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Short Communication

Effect of grafting in tomato to control bacterial wilt (*Ralstonia solanacearum* Yubuuchi)

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Tomato (*Solanum lycopersicum* L.) is the world's most popular and widely used vegetable crop. India ranks second in the world tomato production (18.7 million tonnes) (Press Information Bureau, 2015-16). It is known as protective food because of its special nutritive value. Many diseases affect tomato during the growing season. Bacterial wilt caused by *Ralstonia solanacearum* Yubuuchi affects tomato cultivation and causes heavy yield losses especially during rainy season. Repeated cultivation of tomato in the same field aggravates the problem due to buildup of inoculums. Chemical control measures are costly and pollute the environment. Development of resistant varieties or hybrids is tedious and time consuming process. Grafting of already developed/existing resistant varieties used as rootstocks on high yielding susceptible cultivars gives immediate answer to this problem. Grafting is widely used in horticulture for a variety of reasons. In fruit trees, dwarfing rootstock is used to control the size and vigor of the tree. With field grown vegetables, grafting is used to increase resistance to soil-borne pathogens like *Fusarium oxysporum (*Keinath and Hassell 2014), *Pseudomonas lycopersici* and *Meloidogyne* spp (Besri 2003). In addition to control of soil borne pathogens, tomato grafting has many applications such as low temperature tolerance (Ahn et al. 1999), high temperature tolerance (Riverio et al. 2003), salt tolerance (Fernandez-Garcia et al. 2004 and Estan et al. 2005), flood tolerance (Liao and Lin 1996), drought tolerance (Iacono et al. 1998) and to enhance nutrient and water uptake (Fernandez-Garcia et al. 2002). Greenhouse tomato growers are using grafting to both decrease susceptibility to root diseases and to increase fruit production through increased plant vigor. Black et al. (2003) reported that grafting tomato scions on selected rootstocks of brinjal and *vice-versa* can minimize problems due to flooding and soil borne diseases like bacterial wilt, fusarium wilt, verticillium wilt and root knot nematode. Tube grafting is very simple technique which can be easily practiced by the farmers to produce resistant plants in the same season. Mortality of the grafts is also less. Therefore the present experiment was carried out to study the effect of grafting in susceptible tomato cultivar on different resistant rootstocks for plant survival and fruit yield.

The present investigation was conducted during main season of 2013-14 and 2014-15 at Experimental Farm of ICAR RCER Research Centre, Ranchi (23.35^0 N and 85.33^0 E at 629 m altitude). Total annual rainfall was 1430mm with 1100 mm during June to September and the average maximum and minimum temperatures 37^{0}C and 4^{0}C, respectively. The commercial tomato cultivar Swarna Baibhav was used as scion and non grafted control, while Swarna Pratibha, Swarna Shyamli, HAB 900 and HAB 901 cultivars of brinjal and Swarna Lalima cultivar of tomato were used as root stocks. The choice of rootstocks was made on the basis of their resistance to bacterial wilt. Grafting combinations were 'Swarna Baibhav' as scion and 'Swarna Pratibha' as rootstock, 'Swarna Baibhav' as scion and 'Swarna Shyamali' as rootstock, 'Swarna Baibhav' as scion and 'HAB 900' as rootstock, 'Swarna Baibhav' as scion and 'HAB 901' as rootstock, 'Swarna Baibhav' as scion and 'Swarna Lalima' as rootstock and non grafted 'Swarna Baibhav' as control. Scion and rootstock seeds were sown in peatmoss mixture during last week of June. When the seedlings reached four to five leaf stages, grafting was carried out using tube grafting. Both the scion and rootstock stems were cut at 30^0 angles. Diameter of the rootstock should match with that of scion. A latex tube cut at 30^0 is slided over the scion. Ensure both the cut angles are parallel. Scion fitted with the latex tube is slided over the seedling of rootstock. Again ensure the cut angles of tube and rootstock stem are parallel. Scion and rootstock are gently pushed together to have complete

