut into the rootstock (Oda *et al*, 2005). In chilli, plants were grafted using the cleft grafting technique, which is most commonly used on solanaceous crops (Lee *et al*., 1994). Thus, the present experiment on grafting compatibility of tomato (*solanum lycopersicum*), brinjal (*solanum melongena*) and chilli (*capsicum annum*) through cleft grafting method was undertaken at college Orchard, Department of Horticulture, Agricultural College and Research Institute, Madurai during 2019-2020.

REVIEW OF LITERATURE

In solanaceous crops are grafting through different grafting methods. They are Hole insertion grafting (HIG), Tongue approach grafting (TAG), Splice grafting (SG), tube grafting (TG), and one cotyledon splice grafting (OC-SG), Cleft grafting (CG), Pin grafting (PG). The most common technique for solanaceous grafting is cleft grafting because it is the simplest, effective and most convenient method. It shortens the time taken to first production of flowers or fruits by the scion, to impart disease resistance or hardiness, improving tolerance resistance to soilborne and nematodes and increasing the yield and quality of fruits. The present experiment on grafting compatibility in tomato, brinjal and chilli through cleft graft method and the literatures on grafting studies of solanaceous crops (tomato, brinjal and chilli) have been reviewed under this chapter.

Grafting in solanaceous crops: Grafting is an effective method to improve the yield and disease resistance for crops. It has been repeatedly confirmed by several workers that Grafted plants have been shown to produce higher yields. In grafting the vigorous rootstocks are selected that can exhibit excellenttolerance to serious soil-borne diseases, such as those caused by *Fusarium, Verticillium, Phytophthora, Pseudomonas, Didymella bryoniae, Monosporascus cannonballus*, and nematodes (Djidonou *et al*., 2015). Grafts were used to induce resistance against low and high temperatures and also it enhance nutrient uptake (Venema *et al.*, 2008), increase synthesis of endogenous hormones, improve water use efficiency, reduce uptake of persistent organic pollutants from agricultural soils, improve alkalinity tolerance, raise salt and flooding tolerance (Romano and Paratore,2001) and limit the negative effect of boron, copper, cadmium, and manganese toxicity.. Lucas *et al.*,(2017) suggested that improved nutrient uptake in grafted seedlings increases photosynthesis. Which is particularly noticeableunder less than optimal growing conditionssuch as weak sunlight and low CO2 content insolar greenhouses during winter months. Lee *et al.*, (1994) noticed on grafting suggest that changes in the scion are controlled by the rootstock through controlled uptake. Synthesis and translocation of water, minerals and plant hormones. Grafting has primarily been used to reduce the occurrence of soil- borne disease in non-native fruit vegetable plants, primarily tomato, pepper, eggplant and various Cucurbitaceae.

Cleft grafting in solanaceous crops: The use of cleft graft method is one of the least expensive, easiest and less time consuming method of grafting. It is a process which involves cutting the stem of the scion into a wedge and fitting it into a cleft cut into the rootstock (Oda *et al*., 2005). Lee *et al*., (1994) reported that plants were grafted using the cleft grafting technique, which is most commonly used on solanaceous crops. Lee *et al*., (1994) found that eggplants cleft grafted on to two tomato rootstocks gave a higher yield and bigger fruit size than those grafted on to two eggplant rootstocks, but the mineral composition of fruits from grafted plants did not differ from that of non grafted plants. Tomato cleft grafting was adopted to limit the effects of Fusarium wilt (Lee *et a.,* 1994). Vibhuti sharma *et al* (2019) reported that cleft grafting method in tomato was very successful and it gives higher fruit yield.

C. annuum scions are grafted onto *C. annuum* rootstocks that have soilborne disease and nematode resistance. The apical wedge graft (cleft) is commonly used to propagate herbaceous stems. Maria Maribel Rodriquez and Paul W. Bosland (2010) reported that the high percentage of successful Capsicum onto tomato rootstocks grafting he obtained with the apical wedge(cleft) graft (60%) method.

Grafting compatibility in solanaceous crops: Lee *et al*., (1994) reported that grafting is very similar to the production of hybrids, as it is an attempt to take advantage of the interactions between two different genotypes. In highly compatible graft pairings, the growth response of the scion to a vigorous rootstock is enhanced growth or “hybrid vigor” observed in cultivars. This suggests that the interaction of two different, but related genotypes (whether via hybridization or grafting) may provide an invigorating effect on the whole plant (though the scion may benefit the most, as many rootstocks already benefit from hybrid vigor).

