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Impact of saline soils on grafted tomato (*Solanum lycoparsicon*) onto brinjal (*Solanum melongena*)

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Abstract

The experiment was conducted to evaluate the effect of salinity on horticultural traits of grafted tomato (*Solanum lycopersiocon* Mill.) onto brinjal (*Solanum melongena* L.) rootstock and to find out the best salt tolerance or resistant rootstock/graft combination during 2021-22 at ICAR-IIVR KVK, Bhadohi, Uttar Pradesh. Three rootstocks (IC-111056, IC-354557, and Surya) and graft between three different scions (Kashi Aman, Kashi Chayan and NS-4266) were compared with their scions. Among rootstock, IC-111056 and IC-354557 were observed highly salt tolerant to saline condition which could be used as rootstock for further crop production in saline conditions and its use in conventional breeding programme to develop salt tolerant/resistant variety.

Tomato (*Solanum lycopersiocon* Mill.) is most used vegetable crop. In eastern Uttar Pradesh, most of farmers prefer fertile land for cultivation of other crops. The high soil salinity renders the cultivation of vegetables in many areas prohibitive. Almost 20% of total arable land and 50% of irrigated land are deteriorated by salinity (Arzani, 2008), caused either by irrigation water or underground water of low quality. The grafting techniques is being employed as a means of assuaging the negative impacts of high salinity, by using rootstocks capable of getting over the problems induced by high concentrations of salts in the root environment (Yetisir and Uygur, 2010). Grafting has been demonstrated as a simple and cheap technique to improve adaptation of tomato plants to salt stress Colla *et al.*, 2010. Use of grafting techniques to overcomes many biotic and abiotic problems in cucurbits Holer, *et al.,* 2024. Therefore, an experiment was conducted to find out the effect of rootstock × scion combination on growth, development and yield of tomato grafted onto three rootstocks and themselves, and grown in under salt stress at outdoors environmental conditions.

Materials and Methods

The experiment was conducted at ICAR-IIVR Krishi Vigyan Kendra, Bejwan Bhadohi, during 2021-22. The samples were collected from ICAR-IIVR. Brinjal (*Solanum melongena* L.) rootstock was grafted onto tomato scion. Rootstock of three brinjal accessions (IC-354557, IC-111056 and Surya) were grafted with three tomato cultivars (Kashi Aman, Kashi Chayan and NS-4266) and compared with them. Graft combination details given (Table 1).

The experimental site is situated at 25.12° to 25.32° North Latitudes and 82.12° to 82.42° East Longitudes and at an elevation of 85 m above mean sea-level.

Table 1: Graft combination used

Rootstock	Scion	Graft combination
IC-111056	Kashi Aman	IC-111056 x Kashi Aman
	Kashi Chayan	IC-111056 x Kashi Chayan
	NS-4266	IC-111056 x NS-4266
IC-354557	Kashi Aman	IC-354557x Kashi Aman
	Kashi Chayan	IC-354557x Kashi Chayan
	NS-4266	IC-354557x NS-4266
Surya	Kashi Aman	Surya x Kashi Aman
	Kashi Chayan	Surya x Kashi Chayan
	NS-4266	Surya x NS-4266

This region is humid and sub-humid. The soil textural class was alluvial (Inceptisols) formed by deposition of sediments brought by the river Ganga. Soil samples were collected from five different locations of each bed at the depth of 15cm in zigzag pattern across the required areas. A composite sample of about 2 kg was taken through mixing of represented soil sample. These soils were first sieved by gyrator sieve shaker

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with approximately 2 mm spacing to remove the coarser particles and then allowed to dry in air for 1 hour. The proposed samples were analyzed for physico-chemical properties using standard procedures. The nutrient concentrations and physico-chemical parameters of soil samples are represented in Tables 2.

The experiment was laid out in RCBD with three replications. The net plot size was 1.40 m^2 with a spacing 70 cm row-to-row and 50 cm plant-to-plant. The recommended package of practices were followed to raise the crop. After eliminating the border plants, observations were recorded on five randomly chosen plants for 13 quantitative traits, viz. days to first fruit picking (days), number of branches, plant height (cm), fruit length (cm), fruit breadth (cm), average fruit weight (g), number of truss per plant, number of fruit/truss, number of fruits/plant, harvesting duration (days), marketable yield/plant (g), marketable yield per plot (kg) and self-life (days). The statistical analysis was carried out for each observed character under the study using MS-Excel, SPSS 16.0 and SPAR 2.0 packages. The mean values of data were subjected to analysis of variance and ANOVA was set as per Gomez and Gomez (1983) for randomized block design.