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Fig 1: Steps in grafting

contact with each other. The tube will stay on the seedling until it naturally hardens splits and falls away. Grafted seedlings are immediately shifted into a shaded chamber for 4-5 days. They are shifted into screen house for five days and kept out in the sun for hardening for another five days. Various steps in grafting are illustrated in Fig 1. After 15 days of healing and hardening, the grafted plants were transplanted in natural field conditions during first week of August with 1m inter row and 40 cm intra row spacing under drip irrigation. The graft union was kept above the soil line to avoid infection to the scion. Non-grafted tomato scion Swarna Baibhav was also grown as control. Recommended agronomic practices were adopted to raise a good crop. The treatments were arranged in a randomized block design with four replications. Each replication consisted of 10 plants per treatment.

Bacterial wilt resistance was recorded in natural field conditions by recording percent plant survival after 90 days after transplanting. Plant survival at 80-100% was classified as resistant and less than 80% as susceptible. Yield characters were measured randomly and average was determined for two years of experimentation. Fruit quality characters like TSS, titratable acidity, ascorbic acid, carbohydrate, reducing sugar and phenols were recorded on ripe fruits using standard methods. Analysis of variance was performed using SPAR 2.0 and significant differences among treatments were determined by Fischer's F test at P d" 0.05 and P d" 0.01

Complete compatibility among rootstock and scion was reported. A total of 90-100% survival of the grafts was observed. The grafts were vigorous in growth and fruiting season was one month longer than in conventional methods. Grafted plants exhibited markedly higher disease resistance than non grafted plants (Table 1). Swarna Baibhav was highly susceptible to wilt with 42% plant survival at 90 days after transplanting whereas grafting with resistant rootstock improved the resistance of susceptible scion (>90%). The highest percentage survival against bacterial wilt was obtained in Swarna Baibhav grafted on HAB-900 (96.62%) and HAB-901 (95.37%). Also fruit yield was improved by grafting. Swarna Baibhav grafted on Swarna Lalima recorded maximum yield of 2.26kg/plant, where as non grafted Swarna Baibhav

Table 1: Effect of grafting on yield and survival of the plant in tomato

Rootstock+scion	No. of fruits/ plant	% increase over non-rafted	Yield/ plant (kg)	% increase over non-grafted	Yield in q/ha	% increase over non-grafted	Survival % of the plants at 90 DAT	% increase over non-grafted
Swarna Pratibha + Swarna Baibhav	25.18	-10.0	1.73	6.1	413.16	109.1	94.72	123.1
Swarna Shyamali + Swarna Baibhav	32.10	14.7	2.03	24.5	476.92	141.3	93.96	121.3
HAB-900 + Swarna Baibhav	34.57	23.5	2.24	37.4	542.00	174.2	96.62	127.6
HAB-901 + Swarna Baibhav	31.01	10.8	2.12	30.1	514.97	160.6	95.37	124.7
Swarna Lalima + Swarna Baibhav	36.27	29.6	2.26	38.7	547.22	176.9	91.08	114.6
Swarna Baibhav (non-grafted)	27.99	-	1.63	-	197.61	-	42.45	-
CD	2.75	-	0.32	-	21.19	-	3.37	-
CV	4.79	-	8.61	-	2.56	-	2.14	-

