

## Original Research Article

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## Effect of Root Stocks and Grafting Techniques on Quality of Tomato (*Solanum lycopersicum* L.) under Polyhouse Conditions

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### ABSTRACT

Tomato is one of the potential vegetable crops both under protected and open field conditions in mid hills of Himachal Pradesh. The production under protected as well as open conditions has suffered in mid hills of HP due to biotic and abiotic stresses. Among biotic stresses bacterial wilt caused by *Ralstonia solanacearum* is the most devastating disease under protected as well as open field conditions in mid hills of HP which reduces tomato yield to very low levels. Chemical control is not effective and resistant varieties are scanty, therefore, vegetable grafting is the effective alternative to combat this problem. The experiment was conducted during Spring-Summer season 2016 at Palampur to find out bacterial wilt resistant rootstock and for quality traits i.e. TSS, Pericarp thickness and Ascorbic acid content. Three grafting techniques were used and tomato scion grafted on five brinjal and two tomato rootstocks plus control (non-grafted plots). Difference rootstocks and grafting techniques significantly affected the quality traits of tomato. Among the rootstocks RS6 (Palam Pink) had maximum pericarp thickness (8.14 mm). The treatment RS2 (VI-047335) was recorded highest ascorbic acid content 18.07 mg/100g in tomato fruits. Maximum TSS of 5.08 °Brix was observed in fruit from plants grafted on rootstock RS1 (VI-045376), which was significantly superior to other rootstocks used in the study. Slant cut grafting was found as best grafting technique in tomato for quality traits. All the rootstocks used in the study showed resistance to bacterial wilt. Control (non-grafted tomato) recorded 67.66% bacterial wilt disease incidence.

#### Keywords

Tomato, Grafting techniques, Rootstock, Scion, Bacterial wilt, Protected environment

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### Introduction

Tomato (*Solanum lycopersicum* L.), a member of solanaceae family is the most important and widely grown off-season commercial vegetable crop under polyhouse conditions in Himachal Pradesh. It is the world's largest vegetable crop known as productive as well as protective food. It is a rich source of minerals, vitamins, organic acid, essential amino acids,

nicotinic acid, pantothenic acid, protein, fat, carbohydrates, iron, phosphorus, Lycopene and Beta-carotene pigments. Protected cultivation is the concept of growing potential crops in the modified natural environment for ensuring optimum growth of the crop plants without any or least stress and hence offers great scope to harness this potential of growing the high value crops by achieving independence of climate and weather, and to

grow these crops during off -season and in marginal environments. The practice of protected cultivation of vegetable crops is also becoming popular in the hilly regions of the country, which offers a great scope for use of low cost naturally-ventilated polyhouses because of mild climate. Himachal Pradesh is also not an exception to this cultivation and most of the growers in the lower mid hills and mid hills are adopting this technology. As per recent estimates, area under protected cultivation in Himachal Pradesh is approximately 350 hectares (Anonymous 2013). The area under protected cultivation is increasing day by day with interventions of the state and central government funded schemes. However, it occupies an area of 10,370 hectares with the production of 430790 metric tonnes in the state under open field conditions (Anonymous 2015). The production under protected conditions has suffered in mid hills of HP due to biotic and abiotic stresses. Among biotic stresses bacterial wilt caused by *Ralstonia solanacearum* is the most devastating disease under protected as well as open field conditions in mid hills of HP which reduces tomato yield to very low levels. The disease was first reported in Kangra valley in 1981 on solanaceous crops, and now it become endemic in Kangra and Mandi districts (Sood and Singh, 1992). The chemical control is not effective and resistant varieties are scanty, therefore vegetable grafting is the effective alternative technique to combat this problem (Kumar *et al.*, 2015). Grafting is the union of two or more pieces of living plant tissues that grow as a single plant (Lee and Oda 2003). It is usually used to reduce infections by soil borne pathogens and to enhance tolerance against abiotic stresses such low and high temperature, salt, flooding etc. Vegetable grafting is now common in Asia, parts of Europe and the Middle East. In Korea, about 90% of the cucurbitaceous vegetable and 30% of solanaceous vegetable are grafted on

