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Exploitation of grafting technique on Tomato and Brinjal under controlled condition

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Abstract
The experiment was conducted at College of Agriculture and Research Station, IGKV, Raipur Farshakani Farm, Kunkuri, Jashpur, during Kharif 2020 under controlled cultivation. The objective of the study was to assess the influence of tomato grafting on rootstock of Brinjal *cv.* Pant Rituraj. So that farmers can earn supplementary from tomato harvested during rains, in this experiment tomato varieties Kashi hemant (V1), Kashi adarsh (V2), Arka saurabh (V3) cultivars were used as scion material and brinjal variety, Pant Rituraj (B) was used as rootstock. Non-grafted tomato plants (Kashi hemant, Kashi adarsh were also used as a control. Grafting technique used is splice or side grafting was followed wherein 45° slant-cut made on the sides both in the rootstock and scion. Maximum Grafting success rate (90.00%) in treatment V2+B and V3+B. Minimum grafting success (85.00%) was recorded in V1+B treatment. Graft combination of tomato scion variety, Kashi adarsh (V2+B) onto brinjal rootstock (Pant Rituraj) proved the best combination regarding physical (Average fruit weight 52.13 g, diameter 5.13 cm) of tomato fruit.

Keywords: Grafting technique, tomato, brinjal, controlled conditions, rootstock

Introduction
India is the second largest producer of horticultural crops especially vegetables in the World followed by China. Area under vegetables is 10.29 mha with total production of vegetables is 188.01 mt. Anonymous, 2019-20 [1]. Tomato is one of the most consumed ‘’vegetables’’ in the world. Tomato is grown as an annual plant in the temperate zone and can be grown in a wide range of soils have good drainage and pH over 6. Cultivation practices of tomato vary from region to region depending on soil conditions, altitude, agro-climate, source availability, skills of farmers, and finance availability. Tomato consists of 95% of water, 4% carbohydrate per 100-gram, crude tomatoes supply 18 calories of energy and 17% vitamin C. China is the major producer, sharing 32% of the total production, followed by the European Union, India, USA and Turkey. In India the major producing states are Andhra Pradesh, Madhya Pradesh and Karnataka contributing approximately 30% to the total production. The total area of vegetable crops in the Chhattisgarh was recorded 0.489 mha. in the year 2020-21 with the production of 6.868 MT. Tomato crop is highly prone to disease and pest and cause considerable loss in yield and quality of produce. To overcome commercial production and demand for grafted vegetable plants continue increases across Asian and European countries. All over the world, grafting technique has gained more popularity especially in case of cucurbits, eggplant and tomato, by using vigorous rootstocks to ensure adequate yields. Buller *et al*., 2013 [2]. Vegetable grafting was first introduced in the United States almost 20 years ago. Commercial growers and home gardeners are now more aware of grafting technique, potential to manage soil-borne diseases and adverse soil conditions. Vegetable grafting is an old technique utilized in Asian countries to improve plant production, reduce disease susceptibility, and increase plant vigor. Grafting has also been a common practice in fruit trees since past many years, vegetable grafting is of recent popularization on large scale Sakata *et al*., 2007 [3]. This technique reduces the dependence upon chemicals mandatory to treat the soil borne diseases and has opened new view in organic farming particularly vegetables Tirupathamma *et al*., 2019 [4]. In this experiment tomato and eggplant is grafted to overcome several problem various severe problems of tomato. Tomato belongs to the same family as eggplant (Solanaceae), and for that reason

they can be relatively easily grafted together. Eggplant is grown as annually in temperate regions can also withstand high rainfall and high temperature. This vegetable is important vegetable grown in Asia, really has good nutritional value as tomato. The cultivar use in this experiment is Pant Rituraj with a 65-75 days maturity. An area where the land use is intensive, vegetable grafting is considered an innovative technique. High cost, soil-born pests' aspect and diseases management, and adaptation of the grafted seedlings to local conditions or abiotic stresses are the major constraints that can be overcome by grafting. In soil less tomato cultivation, grafted plants had higher marketable yield and better fruit quality Gebologlu *et al*., 2011 [5].