Lee *et al*., (1994) suggest that a number of grafting tools to perform automated grafting and to hold the graft union together have been developed by various agricultural companies. Many researchers reported that an interaction between rootstocks and scions (graft union)exists resulting in high vigor of the root system and greater water and mineral uptake leading to increased yield and fruit enhancement (Lee *et al*., (1994). Goldschmidt, (2014) outlined three basic characteristics of compatible grafting partners: 1) the establishment of a successful graft union 2) the extended survival of the composite plant, and 3) the proper functioning of the composite, grafted plant. Grafting compatibility may not be limited to the interactions between rootstock and scion. The environment often presents a third factor in the grafting relationship which can affect the communication and interaction between the grafting partners.

The initial graft-healing process, as important to the ultimate success of the graft as it is, does not always correlate with the long-term survivability or overall health of either the graft union or the new composite organism (Goldschmidt, 2014).Grafting (in) compatibility is often loosely defined as the failure or success of two plants, when grafted together, to survive and form a "successful" graft union. Grafting reaction within the same species is considered compatible (Kawaguchi *et al.*,, (2008). successful graft union formation, following conditions should be fulfilled (i) callus proliferation, both from the rootstock and the scion. (ii) Callus bridge formation (iii) differentiation of new vascular tissue from callus cells and (iv) production of secondary xylem and phloem (Andrew Petran and Emily Hoover, 2014).

MATERIALS AND METHODS

The experiment was carried out at College Orchard, Agricultural College and Research Institute, Madurai during January to March 2020. The experiment comprised of nine treatments and ten replications of grafting compatibility on tomato, brinjal and chilli through cleft grafting method.

Materials

Crop and Variety: Tomato (PKM-1), Brinjal (PKM-1), Chilli (K-2) are available at Orchard, Department of Horticulture, Agricultural College and Research Institute, Madurai is used for the present study of grafting compatibility by cleft grafting method. In each treatment ten replications were used for this study.

Nursery preparation

Mist Chamber: The seeds (Tomato, Brinjal, Chilli) are sown into the portray filled with vermicompost and coir pith mixture. These seedlings are used as planting materials. The planting materials are prepared in the nursery area which was covered with 50 per cent shade net and the sides were covered using 40/50 mesh insect proof nylon net. Seedlings are kept inside the mist chamber for easy rooting.

Poly bag: 250 gauge thickness block colour polybags of size 18 cm height and 10 cm diameter is used for growing seedlings.

Growing medium: For preparing the rootstock, red soil and farm yard manure (FYM) in ratio of 1:1 by v/v were mixed thoroughly, cleaned for stones and grasses, then the mixture was filled in polybags.

Cleft graft method: It is also called Apical or Wedge grafting. This method is widely used in Solanaceous crops. The experiment comprised of Nine treatments of Ten replications (Tomato x Tomato, Tomato x Brinjal, Tomato x Chilli, Brinjal x Brinjal, Brinjal x Tomato, Brinjal x Chilli, Chilli x Chilli, Chilli x Tomato, Chilli x Brinjal) grafting compatability of Tomato, Brinjal, Chilli through cleft graft method. A total of 10 grafted plants were placed in each treatment. In this method scion plants are pruned with 1-3 true leaves and the lower stem is cut to slant angle to make a tapered wedge and clip is placed to make contact between scion and rootstock after placing scion into split made. These grafted plants were labelled and kept under mist chamber for sprouting.

Experimental design: The study was laid out in a Completely Randomized Block Design (CRD) with nine treatments and ten replications.

Observations recorded: Observations on data on success percentage (%), number of sprouts per seedlings, number of leaves, height of the plant (cm), shoot length (cm), root length (cm), fresh root weight (g) and dry root weight (g) were recorded and analyzed statistically.

RESULTS

Success percent (%): The results revealed that all the treatment significantly different from other treatments and are presented in Table 1. The rooting success percentage was influenced significantly by Grafting treatment. The success percent ranged from 95.47 percent T3 to 52.22 percent T6. The highest success percentage (95.47%) was recorded in the Tomato X Chilli graft union(T3) followed by T8 Chilli X Brinjal graft union (77.35%) which was significantly higher than rest of the treatments. The minimum success percentage of cutting (52.22%) was observed in T6 (Brinjal X Chilli). The treatments T7 (72.20 %), T1 (70.20 %), T2 (68.35 %), T9 (68.20%), T5(67.35%), T4 (66.57%) were recorded the higher percentage of success grafted plants under the mist chamber condition (Table1).

Days taken for sprouting (days): The data on days taken for sprouting was statistically significant under all the treatments. Results represent that days taken for sprouting of grafted plants ranged from 10.40 to 12.40 days after grafting. The minimum duration (10.40days) was obtained in T3 (Tomato X Chilli) followed by T8 (10.60days) which was significantly higher than all other treatments. The highest days taken for sprouting (12.40days) were observed in T1 (Tomato X Tomato) (Table1).