Table 2: Effect of grafting on quality of the fruit in tomato

Rootstock+ scion	Titratable acidity (mg/ 100ml)	% increase over non-grafted	Ascorbic acid (mg/ 100 ml)	% increase over non-grafted	Carbo-hydrate (mg/ 100ml)	% increase over non-grafted	Phenols (mg/ 100ml)	% increase over non-grafted	TSS	% increase over non-grafted	Reducing sugar (mg/ 100 ml)	% increase over non-grafted
Swarna Pratibha + Swarna Baibhav	0.32	28.0	18.13	-47.3	0.24	100.0	6.0	46.70	4.25	1.19	1.57	0.64
Swarna Shyamali + Swarna Baibhav	0.32	28.0	43.33	26.03	0.13	8.33	2.93	-28.36	4.3	2.38	1.48	-5.12
HAB-900 + Swarna Baibhav	0.32	28.0	33.33	-3.05	0.13	8.33	4.94	20.78	4.33	3.1	1.56	0
HAB-901 + Swarna Baibhav	0.26	4.0	38.13	10.91	0.11	-8.33	3.75	-8.31	4.33	3.1	1.56	0
Swarna Lalima + Swarna Baibhav	0.23	-8.0	32.92	-4.25	0.18	50.0	3.03	-25.92	4.03	-4.0	1.41	-9.61
Swarna Baibhav (non-grafted)	0.25	-	34.38	-	0.12	-	4.09	-	4.2	-	1.56	-
CD	0.009	-	0.009	-	0.011	-	0.028	-	0.055	-	0.014	-
CV	1.8	-	0.031	-	4.127	-	0.375	-	0.712	-	0.499	-

RS – Root stock

recorded a yield of 1.63kg/plant. Grafted plants recorded 38.65% increase in yield per plant compared to non grafted control. Khah et al. (2006) also observed that grafted plants 'Heman' and 'Primvera' were more vigorous and produced 32.5, 12.8% and 11.0 and 11.1% more fruit than the control under green house and open condition, respectively. Yield in quintal per hectare gave a good insight into the advantages of grafting. Non grafted Swarna Baibhav yielded very low (197.61 q/ha) and Swarna Baibhav grafted on Swarna Lalima yielded highest (547.22 q/ha) (Fig 2). Liu and Zhou (2009) reported that early yield, total yield, and average fruit weight increased significantly by grafting. Hence, it can be concluded that grafting improved resistance of susceptible variety along with higher yield.

Highest phenol content and ascorbic acid was recorded in Swarna Baibhav grafted on Swarna Pratibha (Table 2). Analysis of variance (Table 3) for various characters showed that there were significant differences among various treatments for yield, survival percent against bacterial wilt, titratable acidity, ascorbic acid, carbohydrate and phenol content. There was change in quality of grafted fruits regarding the above characters and this should be validated. Quality traits like fruit shape, skin colour, skin or rind smoothness, flesh texture and colour, soluble solids concentration, etc. are influenced by the rootstock (Lee 1994). Grafting increased percent survival of plants against bacterial wilt. Grafting tomato plants was proved to be a useful technique for controlling pests and diseases including nematodes (Ginoux et al. 1979). Liu and Zhou (2009) reported higher disease resistance was recorded in grafted egg plant than non grafted egg plant when challenged with *Verticillium dahliae* and allelopathic suppression exhibited by the root exudates from grafted plants directly inhibits spore germination and mycelium growth. Colonization frequencies and bacterial densities of *Pseudomonas solanacearum* observed in plants grafted on resistant or susceptible rootstocks showed that resistance was correlated to the limitation of bacterial spread in the lower part of the stem as reported by Grimault and Prior (1994). According to Richard (2005), grafting is used with field vegetables to increase their resistance to soil-borne diseases, increase fruit production through increased plant vigor, decrease the likelihood of root disease and increase the plant's tolerance to bacterial wilt. This study shows that grafting tomato on suitable rootstocks improves the yield and also effectively manages soil borne diseases like bacterial wilt with an easy and simple technology. HAB-900, HAB-901 and Swarna Lalima can be effectively used as rootstocks to control bacterial wilt.