Materials and Methods

Plant materials and Location: The experiment was conducted using eggplant rootstock (*Solanum melongena* L.) grafted with tomato scion (*Solanum lycopersicum* L.) at College of Agriculture and Research Station, Fashakani Farm, Kunkuri, Jashpur, during Kharif 2020. Kunkuri is a tehsil situated at Jashpur district of Chhattisgarh state lies at 22˚75" N Latitude and 83˚95"E Longitude with an altitude of 468 m above the mean sea level. In this experiment tomato varieties Kashi hemant (V1), Kashi adarsh (V2), Arka saurabh (V3) cultivars were used as scion material and brinjal variety, Pant Rituraj (B) was used as rootstock. Non-grafted tomato plants (Kashi adarsh, Kashi hemant were also used as a control for comparison. Seeds of above genotypes of eggplant were sown in the last week of June at 1.5-2.0 cm depth in small plastic glasses (size 7× 9 cm^2) filled with soil, sand, vermicompost and cocopit (2:1:1:1). After one week, the seeds of scion cultivars of tomato were also sown in small earthen pots accommodating about 50 seedlings. The pots of rootstocks and scions were irrigated daily for 25 days. Four to five weeks old seedlings of eggplant were used as rootstocks, whereas three to four weeks tomato seedlings as scions. Many techniques of grafting have been developed with different ones suggested for each plant type and grafting situations. Here, because we are dealing with young plants that have very small diameter stems, we use the splice graft (speed graft). Splice or side grafting was followed wherein 45° slant-cut made on the sides both in the rootstock and scion the way to proceed is by doing diagonal matching cuts in both the scion and the rootstock and clip together with a silicone grafting clip. The two cuts have to match together. A clip is used to hold the two different plants together firmly as shown in figure 1.5. The light interception in grafting chamber was not more than 25% of the total incoming radiation. After 10-12 days of establishment of graft union, the grafted plants were transplanted into bigger pots (30 × 30 cm2 size) filled with mixture of field soil and vermicompost (3:1 ratio), and kept in the greenhouse for another 10-12 days for the establishment of seedlings. Various types of cultural practices were followed such as irrigation, fertilization, trilling, weed control, training and pruning, etc., as recommended. In this experiment six treatments were done to identify the success of grafting on different situation.

Fig 1.1: Seedling Preparation

Fig 1.2: 15 Days after Grafting

Fig 1.3: 45 Days after Grafting

Fig 1.4: First Fruiting 50 Days after Grafting

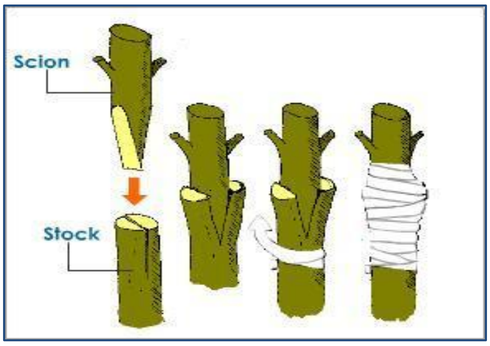

Fig 1.5: Technique Used

These six treatments were done in the experiment

1. Effect of hetero-grafting on tomatoes and eggplants

Treatment 1: 20 grafts of a tomato scion on eggplants rootstock.

Treatment 2: 20 grafts of eggplant scion on a tomato rootstock.

2. Effect of homo-grafting on tomatoes and eggplants

Treatment 3: 20 grafts of tomato on tomato rootstock.

Treatment 4: 20 grafts of eggplant on eggplant rootstock

3. Effect of no-grafting (used as a control)

Treatment 5: 20 tomatoes will be grown without grafting.

Treatment 6: 20 eggplants will be grown without grafting.

Record of the experiment

The success grafted plants planted in controlled condition with an average temperature of ranged between 20-25 °C and relative humidity was 65-75%. Grafting success (%) was calculating by dividing the number of successful grafting plants and the total number of plants grafted and following formulae was used-

Grafting success (%) = (No. of successful grafted plant/total no. of grafted plant) ×100

On maturity various parameters of the tomato fruit like fruit length, diameter, weight and firmness were determined from all the replication and average was calculated.

Results and Discussion

Before taking the observations grafting success (%) between different scion and rootstock was recorded as under- Data pertaining to graft success (%) has been presented in Table 1 showed maximum success rate (90.00%) in treatment V2+B and V3+B. Minimum grafting success (85.00%) was recorded in V1+B treatment. All tomatoes survived homo-grafting. The results of homo-grafting for the eggplant were less successful, only thirteen of twenty survived. For heterografting, the results were also different for all the treatment. Only 17-18 of the twenty tomato (scion) on egg plants (rootstock) survived. The control non-grafted plants all grew well. In conclusion, tomatoes seem to be more suited to grafting than eggplant. The diameter of the grafted plants is also really important. In this experiment, the eggplant was a little bit smaller in diameter than the tomatoes and sometimes it created some difficulties that could have had a bad influence on our results. So it is better to select rootstock (eggplant) should be greater in diameter than the tomatoes. Success of grafting operation depends on several factors like, grafting technique adapted, seedling age, post-grafting management, environmental conditions and rootstock-scion compatibility. High seedling survival rate can also be achieved by beginners through tongue approach or approach grafting methods, but it is mandatory for high rate of success, relative humidity should be sustained at 95%. The optimum temperature should retain at 21-36 °C for better transplanting Kumar, 2017 [6], Ofori, 2015 [7] and Msogoya Singh *et al*. 2019 [8] reported similar types of result in their study while grafting tomato on brinjal rootstock. There is not much difference in size, shape of the fruit of the grafted plant as compared to non-grafted plants used as control.