Results and Discussion

The nutrient status of plot falls under high soil pH means higher salt concentration, which increase higher osmotic potential in root zone resulting in water scarcity condition. Due to less absorption water, the plants are not able to absorb the essential plant nutrients, resulting is internodal length of plant, which becomes smaller. Due to reduced plant growth, flower become early, resulting in reduced yield. Due to formation of soils over basaltic parent material (calcium rich) and higher or moderately alkaline earth contents leads to neutral to alkaline conditions. Higher pH value in soils may be due to basalt as parent material, which is alkaline in nature (Chinchmalatpure *et al.*, 2000).

Higher amount of salts in soils restricts the nutrient uptake and thus affects plant growth. The electrical conductivity is show optimum level. The EC of surface soils was lower than that of subsurface soils and in general increased with depth. This may be due to leaching of salts from the surface to subsurface horizons through pedogenic processes. It contains, retains and supplies all essential plant nutrients and thus, asserts an abiding influence on sustenance of soil fertility. In addition, it also improves soil structure, infiltration rate, water and nutrient storage capacity and reduces soil erosion. The low level of organic carbon is found in plot due highly saline condition with sluggish rate of mineralization. Similar results were observed by Wiesmeier *et al.,* 2014.

The available P and K content, which denotes high level of P and Medium level of K present. Therefore, P availability in soils might have been favored by the warm climatic condition of study area along with the preferred pH range. Available P values declined with increasing depth which could be attributed to decrease in soil OC. Potassium removal from primary minerals requires hydronium ion, which dissociates from organic and inorganic acids in soil solution (Buol *et al.,* 2003). The supply of hydronium is relatively higher in surface horizon due to relatively higher contents of organic matter and root activities, which release CO_2. The dissolution of CO_2 forms H_2CO_3 and ultimately hydronium ion. This process might have resulted in higher available K in surface than subsurface layers (Table-2).

Table 2: Soil properties and nutrient status of research plots

Parameter	Mean value
Physical properties	
pH	9.0
EC (dSm^{-1})	0.09
OC (g/Kg^{-1})	0.37
Chemical Properties	
Major Nutrients (Kg/ha)	
N	175
P	27
K	158
Minor nutrients (Mg/ha)	
Fe	10.5
Mn	16.3
Cu	2.5
Zn	2.0

Relatively higher values of available micronutrients were expected under highly organic decomposed lands which are organic matter can find physical protection from microbial decomposition, which is a potential source of micronutrients. Under investigation, Fe, Mn, Cu and Zn were categories as a sufficient level. Similar results were reported by Jibhkate *et al.* (2009).

The mean sum square shows highly significant differences among graft combinations. Minimum days to first fruit picking was taken in IC-111056+ Kashi Aman, IC-111056+K. Chayan and non-grafted

NS-4266, while IC-111056+NS-4266 better performed from your non -grafted scion. However, minimum days promote earliness, IC-111056 promoted earliness on Kashi Aman and Kashi Chayan scion. Fruit length, fruit breadth, average fruit weight, marketing yield and total yield directly promoting economical yield of crops.

Maximum fruit length, fruit breadth and average fruit weight was recorded in IC-111056+ Kashi Aman, IC-111056+K. Chayan and IC-111056+NS-4266 compared to non-grafted scion. IC-111056 encourages economical yield in saline condition. Grafting tomato plant had a significant effect on plant vegetative growth (Table 3). The result showed a significant increase in plant height, number of branches, number of truss, number truss/cluster and number of fruit/plant was sequel with Karaca *et al.* (2012). Harvesting duration and selflife of grafted tomato on IC-111056 was found better than non-grafted tomato under saline condition. The IC-111056 was promoted harvesting duration of crops under salt condition as well as post-harvest life of tomato.