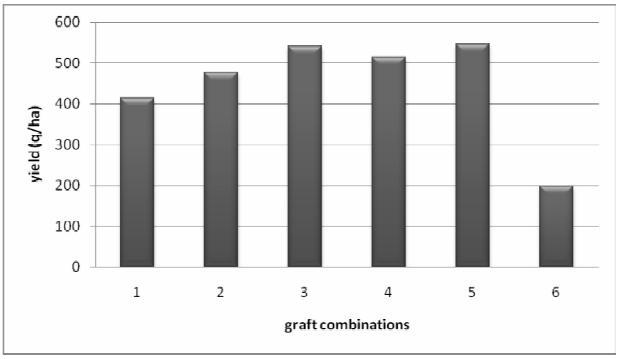

Fig 2: Graphical representation of yield (q/ha) of grafted and non-grafted brinjal
(**1:** Swarna Pratibha + Swarna Baibhav; **2:** Swarna Shyamali + Swarna Baibhav; **3:** HAB-900 + Swarna Baibhav; **4:** HAB-901 + Swarna Baibhav; **5:** Swarna Lalima + Swarna Baibhav; and **6:** Swarna Baibhav as non-grafted)

References

Ahn SJ, Im YJ, Chung GC, Cho BH and Suh SR (1999) Physiological responses of grafted cucumber leaves and rootstock affected by low root temperature. Sci Hort 81: 397-408.

Besri M, 2003. Tomato grafting as an alternative to Methyl Bromide in Morocco. Proc of the international research

conference on methyl bromide alternatives and emissions reductions, November 3-6, 2003, San Diego, California.

Black LL, Wu DL, Wang JF, Kalb T, Abbass D and Chen JH (2003) Grafting tomatoes for production in the hot-wet season. AVRDC International Cooperators Guide 03, pp 551.

Estan MT, Martinez-Rodrigues MM, Perez-Alfoce F, Flowers TJ and Bolarin MC (2005) Grafting raises the salt tolerance of tomato through limiting the transport of sodium and chloride to the shoot. J Exp Bot 56(412): 703-712.

Fernandez-Garcia N, Martinez V and Carvajal M (2004) Effect of salinity on growth, mineral composition, and water relations of grafted tomato plants. J Soil Sci Plant Nutr 167: 616-622.

Fernandez-Garcia N, Martinez V, Cerda A and Carvaja M (2002) Water and nutrient uptake of grafted tomato plants grown under saline conditions. J Plant Physiol 159: 899-905.

Ginoux G, Dauple P and Lefebvre JM (1979) Tomato grafting, a method of controlling soil pests. Can J Plant Sci 61: 1027-1028.

Grimault V and Prior P (1994) Grafting Tomato Cultivars Resistant or Susceptible to Bacterial wilt: Analysis of Resistance Mechanisms. J Phytopathol 141(3): 330–334.

Iacono F, Buccella A and Peterlunger E (1998) Water stress and rootstock influence on leaf gas exchange of grafted and ungrafted grapevines. Sci Hort 75: 27-39.

Keinath AP and Hassell RL (2014) Control of Fusarium wilt of watermelon by grafting onto bottle gourd or interspecific hybrid squash despite colonization of rootstocks by *Fusarium.* Plant Dis 98 (2): 255 – 266.

Khah EM Kakava E Mavromatis A Chachalis D and Goulas C (2006) Effect of grafting on growth and yield of tomato in greenhouse and open-field. J App Hort 8(1): 3-7.

Lee JM (1994) Cultivation of grafted vegetables I- current status, grafting methods and benefits. HortScience 29: 235-239.

Liao CT and Lin CH (1996) Photosynthestic responses of grafted bitter melon seedling to flood stress. Environ Exp Bot, 36(2): 167-172.

Liu N and Zhou B (2009) Grafting Eggplant onto Tomato rootstock to suppress *Verticillium dahliae* infection: The effect of root exudates. Hort Sci, 44(7): 2058-2062.

Press Information Bureau, Government of India, Ministry of Agriculture, Final estimates 2015-16. pib.nic.in/newsite/PrintRelease.aspx?relid=158533.

Richard MA(2005) Grafting Techniques for Greenhouse Tomatoes. In: Proceedings of Greenhouse Tomato Conference, Sponsored by University of Connecticut Cooperative Extension System, NESARE and UMass Extension.

Riverio RM, Ruiz JM and Romero L (2003) Can grafting in tomato plants strengthen resistance to thermal stress? J Sci Food Agric 83: 1315-1319.