various rootstocks (Lee *et al.*, 2010). Grafting tomato scions on compatible rootstocks improves quality parameter of the plant. Grafting scions on resistant root stocks makes it possible to control soil borne disease and increase yield of susceptible cultivar (Lee and Oda, 2003). The use of resistant rootstocks reduces dependence on agrochemicals, so the technique is therefor, considered to be ecofriendly for sustainable vegetable production (Rivard and Louws, 2008). Grafted seedlings were used to induce resistance against low and high temperature (Venema *et al.*, 2008), enhance nutrient uptake (Colla *et al.*, 2010), increase synthesis of endogenous hormones (Dong *et al.*, 2008) and improve water use efficiency (Rouphael *et al.*, 2008). The main purpose of grafting seedlings is to increase the yield and tolerance to biotic and abiotic stresses. This technology was ignored because the focus of the breeders remained only to develop suitable varieties or hybrids resistant to biotic stresses. Since grafting gives increased disease tolerance and vigour to crops so it will be useful in the low-input sustainable horticulture of the future. Since, there is no other alternative method or strategy to control serious diseases like bacterial wilt, grafting has become an essential technique for the production of repeated crops of fruit bearing vegetables grown in polyhouse. The recent studies showed that the use of the suitable rootstocks will help to improve biotic and abiotic stresses in tomato has positively increased the yield, particularly under greenhouse conditions. Further research studies more focused on physiological aspects in addition to yield and quality parameters of tapping the potential of the crop plant (tomato) as with more benefits and manage bacterial wilt. Therefore, keeping in view the above stated facts, the present investigation entitled “Effect of root stocks and grafting techniques on yield and quality of tomato (*Solanum lycopersicum* L.) under protected environment”, was planned with the following

objective, to find out best rootstock for quality of tomato and bacterial wilt resistant rootstock.

## **Materials and Methods**

The present investigation was undertaken at Palampur during Spring-Summer season 2016. The experimental material for the present study comprised of five brinjal and two tomato rootstocks and one tomato hybrid used as a scion plus control (non-grafted plots). Commercial tomato hybrid GS-600 was used as scion. The different bacterial wilt resistant rootstocks were procured from AVRDC-Taiwan, CSKHPKV-Palampur and IIHR-Bengaluru. Whereas, the scion of tomato cultivar was commercial private sector hybrid and recommended for cultivation under protected condition (Table 1).

Three grafting methods were followed, including: tongue grafting (G1), cleft grafting (G2) and slant cut grafting (G3). The nursery of the rootstocks and scion was raised in plug trays and in disposable cups by using soil-less media (Cocopeat: Perlite: Vermiculite in the ratio of 3:1:1). Rootstocks were sown on 10th Feb. 2016, whereas, sowing of scion variety was done on 24th Feb. 2016 in growth chamber. The width of the bed was kept at 90 cm, whereas length was kept at 2 m. The plants were planted at 70 cm row to row and 30 cm plant to plant spacing thus accommodating 12 plants per bed. The beds were covered by plastic mulch and 12 plants in each control plot (one plot in every replication) were transplanted at inter row distance of 70 cm and plant to plant distance of 30 cm in Randomized Block Design with three replications in 250<sup>m</sup> modified naturally ventilated polyhouse. Observations were recorded on five plants were randomly selected from each treatment in each replication viz., TSS (°Brix), Pericarp thickness (mm) and ascorbic acid content mg/100g and

for screening of rootstocks against bacterial wilt (*Ralstonia solanacearum*) was done. The observations were recorded on bacterial wilt incidence at weekly intervals under protected conditions. The data regarded above mentioned characters were averaged and subjected to analysis of variance (Pane and Sukhatme, 2000).