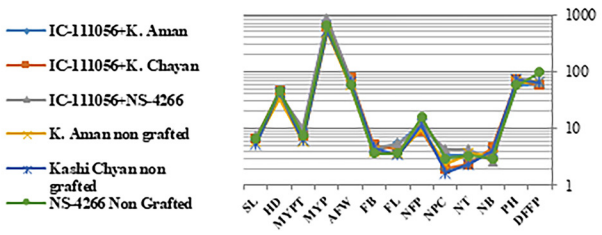

Fig. 1. Performance of rootstock IC-111056 on tomato

Minimum days to first fruit picking was taken in IC-354557+Kashi Aman, IC-354557+ Kashi Chyan and Kashi Aman non-grafted, while other graft combination non-significantly performed in saline conditions. Similarly, IC-354557 significantly promoted earliness on Kashi Aman and Kashi Chayan Scion. The result showed a significant increase fruit length, total yield / plant, yield/plot and selflife. The IC-354557+Kashi Aman, IC-354557+Kashi Chyan and IC 354557+NS-4266 compared to non-grafted plant in salty soils. While, maximum fruit breadth, average fruit weight and harvesting duration was found in Kashi Chyan non-grafted, IC-354557+Kashi Chyan and IC 354557+NS-4266 and compared to other graft combination.

They found that grafted tomato plants were encouraging the economical yield in salt condition. Similar results were reported by Turhan *et al.* (2011) and Echevarria *et al.* (2012) who found that grafting tomato plants improved yield and its components. Grafting tomato plants resulted had a significant effect on plant vegetative growth (Table 3). The result showed a significant increase in Plant height, number of branches, number of truss, number truss/cluster and number of fruit/plant was sequel with the observations Karaca *et al.* (2012). They found that grafted tomato plants were more vigorous than non-grafted plants.

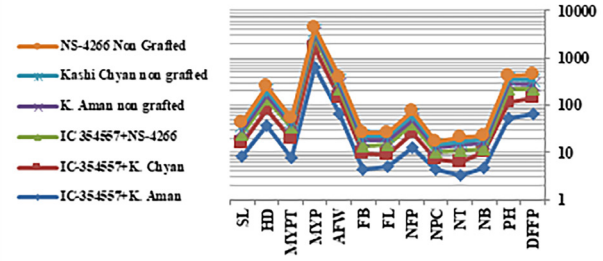

Fig. 2. Performance of Rootstock IC-354557 on tomato

The IC 354557 was found better than non-grafted tomato under saline condition. They observed that IC 354557 was promoted marketing yield as well as vegetative growth of crops under salt condition.

Minimum days to first fruit picking was taken in Surya+ Kashi Aman and Kashi Chayan non-grafted, whereas Surya + NS-4266 better performed their scion. However, Surya promoting on Kashi Aman is minimum days taken to harvesting. Fruit length, fruit breadth, average fruit weight, Marketing Yield/plant and total yield/plot directly promoting economical yield. Maximum fruit length, fruit breadth and average fruit weight was recorded in Surya+ Kashi Aman, Surya+Kashi Chayan and Surya+NS-4266 compared to non-grafted scion.

Surya also encourages the economical yield in salt condition. Grafting tomato plant had a significant effect on plant vegetative growth (Table 3). The result showed a significant increase in plant height, number of branches, number of truss, number truss/cluster and number of fruit/plant was sequel with the observations Iseri *et al.* (2015). They found that grafted tomato plants were more vigorous than non-grafted plants.

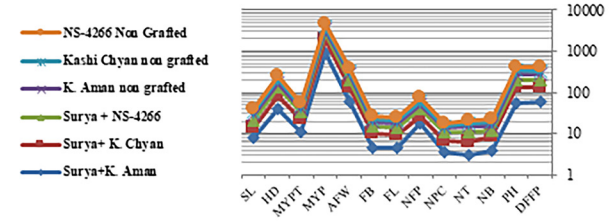

Fig. 3. Performance of Surya rootstock on tomato

Among rootstock, IC 354556 and IC-111056 comparatively better performed under saline condition.

