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Induced-growth and yield responses to three varieties by grafting in tomato (*Lycopersicon esculentum* Mill.)

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ABSTRACT

The role of grafting technique for combining the desirable traits of two different plant was studied in cultivated tomato with the aim of inducing variability that could be exploited in the improvement of some important quality attributes to tomato. Tongue grafting approach was applied on to the seedlings of two varieties (*Roma and Local variety*). The result obtained revealed highly significance difference ($p \leq 0.01$) in the effect of grafting on the number of fruits, fruit weight, pericarp thickness and number of seeds/fruit. Significant improvement ($p \leq 0.05$) was also recorded for fruit diameter and fruit weight. More so, significant differences were found among the two tomato cultivars in terms of all the yield attributes such as fruit number, pericarp thickness, fruit weight, and fruit diameter. It was therefore concluded that, grafting improves some quality traits of tomato that are of high economic value.

Key words: Fruit weight, Grafting, Roma, Tomato, Season.

1. INTRODUCTION

Tomato (*Lycopersicon lycopersicum* Mill.) is an annual plant which originated from the south America probably Peru (Purseglove, 1968), that belongs to the small genus *Lycopersicon* which comprises nine species in the large family *Solanaceae* (Hille *et al*., 1989). It is now one of the most important horticultural vegetable cultivated throughout the world and is grown in a wide range of environment comprising natural and protected conditions (Dhaliwal *et al.,* 2002) of both the tropical, sub-tropical and temperate parts of the world. Despite all the tremendous importance of tomato, little importance has been put into the improvements of its genetic diversity to meet the demand of the local populace in Nigeria. The plant is threatened by neglect from the authorities concerned the consequent effect of which is it's seizure during some periods of the year; leading to high increase in its price. Therefore, efforts need to be placed in order to improve the quality and quantity of this valuable plant to relieve the larger society from its incessant demand that projects prices above tolerable limits for the poor man.

Grafting (an asexual method of propagating plants) is a method used to combine advantageous characteristics of scion of one plant and stock of another plant of the same species. The primary advantage of grafting for tomato production is similar to that of the previously published works (to utilize root stocks that: reduce the likely hood of infection by a pathogen, tolerant of certain abiotic stress, or can add to plant vigor and ultimately fruit yields as well as resulting in better yield and economic stability throughout the year) (Anonymous, 2007). However, little information is available for using grafting in the improvement of certain plants of economic interests in Nigeria. The main objective of this study is to merge some important quality traits of three tomato varieties using grafting.

2. MATERIALS AND METHOD

Study Site

The research was conducted in the Green House of the Botanical Garden of the Department of Biological Sciences, Ahmadu Bello University Zaria (Lat 11^0 12^1N, Long 7^0,37^1E, Alt 550-700 m above sea level).

Experimental Design

The seeds of three varieties of cultivated tomato (*Roma*, *UC* and a *local variety*) were collected from the Institute for Agricultural Research (I.A.R), Ahmadu Bello University Zaria, Nigeria. Roma was said to flourish successfully during the rainy season while UC flourishes and grows successfully during the dry season. The plants were grown during the 2013 rainy season. The treated plants were grown in 45 polythene bags arranged in a Completely Randomized Design (CRD) with three repetitions in each season. A total of 370 plants were raised after thinning. After two weeks of planting, the plants that germinated were grafted by transferring the scions of one variety to the stock of another variety; while the controls were allowed to grow without grafting.

Grafting Method

Tongue grafting approach was used. This is due to the relative advantage of the method over others such as its being used on larger plants, three times faster than other techniques, high success rate and is easy to handle. The seeds used for rootstocks were planted 2 days prior to that of the shoots. After two weeks of planting, and a day prior to grafting, the plants used for grafting were watered fully to make them turgid. One-fourth of the plants used for rootstock was cut at slant early in the morning. The shoot was also cut in the same way. The two cut ends were placed in direct contact and use a small clip to hold the cut surfaces together. This was repeated in the 3^{rd} and 4^{th} week of planting, while the remainder was left as control as described in McVoy (2005) protocol. The fruits quality of grafted plants were compared with those of non-grafted plants.

Data collection

Data were obtained for number of fruits/plant, and diameter of the fruits, thickness of pericarp, number of seeds/fruit, fruit weight, and pH values.

Data Analysis

All the data obtained were analyzed using Analysis of Variance. The means were separated using Duncan's Multiple Range Test (Duncan, 1955).

3. RESULTS

The result obtained for the analysis of variance of the effect of grafting on some quality traits of tomato was presented in Table 1. The result showed highly significant difference (P≤0.01) among the grafted varieties in almost all the selected traits except in the pH of fruit juice where the effect is significant (P≤0.05). Similar result was found among the varieties except in pericarp thickness where no significant difference was found and fruit diameter where the effect of grafting is significant (P≤0.05)

Table 1 Mean Squares for the Effects of Grafting on some Quality Traits Three Different Tomato Varieties

Sources of Variation	DF	Number of Fruits	Fruit Weight	Pericarp Thickness	Number of Seeds/Fruit	Fruit Diameter	pH
Replication	2	11.87*	55.92**	0.01^{ns}	476.72*	0.12^{ns}	0.01^{ns}
Treatment	1	188.59**	383**	0.53**	5594**	0.28*	0.92**
Variety	2	37.26**	564.34**	0.07^{ns}	2892**	0.20*	0.42**
Error	142	2.78	7.53	0.05	105.50^{ns}	0.06	0.01

Keys: ns= No significant difference * = Significant difference (P≤0.05) **= Highly significant difference (P≤0.01)

However, the result of the means for the effects of grafting on three varieties of tomato was shown in Table 2. The result indicated the effects of grafting to be higher on all the selected traits of variety UC except on number of fruits/plant; where the effects are higher on variety Roma. More so, the effects of grafting were found to be lower on the traits of the local variety of tomato.