Table 1: Effect of grafting operation on grafting success (%) in case of tomato grafted on brinjal

Grafting	Treatment Details		Graft success (%)
	Scion	Rootstock	
Homografting	V1	V2	100%
	V2	V1	100%
	V3	V1	100%
	B1	B2	65%
Heterografting	V1+B	Brinjal	85%
	V2+B	Brinjal	90%
	V3+B	Brinjal	90%

No. of fruits per plant

It is clear from the data, presented in Table 2, pertaining to number of fruits in grafted and non- grafted plants confirms that highest number of fruits per plant (98.00) was recorded in V1+B followed by (97.00) in V2+B whereas, lowest number of fruits per plant (96.00) was found in V3+B. This clearly reflects that number of fruits per plant was affected highly significant by grafting. Grafted plants tolerated better the out of optimum range temperatures; therefore, they were able to produce more fruits due to less dropping of flower. This result was supported by the study of Khah *et al*. 2006 [9] Singh *et al*. 2019 [10] and Gisbert *et al*. 2011 [11] which found significant result in grafted tomato.

Average fruit weight (g)

It is evident from Table 2 that average fruit weight of tomato was maximum (52.15 g) in V2+B treatment followed by (50.22 g) in V3+B treatment while minimum fruit weight (42.50 g) was reported in V2 treatment. In this study, highest average tomato weight 52.15 g was observed in grafted plants of (V2+B). Lee and Oda, 2003 [12] suggested that higher yield of fruits from grafted plants might be due to the influence of the vigorous root system of the used rootstock, which enhanced the uptake of water and minerals. Schwarz *et al*. 2013 [13], Singh *et al*. 2019 [10] and Turhan *et al*. 2011 [14] also reported similar increasing trend in fruit weight by using grafting.

Fruit diameter (cm)

Significant variations were found in case of fruit diameter among all the grafted and non- grafted combination as presented in Table 2. The highest fruit diameter was recorded in grafting combination V2+B treatment, 5.13 cm trailed by V3+B treatment combination as 4.78 cm and (4.43 cm) in V1+B treatment. It was interesting to note that non- grafted variety V3 treatment resulted in the lowest fruit diameter (4.10 cm) of tomato fruit. Increased fruit diameter in case of grafted plants could be attributed to enhanced water and nutrient uptake when vigorous rootstock was used. Increase in fruit diameter is also supported by the findings of Yetisir *et al*. 2007 [15] and Singh *et al*. 2019 [10]. He recorded that grafting of watermelon onto interspecific squash hybrid resulted in increased fruit size by 52

Table 2: Grafting influence on physical traits fruit on brinjal root stock

Treatment	Treatment Details	No. of fruits plant-1	Average fruit weight (g)	Fruit diameter (cm)
Non-Grafted Plant	V1	82	47.19	4.22
	V2	90	42.50	4.24
	V3	80	44.62	4.10
Grafted Plants	V1+B	98	49.24	4.43
	V2+B	97	52.15	5.13
	V3+B	95	50.22	4.78

Summary and Conclusion

The experiment was conducted at College of Agriculture and Research Station, IGKV, Raipur Fashakani Farm, Kunkuri, Jashpur, in this experiment tomato varieties Kashi adarsh (V1), Kashi hemant (V2), Arka saurabh (V3) cultivars were used as scion material and brinjal variety, Pant Rituraj (B) was used as rootstock. Non-grafted tomato plants (Kashi adarsh, Kashi hemant were also used as a control. Maximum Grafting success rate (90.00%) in treatment V2+B and V3+B. Minimum grafting success (85.00%) was recorded in V1+B treatment. As per data number of fruits in grafted and non- grafted plants confirms that highest number of fruits per plant (98.00) was recorded in V1+B followed by (97.00) in V2+B whereas, lowest number of fruits per plant (96.00) was found in V3+B. Grafted plants tolerated better the out of optimum range temperatures; therefore, they were able to produce more fruits due to less dropping of flower. Average fruit weight of tomato was maximum (52.15 g) in V2+B treatment followed by (50.22 g) in V3+B treatment while minimum fruit weight (42.50 g) was reported in V2 treatment. In this study, highest average tomato weight 52.15 g was observed in grafted plants of (V2+B). The highest fruit diameter was recorded in grafting combination V2+B treatment, 5.13 cm trailed by V3+B treatment combination as 4.78 cm and (4.43 cm) in V1+B treatment. It was interesting to note that non- grafted variety V3 treatment resulted in the lowest fruit diameter (4.10 cm) of tomato fruit. Various scientists suggested that higher yield of fruits and diameter of fruits from grafted plants might be due to the influence of the vigorous root system of the used rootstock, which enhanced the uptake of water and minerals. Graft combination of tomato scion variety, Kashi adarsh onto brinjal rootstock, Pant Rituraj (V2+B) proved the best combination regarding physical (Average fruit weight 52.13 g, diameter 5.13 cm) of tomato fruit.

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