## **Results and Discussion**

A scrutiny of data in Table 2 and 3 that rootstocks and grafting techniques significantly affected pericarp thickness. Among the rootstocks RS6 (Palam Pink) had maximum pericarp thickness (8.14 mm), followed by Arka Keshav (RS5) (8.10 mm). The data recorded for quality traits are presented in Table 3 that cleft grafting (G2) resulted in maximum pericarp thickness (6.92 mm), followed by slant cut grafting (G3) (6.88 mm) pericarp thickness and non-grafted recorded (8.02 mm) pericarp thickness. Similar findings were recorded by Kumar *et al.*, (2016). The treatment RS2 (VI-047335) had highest ascorbic acid content 18.07 mg/100g in tomato fruits, followed by Arka Nidhi (RS4) (16.27 mg/100g) ascorbic acid content. Generally the quality attributes depend on the compatibility of the scion and stocks. Some rootstocks may give positive results on the quality with particular scion but may give negative results on the other scion. Wahb-Allah (2014) and Al-Harbi *et al.*, (2016) found reduced ascorbic acid in grafted plants. Balliu *et al.*, (2008) and Kumar *et al.*, (2016) found higher ascorbic acid content in grafted plants as compared to non-grafted plants. Gebologlu *et al.*, (2011) and Chen and Wang (2016) found no significantly difference for quality attributes among grafted and non-grafted plants. Maximum TSS of 5.08 °Brix was recorded in fruit from plants grafted on rootstock RS1 (VI-045376), which was significantly superior to other rootstocks used in the study.

**Table.1** List of rootstocks

Rootstocks	Symbol	Source	Salient features
VI-045376 (Brinjal)	(RS1)	AVRDC, Taiwan	Resistant to bacterial wilt
VI-047335 (Brinjal)	(RS2)	AVRDC, Taiwan	Resistant to bacterial wilt
VI-034845 (Brinjal)	(RS3)	AVRDC, Taiwan	Resistant to bacterial wilt
Arka Nidhi (Brinjal)	(RS4)	IIHR-Bengaluru	Resistant to bacterial wilt
Arka Keshav (Brinjal)	(RS5)	IIHR-Bengaluru	Resistant to bacterial wilt
Palam Pink (Tomato)	(RS6)	CSKHPKV, Palampur	Resistant to bacterial wilt
Palam Pride (Tomato)	(RS7)	CSKHPKV, Palampur	Resistant to bacterial wilt

**Table.2** Effect of rootstocks on quality traits under protected condition

Grafting techniques	Pericarp thickness (mm)	Ascorbic acid content mg/100g	TSS (°Brix)
Tongue grafting (G1)	6.73	12.58	4.10
Cleft grafting (G2)	6.92	13.20	4.16
Slant cut grafting (G3)	6.88	13.54	4.27
Control (non-grafting)	8.02	15.43	4.39
CD (P=0.05)	<b>0.11</b>	<b>0.09</b>	<b>0.02</b>

**Table.3** Effect of rootstocks on quality traits under protected environment

Rootstocks	Pericarp thickness (mm)	Ascorbic acid content mg/100g	TSS (°Brix)
VI-045376 (RS1)	7.44	15.54	5.08
VI-047335 (RS2)	7.87	18.07	4.74
VI-034845 (RS3)	7.63	12.93	4.71
Arka Nidhi (RS4)	7.90	16.27	4.59
Arka Keshav (RS5)	8.10	13.48	4.81
Palam Pink (RS6)	8.14	14.49	4.68
Palam Pride (RS7)	7.67	14.05	4.79
control (non-grafting)	<b>0.04</b>	<b>0.03</b>	<b>0.01</b>
CD (P=0.05)	<b>0.16</b>	<b>0.14</b>	<b>0.04</b>

Slant cut grafting (G3) resulted in maximum TSS of 4.27 °Brix which was followed by cleft grafting (G2) and tongue grafting (G1) having 4.16 and 4.10 °Brix.

Whereas, non-grafted plants were (control) recorded with maximum TSS of 4.39 °Brix. The results are in accordance with the findings of Al-Harbi *et al.*, (2016), Chen and

Wang (2016) and Kumar *et al.*, (2016). Weekly recorded on bacterial showed wilting symptoms while all the rootstocks were resistance to bacterial wilt. Therefore, less survival rate of control/ non-grafted plants was due to the incidence of bacterial wilt. Therefore, from this study it may be inferred that grafting can be an effective strategy to manage bacterial wilt incidence in tomato.

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