

The Effectiveness of Grafting Method on Growth, Fruit Quality and Yield of Tomato

A. Abdel-Wahab

Vegetable Crops Department, Faculty of Agriculture, Cairo University, Giza, Egypt

Abstract: This experiment was conducted under net house conditions at the Eastern Experimental Station of the Faculty of Agriculture, Cairo University, during the summer seasons of 2015 and 2016 to investigate the effect of tongue approach and cleft grafting methods on growth parameters, fruit quality and yield of tomato cv. Elbash1077 F₁, used as a scion or rootstock. A randomized complete block design with 3 replicates was adopted. The results indicated that no significant differences were recorded between tongue approach grafting and the control on tomato plant height and number of leaves per plant in both seasons as well as number of branches and fruit length in the first season and fruit weight in the second one, while cleft grafting gave the significant reductions for these parameters. On the other hand, no significant differences were recorded between the two grafting methods and the control on fruit weight in the first season, fruit length and leaf SPAD readings in the second season and dry weight of leaves, leaf area, fruit diameter, early yield as well as TSS, total sugars and Ca concentration in the fruits in both seasons. Total yield and K concentration in tomato fruits were significantly higher in the control than both of the two grafting methods in both seasons. It is concluded that tongue approach method was better than cleft method for growth and yield of tomato when grafting needed.

Key words: *Solanum lycopersicum* • Cleft grafting • Tongue approach • Fruit characters • Yield

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the most important horticultural crops in the world and consumers demand more varieties of higher quality, strategies focused on increasing fruit quality continue to be of great interest [1, 2].

Despite its prominence, several factors can limit tomato production, such as adverse weather conditions, pests and diseases [3, 4]. To overcome some of these hurdles, farmers rely on grafting technique.

The grafting is very effective method to the abiotic stress such as low temperature, soil excessive moisture, high temperature and salinity [5-8]. Grafting is nowadays a common practice in many countries of the world. There are many grafting methods applicable to vegetable crops including tomato such as tube grafting, tongue approach grafting, hole insertion grafting, cleft grafting and horizontal pin grafting [9, 10]. A grafting method to be employed varies with the kind of crop being grafted, preferences and experience of growers [10]. The most common methods for grafting fruit vegetables are tube, tongue approach and cleft grafting. In particular, tomato

and eggplants are grafted mainly by conventional tube and cleft grafting methods [11].

Compared to a splice graft, the tongue graft is stronger, because the interlocking tongues are held under compression by the natural springiness (elasticity) of the wood of both stock and scion. This naturally generates the pressure needed for graft union formation. The additional length of the vascular cambium exposed along the cut surfaces of a tongue graft is much greater than the length of cambium exposed by only the diagonal cut without the tongue, in the case of a splice graft. This results in greater cambial contact between stock and scion of a tongue than of a splice graft. Also, for some grafting techniques, such as cleft grafting, the scion can be considerably smaller in diameter than the stock. In such cases, it is important that the scion be placed near the perimeter (outer edge) of the stock so that the vascular cambium on that side are in alignment. The scion should not be centered in the middle of the stock! If the bark of the stock is substantially thicker than the scion, then extra care must be taken to align the cambium, not the outer bark of stock and scion. In this respect, also, Marsic and Osvald [11] reported that the high percentage

(79-100%) of successful grafting observed for both tomato scions and rootstocks, using cleft and tube grafting methods, indicated that both grafting methods are suitable for tomato grafting. Generally, grafting became an essential technique to solve many problems. However, the influence of grafting methods on the yield of fruit-bearing vegetables in Egypt has not been precisely studied enough as yet. So, the aim of this research was to examine the effects of different grafting methods on growth, fruit quality and yield of tomato.

