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Effect of Grafting on Growth and Shelf Life of Tomatoes (*Solanum lycopersicum* L.) Grafted on Two Local *Solanum* Species

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Abstract

The Rio Grande variety of tomato is widely grown because of its high productivity during the cold and dry seasons, and its resistance to *Verticillium* wilt (caused by *Fusarium oxysporium*) and to stem canker (*Alternaria*). Grafting tomato onto compatible rootstocks resistant to these diseases offers a better potential to overcome soil-borne diseases, abiotic stresses, improve growth, yield and fruit quality. However, in Cameroon, there is little or no information on grafting between Rio Grande tomato and selected eggplant rootstocks. The objectives of this study were: 1) To determine the compatibility between Rio tomato grafting and a popular local eggplant (Nkeya) rootstock; 2) To verify the effect of grafting on flowering time; 3) To evaluate the effect of eggplant rootstocks on growth, fruit shelf life and fruit quality of Rio tomatoes. The trial was conducted in a randomized complete block design with 3 replications. Rio Grande (To) was the ungrafted treatment used as a control. To/Ko, To/To and To/Nk were the grafted treatments eventually transplanted to the field. Growth data were subjected to analysis of variance using SPSS software. Descriptive analyses were performed for the other parameters. The results revealed that, 1) The cleft grafting method used was successful with success rate varying between 90 and 100%; 2) Grafting influenced flowering date (DAT, $p = 0.05$) as well as tomato growth parameters including stem height (H, $1.49 \times 10^{-10} < p < 0.00014$) and collar diameter (SD, $4 \times 10^{-14} < p < 0.009$). The To/To treatment was significantly different from the ungrafted cultivar To, which had no significant difference in stem diameter. A significant difference in plant height was also observed between the ungrafted treatment To and the To/Ko and To/Nk treatments. In addition, only the collar diameter of To/Nk was different from To. Also, there was no significant difference between To/To and To, but a significant difference between To/Ko and To/Nk compared to To. Conversely, grafting improved the lifespan of To/Ko. Ultimately, the grafting method used was successful, but further studies are needed to overcome the problem of graft incompatibility in order to improve the agronomic performance of grafted plants.

Keywords

Rio Grande Tomato, *Nkeya* Eggplant, *Solanum lycopersicum* L., *Solanum aethiopicum* L., *Solanum macrocarpon*, Grafting

1. Introduction

Tomato (*Lycopersicon esculentum* L., 2n = 24), *Solanaceae*, is the most important vegetable crop grown throughout the world [1]. Its cultivation is attributed to its food value with many uses, and the relative ease of cultivation [2]. Nutritionally, tomato is an important source of vitamins, minerals, essential amino acids, sugars, antioxidants, carbohydrates and dietary fibers [3]. It is a good source of vitamin C [4], and is an excellent source of lycopene, a powerful antioxidant with anti-carcinogenic potential [3] [5].

Global tomato production in 2017 was at 182,301,395 tons while in the same year in Africa, tomato production was at 21.486.541 tons [6], relatively less optimistic over the demand. In Africa, Egypt (7,297,108 tons), Nigeria (4,100,000 tons), Tunisia (1,298,000 tons) and Algeria (1,286,286 tons) are the major producers [6]; Cameroun occupied the 19th position in Africa in 2017 with a production of 1.279.853 tons constituting a world share of 0.7% [6]. These low yields may be attributed to many factors [7] [8] such as fungal diseases like late blight caused by *Phytophthora infestans*, early blight caused by *Alternaria solani*, and fruit rot caused by *Phytophthora parasitica* [9] in the rainy season. Late blight can cause 100% yield losses while early blight causes 30% - 60% yield losses [10]. Farmers growing tomato in the rainy season may incur higher production costs due to greater fungicide sprays. Meanwhile in the dry season, tomato production may be limited by non-availability or high costs of irrigation water. In addition, important tomato pests are red spider mites (*Tetranychus* sp.), white fly (*Bemisia tabaci*) as a vector of tomato yellow leaf curl virus disease, fruit worms (*Helicoverpa armigera*), and thrips.