Number of sprouts per Plant: The data on number of sprouts per grafted plants were significantly different from each other. The number of sprouts varied from 1.90 to 4.80. Number of sprouts recorded the highest (4.80) in T3 treatment followed by 4.65 in T7 which were higher than all other treatments. The lowest number of sprout was found in T6 (1.90) and T1 (3.35), T4 (2.60), T5 (2.35), T8 (4.30),

T9(2.65) were recorded number of sprouts in the other treatments (Table1).

Number of Leaves: Data regarding number of leaves that significantly influenced by Cleft grafting techniques. The number of leaves varied from 26.75 in T3 to 20.75 in T6. The average number of leaves (26.75) recorded the highest values in the grafted plant in Tomato X Chilli treatment (T3) followed by T5 (Brinjal X Tomato) of 25.25 which was significantly higher than rest of the treatments were studied. The lowest number of leaves (20.75) was observed in T6 (Brinjal X Chilli). Whereas treatment T1 (23.20), T2 (22.45), T4(24.00), T7(23.20), T8(24.35), T9(22.40) were on bar with each other (Table1).

Height of the plant (cm): Plant height of the grafted plants varied significantly. Plant height varied from 56.65 cm to 50.10 cm. Height of the plant recorded the highest in T3 (56.65 cm) followed by T8 (55.87 cm) which was on bar with each other. Whereas the lowest plant height was noticed in T6 of 50.10 cm. The rest of the treatments T1 (55.60 cm), T2 (52.26 cm), T4 (53.39), T5 (53.42), T7 (54.43), T9 (53.52) were recorded (Table1).

Shoot length (cm): The data on shoot length were significantly differed. The shoot length varied from 44.86 cm (T1) to 38.14 cm (T2). The highest shoot length was recorded in T1 (44.86 cm) followed by T8 (43.90 cm). Whereas the lowest root length was noticed in (T2) of 38.14 cm. The other treatments T3 (43.30cm) and T4 (40.63cm), T5 (41.50), T6 (39.82 cm), T7 (42.78), T9 (41.31cm) were recorded (Table1).

Root Length (cm): The data on root length was statistically significant from other treatments and root characters are presented in Table 2. The root length varied from 57.20 cm (T7) to 44.25 cm (T6). The highest root length was recorded in T7 (57.20 cm) followed by T4 (56.50 cm). Whereas the lowest root length was noticed in T6 of 44.25 cm. The other treatments T1 (51.35 cm), T2 (50.52cm), T3 (52.67cm), T5 (49.87cm), T8 (53.10cm) and T9 (50.45cm) were recorded (Table 2).

Fresh root weight: The data on fresh root weight was significantly different from other treatments. Fresh root weight varied from 20.16 g (T4) to 12.13 g (T6). The highest fresh root weight 20.16 g was recorded in T4 treatment followed by T3 of 20.13 g. The lowest fresh root weight was noticed on T6 (12.13 g). The other treatments are also varied significantly. Treatments T1, T2, T5, T7, T8 and T9 were recorded the fresh root weight of 19.75 g, 19.48 g, 20.12g, 20.01g, 19.89 g, 19.23 g respectively (Table 2).

Dry Root Weight (g): The data on dry root weight was statistically significant under all the treatments. Dry root weight varied from 18.90 g to 12.87 g. Treatment T7 recorded the highest dry root weight of 18.90 g followed by 18.50 g (T5) which was significantly higher than all other treatments. Whereas the lowest dry root weight was observed in T6 of 12.87 g (Table 2).

DISCUSSION

Success percentage: The rooting success percentage was influenced significantly by Grafting treatment.

The success percent ranged from 95.47 percent T3 to 52.22 percent T6. The highest success percentage (95.47%) was recorded in the Tomato X Chilli graft union (T3) followed by T8 Chilli X Brinjal graft union (77.35%) .The minimum success percentage of cutting (52.22%) was observed in T6 (Brinjal X Chilli). Higher grafting success may be attributed to compatibility between rootstock and scion, good callus formation and connectivity at graft interface which ensured successful graft union through proper healing. These findings are agreed with findings of Fernandez *et al*., 2004..