Table 2 Means for the Effects of Grafting on some Selected Tomato Traits

Treatment	Variety	Number of Fruits	Fruit Weight (g)	Pericarp Thickness (mm)	Number of Seeds/Fruit	Fruit Diameter (cm)	pH
Grafted	Local	3.00^{c}	11.37^{c}	0.31^{c}	52.00^{b}	0.37^{b}	3.97^{c}
Control	Local	2.00^{d}	6.50^{f}	0.26^{e}	36.66^{e}	0.37^{b}	4.10^{b}
Grafted	Roma	5.41^{a}	12.25^{b}	0.36^{b}	50.25^{c}	0.28^{c}	4.18^{b}
Control	Roma	2.00^{d}	9.00^{e}	0.12^{f}	47.00^{d}	0.13^{d}	4.10^{b}
Grafted	UC	4.08^{b}	17.83^{a}	0.39^{a}	61.79^{a}	0.43^{a}	4.25^{a}
Control	UC	2.33^{d}	11.03^{d}	0.30^{d}	50.33^{c}	0.33^{a}	4.13^{b}
	Means						

N.B: *[1] Means within the columns with the same letter(s) are not significantly differen

4. DISCUSSION

The distinct differences observed in most of the qualitative traits among the grafted tomato plants evaluated showed, though there were few characteristics with no significant differences in responses to the applied treatment. Higher fruit yield parameters found in this study could be due to the fact that grafting combines novel traits of the two grafted plants after grafting operation. This has also been reported by Tsouvaltzis *et al.* (2004). However, the increased pH values of the juice in grafted plants recorded by this work is in contrast to the findings of Leoni *et al.* (1990) and Romano and Paratore (2001) who found that fruit descriptive and qualitative characteristics were not affected by grafting. But Lee (1994) found an increase in yield which was attributed to the vigour of the rootstock and the higher uptake of water and nutrients. Passam *et al.* (2005) found that eggplants grafted on to two tomato rootstocks gave a higher yield and bigger fruit size than those grafted on to two eggplant rootstocks, but the mineral composition of fruits from grafted plants did not differ from that of non-grafted plants.

The fruit index (diameter/length, number of fruits and fruit weight) were significantly influenced by grafting. The results agree with those reported by Lee (1994) who concluded that fruit shapes are influenced by rootstocks. Pogonyi *et al.* (2005) reported that when Lemance F_1 was grafted onto Beaufort rootstock, increased yield was caused mainly by higher average fruit weight. Ibrahim *et*

al. (2014) also found that the total number of fruits per truss in non-grafted plants was statistically different from the total for grafted plants. In a similar study by Khah *et al*. (2006) fruit weight of grafted plants was found to be higher than in non-grafted plants and plants grafted onto Heman and Primavera produced more fruit than the non-grafted, both in the greenhouse and in the open field. In the present study, the number of fruits and fruit weights of non-grafted plants were significantly lower than the corresponding values for plants grafted onto both rootstock cultivars. The results of the study showed that tomato grafting on suitable rootstocks had positive effects on the yield. In grafted combinations, the total fruit yield per plant increased significantly in comparison with that of the control plants. Ibrahim *et al*. (2001) observed similar results in grafted and non-grafted tomato plants. These investigators suggested that the higher yield of fruit from grafted tomato plants was most likely an effect of the vigorous root system of the rootstock. According to Lee (1994), the increased yield of grafted plants is also believed to be due to enhanced water and mineral uptake. Similarly, Osvald (2004) reported that tomato grafting on suitable rootstocks has positive effects on cultivation performance, especially under greenhouse conditions.

The pH value also plays an important role in determining fruit quality characteristics. Many studies focused on pH as a key element in tomato selection as stressed by Hong and Tsou (1998). The analyzed results showed that the pH values of tomato fruit increased among the grafted plants. This is in conformity to the findings of Kuzucu *et al*. (2004) who also reported that Koral, Mobil and H-2274 (fresh tomato) have a pH value of 4.31, 4.33 and 4.33, respectively; but is contrary to the work of Khah *et al*. (2006) who found that fruit pH values were not affected by grafting.

5. CONCLUSION

The effect of grafting was found to be significant in improving the important quality traits of the three tomato varieties under study. It was concluded that, grafting is significant in inducing variability that could be exploited in the improvement of highly economic crops like tomato.

Appendix

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Conflict of Interest: The authors declare that there are no conflicts of interests.

Peer-review: External peer-review was done through double-blind method.

Data and materials availability: All data associated with this study are present in the paper.

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