MATERIALS AND METHODS

This experiment was conducted under net house conditions at the Eastern Experimental Station of the Faculty of Agriculture, Cairo University, during the summer seasons of 2015 and 2016 to investigate the effect of grafting methods on growth parameters, fruit quality and yield of tomato cv. Elbasha 1077 F₁, used as a scion or rootstock, (Techno Green Co. for Agricultural Project). Seeds of scion or rootstock of tomato were sown on 23rd March 2015 and on 21st March 2016 in the seedling-trays. Tomato rootstocks were transplanted before the grafting in black plastic bags, 20 cm² diameter, filled with peat moss and vermiculite (1:1 v:v). Seedlings were grafted (self-grafting) by hand, applying two different methods: tongue approach grafting method and cleft grafting method at 2 true-leaf stage as compared with non-grafted tomato. Then the grafted plants were kept for 7-10 days under 90-95% RH and 45% shading conditions at temperature between 30 to 32 °C for healing. After that the successful grafted tomatoes were planted in the net greenhouse on 26th April 2015 and on 27th April 2016 on both sides of rows at 30 cm distance between plants within each side of row. A randomized complete block design with 3 replicates was adopted. The area of experimental plot was 5 m² (5 m length X 1 m width). The normal cultural practices needed for grown tomato plants and pest control were practiced as commonly followed in the district. Five plants of each treatment were randomly determined at 60 days after transplanting to determine growth parameters (plant height, number of leaves per plant, number of branches per plant, leaf area for the 4th leaf from meristem tip measured by leaf area meter, leaf dry weight per 100 g fresh weight and SPAD readings measured by SPAD 502 chlorophyll meter. Also, 3 fruits were taken from each experimental plot at the second harvest to estimate fruit characters and chemical contents of fruits such as fruit weight, fruit length, fruit diameter, TSS% using Zeiss laboratory refractometer, total

sugar content (according to the method described in AOAC [12]) and K or Ca concentrations in fruits, using absorption flame photometer according to the method described by Brown and Lilliland [13]. In each plot, all fruits of plants were harvested during the growing season and weighted to record early yield (2 weeks after starting harvest) and total yield. Data were treated by analysis of variance with using MSTAT-C v. 2.1 and means were compared by the least significant difference test (LSD) at 5 % level of probability [14].

RESULTS

Data on the effect of grafting method on tomato growth parameters are shown in Table 1. No significant differences were recorded between tongue approach grafting and the control on tomato plant height and number of leaves per plant in both seasons as well as number of branches in the first season. Conversely, cleft grafting gave significant reductions in plant height and number of leaves per plant in both seasons as compared with the control. Also, both of tongue approach and cleft grafting in the second season significantly decreased number of branches as compared with the control. On the other hand, dry weight of leaves and leaf area did not affect significantly by the method of tongue approach or cleft grafting in both seasons as compared with the control.

Regarding the effect of grafting method on fruit characteristics, Table 2 shows that no significant differences were noticed between the two grafting methods and the control in fruit weight in the first season, fruit length in the second season and fruit diameter as well as TSS% in both seasons. On the contrary, cleft grafting caused significant decreases in fruit length in the first season and in fruit weight in the second one as compared with the control.

Moreover, early yield in both seasons did not show any significant variation between the two grafting methods and the control, whereas total yield in both seasons was greater in the control than both of the two grafting methods with significant values (Table 3).

Data in Table 4 demonstrated that except for the leaf SPAD readings in the first season, the two grafting methods did not cause any significant differences in leaf SPAD readings and total sugar content and Ca concentration of tomato fruits in both growing seasons, as compared with the control. Cleft grafting in the first season significantly decreased SPAD readings as compared with the control.