Table 3: Mean performance of different rootstock on tomato

Treatment	DFFP	PH	NB	NT	NFC	NFP	FL	FB	AFW	MYP	MYPT	HD	SL
Performance of IC-111056													
IC-111056+K. Aman	59.57	57	3.67	3.33	3.33	12.33	5.47	4.1	69.57	788	9.46	36.78	6
IC-111056+K. Chayan	57.57	72.33	4.67	2.33	3.30	9	4.27	5.27	77.57	614.97	7.38	45.33	6.67
IC-111056+NS-4266	65.27	75.33	2.67	4.33	4.33	11	5.57	4.63	75.27	853.67	10.24	40.33	7.33
K. Aman non grafted	67.18	64.33	3.33	3.67	2.33	10	3.67	4.03	57.18	496.15	5.95	33	6
Kashi Chyan non grafted	64.53	72.67	4	2.33	1.67	11.67	3.43	4.63	64.53	518.97	6.23	43.67	5.33
NS-4266 Non Grafted	96.67	57	3	3.33	3	15.67	3.63	3.63	57.17	638.63	7.66	45	6.67
Performance of IC-354557													
IC-354557+K. Aman	64.07	51.67	4.67	3.33	4.33	13	4.97	4.27	64.07	660.73	7.93	37.67	8
IC-354557+K. Chyan	74.63	61.33	5.33	3	3	13.67	3.9	4.93	74.63	920.77	11.05	41.67	7.67
IC 354557+NS-4266	75.17	108	2	4.67	3	13.33	5.87	4.8	75.17	1204.17	14.45	52	8.67
K. Aman non grafted	57.18	64.33	3.33	3.67	2.33	10	3.67	4.03	57.18	496.15	5.95	33	6
Kashi Chyan non grafted	64.53	72.67	4	2.33	1.67	11.67	3.43	4.63	64.53	518.97	6.23	43.67	5.33
NS-4266 Non Grafted	96.67	57	3	3.33	3	15.67	3.63	3.63	57.17	638.63	7.66	45	6.67
Performance of Surya													
Surya+K. Aman	60.57	54.67	4	3	3.67	17.33	4.6	4.6	60.57	907.53	10.89	38.33	7.67
Surya+ K. Chyan	65.03	81.67	4.67	3.33	3.33	9.67	4.7	5.57	75.03	993.2	11.92	42.33	6.33
Surya + NS-4266	71.14	67.67	3.33	5	4.33	12.67	4.2	4.37	71.14	1021.24	12.25	55	7.67
K. Aman non grafted	67.18	64.33	3.33	3.67	2.33	10	3.67	4.03	57.18	496.15	5.95	33	6
Kashi Chyan non grafted	64.53	72.67	4	2.33	1.67	11.67	3.43	4.63	64.53	518.97	6.23	43.67	5.33
NS-4266 Non Grafted	96.67	57	3	3.33	3	15.67	3.63	3.63	57.17	638.63	7.66	45	6.67
SE(m)±	2.28	1.62	0.41	0.35	0.47	1.15	0.29	0.21	3.10	78.58	0.94	2.04	0.47
SE(d)±	3.23	2.29	0.58	0.49	0.66	1.63	0.41	0.30	4.39	111.13	1.33	2.89	0.67
Critical Difference	6.55	4.65	1.19	1.00	1.34	3.30	0.83	0.61	8.91	225.60	2.71	5.86	1.36
CV %	5.50	4.09	18.95	17.31	25.22	16.01	11.04	8.03	7.85	16.98	16.98	8.30	11.73

Whereas, DFFP=Days to first fruit picking, PH=Plant height (cm), NB=No. of branches, NT= No. of truss, NFC=No. fruit per truss**,** NFP= No. of fruit per plant, FL= fruit length (cm), FB=fruit breadth (cm), AFW= average fruit weight (gm), MYP= marketing yield/plant (gm), MYPT= Marketing yield per plot (kg), HD= harvesting duration (days) and SL= Self-Life (days),

It is enormous scope for use of usar soil for further cultivation. Similarly, Savvas *et al.* (2011) demonstrated that effect of grafting on tomato fruit yield depends on rootstock and level of salinity.

Similarly, Savvas *et al.* (2011) demonstrated that effect of grafting on tomato fruit yield depends on rootstock and level of salinity.

Conclusion

Thus, it was concluded that IC 354556 and IC-111056, followed by Surya and their scion under saline condition were found to be high salt tolerant. The salt tolerant brinjal rootstock identified for their field assessment. Such a tolerant rootstock can be utilized for further breeding superior variety/ used as rootstock to produce salt tolerant grafted plants under saline condition.

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