Old open-pollinated cultivars such as "Roma VF", "Rio Grande", "Marglobe" and "Moneymaker" are widely grown in Africa [11], and most seed in the market are imported from India, China, and Europe. For example, 57% of the cultivars grown in Cameroon are open-pollinated, with "Rio Grande", "Roma" and "Rossol" dominating the market [11]. In fact, farmers in Cameroon preferentially grow F1 Cobra 26, F1 Mongal, and F1 Kiara for their high yield. These cultivars are also advocated to be resistant to tomato *Fusarium* wilt disease (TFWD), bacterial wilt, tomato yellow leaf curl virus (TYLCV), root knot nematode (RKN), etc. However some farmers complain that some of these cultivars are more susceptible to RKN and TYLCV than some local open-pollinated tomato cultivars like Rio Grande. It is difficult to grow them without frequent chemical sprays. Pesticides are ineffective to control these diseases added to the fact that they are hazardous to humans and the environment, and are expensive [12]. Some of these cultivars also lack sufficient fruit firmness and long shelf life to withstand long-distance transport and rough handling. Also, abiotic stresses including salinity, drought, excessive heat, decline in soil fertility [13] and low soil pH are among production constraints of tomato in sub-Saharan Africa, including Cameroon. Soil pH below 6.0 can result in blossom-end rot and other physiological disorders like fruit cracking [14].

According to Msogoya and Mamiro [15], pesticide application is the major pest managment strategy of tomato pests usually applied on a weekly basis [16]. These increase both the cost of production, risks for human health and environmental pollution [16] [17] [18] [19]. Disease-resistant varieties are limited [13] and can be overwhelmed by novel pathogens and higher disease pressure [20]. All these leave farmers with few options for managing soil-borne diseases [21]. In addition, consumers' interest in the quality [22] [23] of tomato fruit products has also increased tremendously. Quality is an all-embracing term and it includes physical properties (size, shape, color, and absence of defects and decay, firmness, texture), flavor (sugar, acids, and volatiles aroma) and health-related desired compounds (minerals, vitamins, and carotenoids as well as undesired compounds such as heavy metals, pesticides and nitrates) [24].

Since consumers' demand for more varieties of higher quality and longer shelf life, strategies committed to increasing fruit quality and longer shelf life continue to be of great interest [25] [26]. An integrated approach to enhance fruit quality, increase productivity with extended shelf life is very important for sustainable tomato production in Africa, particularly in Cameroon. A rapid and an efficient alternative to achieve this is by vegetable grafting. Grafting has been well-known to be an effective and environmentally sustainable method to provide improved resistance and/or tolerance against soil-borne diseases, nematodes, bacterial wilt, and viruses [27] [28] [29]. According to several studies [29] [30] [31] [32] [33], grafting enhances plant growth and tolerance against biotic stressors, increases yield and improves the quality of fruits. Grafting has been reported to improve the uptake of nutrients [34], enhance water-use efficiency [35] [36], fruit quality [22] [37] [38], increased rate of photosynthesis, and anti-oxidant enzyme activities [39], thereby increasing crop yields under natural growing environment and heavy metal toxicity [40] [41], longer harvest duration [42] and extended shelf life [32] [43] [44] [45].

Grafting thus provides an effective management tool for growers to control soil borne pathogens and cope with environmental stressors [46]. It represents a viable strategy to mitigate such biotic stresses [34] [20] and has been successfully employed to combat FWD, RKN and other diseases [47] [48]. Grafting on compatible and resistant rootstocks [49] has a greater potential to overcome soil borne diseases including TFWD [10] [48]. It also improves growth, yield and quality even in the absence of a disease as a result of tolerance against abiotic stresses [10] [46] [48] [50]. This can therefore be exploited as a positive alternative crop management strategy to reduce postharvest losses by using rootstocks that can enhance fruit quality attributes of the scion with increased yields.