Days taken for sprouting: The data on days taken for sprouting was statistically significant under all the treatments. Results represent that days taken for sprouting of grafted plants ranged from 10.40 to 12.40 days after grafting. The minimum duration (10.40days) was obtained in T3 (Tomato X Chilli) followed by T8 (10.60days) .The highest days taken for sprouting (12.40days) were observed in T1(Tomato X Tomato). The Tomato rootstocks provide resistance against soil borne pathogens, also being used to provide salt stress tolerance and greater nutrient and water uptake (Fernandez *et al*., 2004)

Number of leaves: The number of leaves varied from 26.75 in T3 to 20.75 in T6. The average number of leaves (26.75) recorded the highest values in the grafted plant in Tomato X Chilli treatment (T3) followed by T5 (Brinjal X Tomato) of 25.25 .The lowest number of leaves (20.75) was observed in T6 (Brinjal X Chilli). The rootstock and scion which influenced more efficient uptake minerals, water and nutrients throughout plant system. These findings are agreed with findings of Fernandez *et al*., 2004.

Shoot length: The shoot length varied from 44.86 cm (T1) to 38.14 cm (T2). The highest shoot length was recorded in T1 (44.86 cm) followed by T8 (43.90 cm). Whereas the lowest shoot length was noticed in (T2) of 38.14 cm. The over growth and under growth of the scion which is due to important changes in water and nutrient flow uptake. Similar results were reported by Fernandez *et al*.,2004 in tomato grafted plants.

Root Length: The root length varied from 57.20 cm (T7) to 44.25 cm (T6). The highest root length was recorded in T7 (57.20 cm) followed by T4 (56.50 cm). Whereas the lowest root length was noticed in T6 of 44.25 cm. The Higher percentage of rooting, increase in length of roots in the grafted plants as a result of uptake of water and nutrients as reported by Fernandez *et al*.,2004.

Fresh root weight: Fresh root weight varied from 20.16 g (T4) to 12.13 g (T6). The highest fresh root weight 20.16 g was recorded in T4 treatment followed by T3 of 20.13 g. The lowest fresh root weight was noticed on T6 (12.13 g) Grafting influences absorption and translocation of phosphorous, nitrogen, magnesium, and calcium. Fernandez *et al*.,2004 suggested that improvement nutrient uptake in grated seedlings increases photosynthesis, it increases growth of plant.

Dry root weight: Dry root weight varied from 18.90 g to 12.87 g. Treatment T7 recorded the highest dry root weight of 18.90 g followed by 18.50 g (T5) which was significantly higher than all other treatments. Whereas the lowest dry root weight was observed in T6 of 12.87 g.

Table 1. Compatability of Cleft grafting on success percentage and shoot characters of grafted plants

Treatment details	Success percentage (%)	Days taken for sprouting (days)	Number of Sprouts per grafted plant	Number of leaves	Plant height (cm)	Shoot length of the plant (cm)
T1 (Tomato x Tomato)	70.20	12.40	3.35	23.20	55.60	44.86
T2 (Tomato x Brinjal)	68.35	11.65	2.25	22.45	52.26	38.14
T3 (Tomato x Chilli)	95.47	10.40	4.80	26.75	56.65	43.30
T4 (Brinjal x Brinjal)	66.57	12.15	2.60	24.00	53.39	40.63
T5 (Brinjal x Tomato)	67.35	11.20	2.35	25.25	53.42	41.50
T6 (Brinjal x Chilli)	52.22	11.40	1.90	20.75	50.10	39.82
T7 (Chilli x Chilli)	72.20	12.10	4.65	23.20	54.93	42.78
T8 (Chilli x Tomato)	77.35	10.60	4.30	24.35	55.87	43.90
T9 (Chilli x Brinjal)	68.20	11.85	2.65	22.40	53.52	41.31
SEd	2.623	0.222	0.361	0.620	0.521	0.732
CD (P =0.05)	0.521	1.207	0.929	0.441	0.262	0.361

Table 2. Compatibility of cleft grafting on root characters of grafted plants

Treatment details	Root length (cm)	Fresh root weight (g)	Dry root weight (g)
T1 (Tomato x Tomato)	51.35	19.75	17.60
T2 (Tomato x Brinjal)	50.52	19.48	17.27
T3 (Tomato x Chilli)	52.67	20.13	18.32
T4 (Brinjal x Brinjal)	56.50	20.16	17.75
T5 (Brinjal x Tomato)	49.87	20.12	18.50
T6 (Brinjal x Chilli)	44.25	12.13	12.87
T7 (Chilli x Chilli)	57.20	20.01	18.90
T8 (Chilli x Tomato)	52.10	19.89	17.40
T9 (Chilli x Brinjal)	50.45	19.23	17.53
SEd	0.642	0.913	0.512
CD (P =0.05)	0.307	0.606	0.474

The higher dry weight of roots might be attributed to higher root length which is accompanied by higher uptake of minerals and nutrients by rootstocks as reported by Fernandez *et al*., 2004.

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