Table 1: Effect of grafting methods on growth parameters of tomato plants, 70 days after transplanting, during 2015-2016 seasons

Grafting method	2015 Season					2016 Season				
	Plant height (cm)	Number of leaves /plant	No. of branches / plant	Leaf DW (g)	Leaf area (cm ²)	Plant height (cm)	Number of leaves / plant	No. of branches / plant	Leaf DW (g)	Leaf area (cm ²)
Tongue approach	94.17	11.00	3.33	18.55	13.82	92.00	11.33	3.00	18.37	13.25
Cleft	84.00	9.33	2.67	18.13	13.37	82.00	9.00	2.67	18.22	13.53
Control	94.67	10.33	3.67	18.84	14.29	95.00	11.00	4.00	18.72	14.17
LSD at 0.05	4.31	0.75	0.75	NS	NS	4.44	1.77	0.75	NS	NS

Table 2: Effect of grafting methods on fruit characters of tomato during 2015-2016 seasons.

Grafting method	2015 Season				2016 Season			
	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	TSS %	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	TSS %
Tongue approach	127.70	4.63	6.07	6.77	131.00	4.43	5.90	6.47
Cleft	139.30	4.33	5.67	6.27	114.70	4.23	5.47	6.33
Control	137.70	4.77	6.13	6.50	137.00	4.73	5.93	6.47
LSD at 0.05	NS	0.24	NS	NS	10.33	NS	NS	NS

Table 3: Effect of grafting methods on early and total yields of tomato during 2015-2016 seasons.

Grafting method	2015 Season		2016 Season	
	Early yield (kg/m ²)	Total yield (kg/m ²)	Early yield (kg/m ²)	Total yield (kg/m ²)
Tongue approach	5.695	15.700	5.892	16.430
Cleft	5.380	15.350	5.630	15.700
Control	5.203	17.450	5.118	17.470
LSD at 0.05	NS	1.206	NS	0.895

Table 4: Effect of grafting methods on total sugar content, leaf SPAD readings, Ca and K concentrations of tomato fruits during 2015-2016 seasons.

Grafting method	2015 Season				2016 Season			
	Total sugar (mg/g DW)	SPAD readings	Ca (mmol/kg DW)	K mg/kg DW	Total sugar (mg/g DW)	SPAD readings	Ca (mmol/kg DW)	K (mg/kg DW)
Tongue approach	6.19	47.63	11.95	44.81	6.66	44.87	11.03	45.58
Cleft	6.26	43.03	12.63	43.30	6.59	47.53a	11.97	44.04
Control	6.21	48.17	13.00	46.70	6.87	48.00	12.19	47.39
LSD at 0.05	NS	4.97	NS	1.05	NS	NS	NS	0.30

Also, the values of K concentration in tomato fruits were significantly higher in the control plots than the two methods of grafting. Generally, the lowest values of K concentration were recorded by using cleft grafting followed by tongue approach grafting and the control, respectively.

DISCUSSION

Under the standard growth conditions, no significant differences were recorded between tongue approach grafting and the control on tomato plant height, number of leaves per plant and number of branches as well as fruit characteristics and early yield. These results may be attributed to the efficiency of tongue approach method to cambial regeneration, from which a callus fills the gap area between rootstock and scion tissues, making a

continuous connection between vascular elements of both sides at graft point that keep the efficient of water and elements transportation from rootstock to scion like control treatment and this may construes the high concentration of potassium in fruits in this method of grafting. This connection between vascular elements of both sides at graft point was not the same in cleft method that caused a significant reduction in plant height and number of leaves per plant as well as potassium concentration, while did not affect the fruit quality. These results were supported by those found by Zeist *et al.* [4] and disagreed with those reported by Marsic and Osvald [11] who confirmed that cleft grafting method was suitable for tomato growth.

On the other hand, total yield in both seasons was greater in the control than both of the two grafting methods with significant values. These results may be

attributed to the growth was delayed especially with using the same plant as rootstock (self-grafting). In this regard, Marsic and Osvald [11] found that when 'Belle' was used as scion, the fruit yield of tomato was not significantly affected by using the different grafting methods, but was significantly affected with the cultivar 'Monroe', where the cleft grafting method significantly increased the total fruit yield per tomato plant.

CONCLUSION

The grafting method efficiency may be differed according to the type of rootstock, while in the case of our study the tongue approach method was better than cleft method for growth and yield.

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