For instance, grafted tomatoes have demonstrated remarkable evidence to develop better resistance and/or tolerance against abiotic stress such as soil salinity [51], cold [52], heat and drought [53], and waterlogging [54]. Growing tomatoes using grafting is thus a profitable enterprise [55] that can offer to farmers, new commercial prospects [22] [43]. But if fruit quality is poorly affected as an outcome of grafting, farmers may be less likely to take on this technique [55]. The likelihood practice of grafting to promote growth and yield increase has not quite been investigated in Cameroon. To the best of our knowledge, there is limited information on graft success between the selected eggplant rootstocks (*S. macroparcon* and *S. aethiopicum L.*) and selected tomato cultivar Rio Grande in Cameroon. It is against this backdrop that this research study was conceived to investigate the effect of grafted tomatoes on selected eggplants. It was designed to determine the effectiveness of grafting between Kotobi, Nkeya and Rio Grande and its effect on growth and shelf life for tomato cultivation.

2. Materials and Methods

2.1. Experimental Site

The experiment was conducted in July 2018. The nursery phase was at Simbock and the transplanting phase at Nzeng in the locality of Nyong and So'o, Centre Region of Cameroon, at 32N 0809170, UTM 0397732. The climate is characterized by a bimodal rainfall regime with 1500 - 2000 mm of rainfall and an annual mean temperature of 25˚C.

2.2. Plant Material

The commercial tomato "Rio Grande" (*Solanum lycopersicum* L), was used as self-grafted and non-grafted control, while two eggplants "KOTOBI" (*Solanum aethiopicum* L.) and "NKEYA" (*Solanum macrocarpon*) were used as rootstocks (**Figure 1**). Rio Grande was chosen because it is appreciated for its high productivity during the cool dry season. It is vigorous with long cylindrical very firm fleshy fruits, averaging 95 to 100 g in weight.

Grafting combinations were as follows: To/To (scion "Rio Grande" and rootstock "Rio Grande"), To/Ko (scion "Rio Grande" and rootstock "KOTOBI"), To/Nk (scion "Rio Grande" and rootstock "NKEYA") and To ("Rio Grande"). The seeds of "Rio Grande" and "KOTOBI" were bought at the shop of SEMAGRI SARL located at Mokolo market while the seeds of 'NKEYA' were harvested in a small garden in Yaounde. This NKEYA' variety has a slightly bitter taste and is locally appreciated by consumers for its high nutritional value, high leaf and fruit yield, fairly high resistance to pests and diseases, as well as its medicinal properties [56] [57]. Due to these interesting characteristics, a particular attention was focused on this plant variety [58], to find out what it can offer to the grafted tomatoes.

2.3. Method

Standard seed germination procedures were followed [59]. Seeds were sown in seedling trays filled with soil (**Figure 2**). Eggplant rootstocks were sown one

Figure 1. *Solanum macrocarpum* (Eggplant locally called NKEYA), used as rootstock.

Figure 2. Seeds sown in seedling trays.

month earlier than scion cultivar to secure comparable seedlings stem diameters at the moment of grafting [60].

Before applying the cleft grafting method according to Black *et al.* [54], the working surfaces, hands, grafters', and razor blades were disinfected with 90% alcohol in order to minimize possible contamination [48]. All treatments were grafted using the cleft method [54]. Grafting was performed on the 11 October 2018 when rootstock and scion seedlings were 45 and 30 days old, respectively. The experiment was laid in a multifactorial randomized complete block with three replicates, each containing all the treatments on 256 m^2. The rootstock was truncated and a cut of about 5cm long was made straight down. The scion stem was cut in a form of wedge and inserted in the split made into the rootstock. A grafted clip was used to hold the scion and rootstock firmly until the graft union healed (**Figure 3**).

Grafts were mist-sprayed and then transferred into the dark healing chamber for one week and then placed in a transparent healing chamber where they were held for another one week. The grafts were hardened off for 14 days in the chambers prior to transplanting (**Figure 4**).

Prior to transplanting, the experimental field was well prepared and later on, normal cultural practices were followed for irrigation, fertilizer and pesticide application. NPK compound fertilizer (20:10:10) was applied as top dressing at the rate of 150 Kg/ha one week after transplanting. Then a mixture of NPK (12-11-18) was applied after four and six weeks respectively at the rate of 150 Kg/ha. This was followed by foliar fertilizer (20-20-20) at the rate of 50 g per seedling every 15 days. All cultivars were staked three weeks after transplanting.

A randomised complete block design was adopted with three replicates, each plot comprised of 4 rows of 80 plants each. Plants were spaced at 75 cm × 50 cm

a: eggplant, b: tomato.

Figure 3. Grafted tomatoes on eggplant (notice clip at graft point).

Figure 4. Grafted seedlings placed in the dark (left) and transparent (middle) healing chambers before exposure (right) to the sun.

with a 1 m long walkway between replications. Twenty plants from each replicate were evaluated for percentage of graft success, height, stem diameter, flowering and shelf life while the others remained as guard plants and were not included in the evaluations.

In the open field conditions, data were collected from five of the 20 plants from each experimental unit in each replicate. Grafting success was recorded between 7 - 28 Days Grafting success rate was determined using the following formula:

$$\text{Grafting success} = \frac{\text{Number of successful grafts}}{\text{Total number of grafts}} \times 100$$

Plants height and stem diameter were recorded between 28 - 56 DAT. Days to the first flowering were noted by counting the number of days after transplanting (DAT) to 50% flowering. The stem diameter was measured 5 cm above the ground level with a Vernier caliper (0 - 150.05 * 1/128). Measurements were recorded at 28, 42 and 56 DAT. Plant height was measured at these different growth periods by using a metallic ruler (2 m long) from the base to the apex of the plant. Mean total number of harvested fruits (MTNHF) and total number of harvested fruits (TNHF) were also recorded from five plants of each experimental plot. Only fully ripe fruits were harvested. Fully ripe fruit samples from each treatment were harvested and stored under ambient temperature and relative humidity conditions to assess shelf life. The shelf life was determined by counting the number of days from the day of storage after harvest to the softening of the fruits. Here, 5 fruits were harvested randomly from each replication.

2.4. Data Analyses

Data were collected, recorded and cleaned with Microsoft Excel 2016. They were then subjected to analyses of variance (ANOVA) using SPSS version 20 and the means separated by the least significant difference at P = 0.05.

3. Results and Discussion

3.1. Results

Grafting was successful both at the nursery and in the field. Grafting was 100%

successful for the treatment To/To followed by the treatment To/Ko (98%) and To/Nk (94%) at the nursery. In the field, the treatment To/To still recorded 100% success while To/Ko and To/Nk decreased to 97% and 90% respectively (**Table 1**).

This study also revealed the effect of grafting on flowering and plant growth. Grafted treatments flowered earlier than the ungrafted treatments (**Table 1**). The treatment To/Ko took 29 DAT followed by To/To with 33 DAT, To with 37 and To/Nk with 41 DAT respectively. Plant growth performance in terms of plant height was significantly higher for To (51.53 cm, 76.57 cm and 88.00 cm) followed by To/To (49.03 cm, 67.36 cm and 78.42 cm) and the least was To/Nk (39.00 cm, 54.45 cm and 67.45 cm) over the growth period with significant effects on plant height recorded at 28, 42 and 56 DAT ($p = 0.0001$) for the treatment To/To, as compared to the ungrafted To (**Table 2**). There was no significant difference ($p \le 0.05$) between the ungratfted To and the other two treatments To/Ko and To/Nk.

Plant growth performance in terms of stem diameter was significantly greater for To/To (0.85 cm, 1.11 cm and 1.25 cm) followed by To (0.77 cm, 1.04 cm and 1.22 cm) and the least was recorded by To/Nk (0.65 cm, 0.81 cm and 0.97 cm) over the growth period (**Table 2**). Grafting resuslted in significant effects on stem diameter at 28 DAT ($p = 0.001$) and 56 DAT ($p = 0.009$) for the treatment To/To, To/Ko and To/Nk as compared to the ungrafted To.

Concerning the effect of grafting on fruit yield, the mean values for the number of fruits per plant varied significantly ($P = 0.05$) among treatments (**Table 3**).

Table 1. Influence of treatment on gragting sucess, flowering and shelf life.

Treatments	Grafting success (%)		Days After Transplanting to 50% flowering	Shelf life
	Hardening off	*At the field*	*Days after transplanting*	*Days after harvest*
Rio Grande (To)			37	4
Rio Grande × Rio Grande (To/To)	100	100	33	2
Rio Grande × Kotobi (To/Ko)	98	97	29	0
Rio Grande × Nkeya (To/Nk)	94	90	41	6

Table 2. Influence of grafting on plant height and stem diameter (SD) at 28, 42 and 56 days after transplanting (DAT).

Treatments	Height (cm)			Stem Diameter (cm)		
	28 DAT	42 DAT	56 DAT	28 DAT	42 DAT	56 DAT
Rio Grande (To)	51.53 ± 15.91^{a}	76.57 ± 76.51^{a}	88.00 ± 64.83^{a}	0.77 ± 0.11^{a}	1.04 ± 0.18^{ab}	1.22 ± 0.33^{ab}
Rio Grande × Rio Grande (To/To)	49.03 ± 12.20^{a}	67.36 ± 62.21^{b}	78.42 ± 51.52^{b}	0.85 ± 66.96^{a}	1.11 ± 0.17^{a}	1.25 ± 61.18^{a}
Rio Grande × Kotobi (To/Ko)	40.61 ± 8.05^{b}	50.03 ± 27.32^{c}	63.80 ± 14.18^{c}	0.71 ± 0.20^{b}	0.97 ± 0.19^{b}	1.15 ± 0.18^{b}
Rio Grande × Nkeya (To/Nk)	39.00 ± 7.51^{b}	54.45 ± 37.02^{c}	65.45 ± 30.12^{c}	0.65 ± 0.15^{b}	0.81 ± 0.20^{c}	0.97 ± 0.22^{c}

The treatments with the same letter indicate that they are not significantly different at 5 % probability.

Highest mean total of fuits harvested and total number of fruits harvested ware observed for To (13.26; 66.33) followed by To/To (11.13; 55.66) and the least To/Ko (1.46; 7.33). Grafting resulted in significant effect at harvest ($p = 0.02$) for the treatments To/Nk and To/Ko as compared to the ungrafted To. The treatment To/To did not significantly differ ($p \leq 0.05$) from To (**Table 3**).

Shelf life of tomato fruits was also influenced by grafting in this study. Shelf life was significantly higher for To/Ko (6 days) followed by To (4 days) and the least by To/To (2 days) (**Table 4**).

3.2. Discussion

With regards to grafting success (%) of rootstock/scion treatments during the healing process at the nursery level and in the field, observations at the healing chambers unveiled a high grafting success among all treatments, ranging from 83 to 100% after hardening off. Grafting success decreased as grafts moved from one healing environment to the next. By the end of hardening off, only To/To retained the 100% grafting success trend. The rest of the treatments achieved a grafting range of 94% and 98%. Grafting success is determined by such factors as grafting technique employed, seedling age at grafting, post-grafting environmental conditions and rootstock-scion compatibility. Other factors include comparability of stem diameters of rootstocks and scions during grafting, and the level of mastery of the technique by the grafter, amongst others [61] [62] [63]. The method employed in this study was the cleft method [63] which resulted in a grafting success rate of 100% for the treatment To/To.

The high graft success observed in this experiment is supported by the results from other studies by Msogoya and Mamiro [15]. Despite of the high graft

Table 3. Influence of grating on the mean total of fuits harvested and total number of fruits harvested.

Treatments	Mean total of fruits harvested	Total number of fruits harvested
To	13.26 ± 6.95^a	66.33 ± 34.77^a
To/To	11.13 ± 10.35^a	55.66 ± 51.75^a
To/Ko	1.46 ± 2.88^b	7.33 ± 14.40^b
To/Nk	2.26 ± 4.32^b	11.33 ± 21.63^b

The treatments with the same letter indicate that they are not significantly different at 5 % probability.

Table 4. Influence of different grafting treatments on shelf life.

Treatments	Number of days from harvest to fruit softening
To/Ko	6
To	4
To/To	2
To/Nk	0

success at the nursery level, To/Ko and To/Nk expressed low graft success in the field. They produced adventitious roots in comparison to the control ungrafted treatment. These were more apparent in To/Ko and To/Nk, probably indicating graft incompatibility [64]. Adventitious roots at the graft union are triggered by accumulation of carbohydrates and auxins at this point [65]. Such accumulation of carbohydrates and auxins is due to lack of, or limited vascular continuity [66] which prevents free translocation of these substances along with water. This results in enlarged stem diameter at that point in comparison to rootstock stem diameter. Bletsos and Olympios [62] reported incompatibility between tomato scion and *S. intergrifolium* rootstock, causing smaller stem diameter of rootstocks than scions.

Tamilselvi and Pugalendhi [60] also reported delayed incompatibility in bitter gourd (*Momordica charantia* L.)/cucurbit graft combinations owing to discontinuous xylem elements at the graft union. On their part, Ives *et al.* [66] observed the development of adventitious roots at the scion base of pepper/tomato heterografts due to incompatibility. In terms of growth, To/To grew more than To/Ko and To/Nk. This is an indication that more vascular bundles were formed with effective connections between them in comparison to To/Ko and To/Nk. These treatments may therefore be partially incompatible. Heterografts such as tomato scions/eggplant rootstocks usually exhibit partial incompatibility, which further impairs water and nutrient translocation from the rootstock to the scions in comparison to homografts [65] [67].

Observations regarding grafting effect on plant growth, especially relative to earliness or number of days to the first flowering revealed interesting results. In general, grafted plants may develop faster, contributing to earliness in the absence of incompatibility problems and environmental stress [68]. In this study, earliness was observed with the most vigorous rootstock Kt characterized by early flowering compared to ungrafted To. This shows that the influence of grafting and rootstock selection are important in conferring earliness on the scion, though the earliness could also be influenced by scion selection. Other studies have assessed grafting between tomato and eggplants [49]. Increased earliness have also been reported for tomato grafted on eggplant rootstock [69]; for eggplant grafted on tomato hybrid rootstock [70]; for eggplant grafted on eggplant rootstocks [68] and for watermelon grafted on bottle gourd [71]. In fact, early harvest may be more important for the farmer both in the greenhouse and in the open field to capture higher market prices [55].

Results of this study also revealed that grafting influenced growth rate and hence reduced plant height in To/To at 56 DAT in comparison to the ungrafted To. However, no significant difference was observed from the combinations To/Ko and To/Nk at 56 DAT. There was also no significant differences in stem diameters for To/To and To/Ko in comparison to the ungrafted To. However, grafting reduced stem diameter in To/Nk as compared to the ungrafted To. Both lower and greater plant heights observed in this study have been reported in other studies. In a study by Ibrahim *et al.* [69], the height of tomato cv. "BARI tomato 3" grafted on wild *solanum* was shorter than the ungrafted. On the other hand, Khah *et al.* [70] observed that "Big Red" tomato scion grafted on "He-man" rootstock was taller than non-grafted plants in open-field cultivation. Moreover, a decrease in stem diameters of grafted plants observed in this study is contrary to findings by Al-Harbi *et al.* [72] who reported a significant increase in stem diameters and plant heights as compared to ungrafted plants.

On the one hand, low plant heights (To/Ko and To/Nk) and small stem diameters (To/Nk) could be attributed to limited vascular system continuity [73] and few vascular bundles regenerated at the graft union. This could result in the limited or insufficient translocation of minerals, photosynthates and water [66], thereby impacting plant growth negatively. Low plant growth might also have resulted from less vigorous rootstocks unable to support vigorous scions. This observation is supported by the results from other studies [20] [46] [48] [50], which asserted that growth, yield and quality are improved when a crop is grafted on a vigorous rootstock. It has been observed that some rootstocks reduce growth and production of scions [62]. In addition, Abdelhafeez *et al* [74] found that tomato grafted on eggplant exhibits limited growth and lower yield than self-rooted plants. On the other hand, the greater stem diameters in To/To may be due to sufficient vascular regeneration and continuity across the graft interface [66], and enhanced vigour of the scions by the rootstocks. This is an indication that the rootstock variety may play a key role by which the grafted plant responds in terms of plant growth.

Concerning the mean total number of harvested fruits and the total number of harvested fruits, grafting in this study reduced them for the treatment To/Ko and To/Nk as compared to the ungrafted To. However, a significant difference was observed for the treatment To/Ko as compared to the ungrafted To. Yield is considerably reduced by the decrease in the mean number of fruits and mean total number of fruits harvested. This was reported by Msogoya [15] for EG219/Tanya and EG203/Tanya graft combinations during both rainy and dry seasons. The low total number of fruits in To/Ko and To/Nk was sure to follow due to their impaired growth performance emanating from constricted graft unions and possibly low rootstock vigour. Abdelhafeez *et al.* [74] observed limited growth and lower yields in eggplant/tomato as compared to self-rooted plants.

Another parameter measured by this study was shelf life of tomato fruits. Tomato fruit has a relatively short postharvest life span since many processes affecting quality take place after harvest. The main factors associated with tomato postharvest life span or shelf life, particularly in tropical regions are high temperature and increased respiration which result in faster ripening and deterioration of fruit quality [8]. Thus beside all available strategies for minimizing postharvest losses, grafting on rootstocks have the ability to extend or increase the postharvest life span. This study revealed that To grafted on Ko had greater increment of shelf life than that of To/To, To/Nk and the ungrafted To. The results agree with that of Nkansah *et al.* [32] who observed that grafting on African eggplant significantly extended the postharvest life of tomato. In this light and as a complement to breeding programmes, further research is needed in Cameroon to identify and characterize compartible rootstocks and scions [75] that can improve the quality and shelf life of fruits particularly under biotic and abiotic stress.

4. Conclusions

The objectives of this study were 1) To determine graft success between selected eggplant rootstocks and Rio tomato cultivar; 2) To determine the effect of grafting on the period of flowering and harvesting; 3) to evaluate the effect of selected eggplant rootstocks on plant growth and shelf life of Rio tomato cultivars. Results revealed high success at the nursery stage but low graft success for To/Ko and To/Nk after transplanting in the field as manifested by low plant growth, wilting and death in comparison to ungrafted treatment (To). On the other hand, To/To treatment maintained high graft success even at field level and also expressed good growth performance similar to the ungrafted treatment. The treatment To/To had better productivity and the treatment To/Nk had a better shelf life. These benefits can be of value to farmers, eventhough they may be less likely to adopt the technique if growth and shelf life are poorly affected at the expense of yield and disease resistance. This study successfully demonstrated that grafting is possible between known important tomato cultivars and locally unexploited species of this family like *Solanum torvum* [76] [77] and *Solanum macrocarpum* (*Nkeya*).

However, further studies are needed to address the issues of grafting incompatibility given that scion-rootstock interactions [78] are not fully understood. It is thus prudent that different grafting combinations be assessed under different agroecological conditions before selecting the suitable rootstocks and integrating this technology on a larger scale. In this light and based on the results of this study, we recommend that future research should be conducted in major production regions with multiple rootstocks. Moreover, there is a need to evaluate healing chamber designs on graft survival under different environmental conditions using locally available materials. It could also be interesting to envisage assessment of photosynthetic performance [79] and molecular studies of inheritable grafting induced changes in tomato as has been done for pepper (*Capsicum annuum*) fruit shape [80].

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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