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Tomato Production through Vine Cutting Technology in Hydroponics System

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ABSTRACT

Tomato is an important vegetable in Nigeria, but the cost of purchasing the seeds for planting is high. This has necessitated the search of production alternatives through the vine cutting technology to complement the use of seeds in tomato production. Seeds of three exotic tomato varieties (Red Cherry Large-RCL, Roma and San Marzano-SM) and one local variety (Ibadan local) were purchased from the Soilles Farmlab, Abeokuta and Bodija market, Ibadan respectively. The seeds were sown directly in hydroponics troughs containing cocopeat, watered and fertigated with liquefied poultry manure (1 mg/ml concentration) and thinned to one per partition after three weeks. Vines were cut from the growing tomato plants at 1, 2 and 3 months of growth from the varieties and sown in another hydroponics trough in three replicates. Data were taken on the percentage survival of cut vines, days to the formation of new shoot (DTNSF), Number of new shoots (NNS) at 2, 3 and 4 weeks respectively, days to 50 % flowering, number of fruits and fruit weight at harvest. Data collected were analyzed using ANOVA and differences in the treatment means were separated using Least Significant Differences (LSD) at 5 % level of significance.Results obtainedshowed that Cherry Red Large-CRL tomato had the highest vine survival (81.25%) and number of fruits produced (5.83±0.41), while the local variety had the highest fruit weight (23.98±1.09). Also, the cut vines at 1-month old had the highest vine survival (93.75±5.02) and the fruit weight (20.01±0.94). However, the cut vines at 2-month old produced the highest number of fruit (5.81±0.36).

1. Introduction

Tomato (*Solanum lycopersicum* L.) is a vegetable with high market acceptance and compensating prices for the producer (Cardozo *et al*., 2018). This make tomato production one of the most profitable vegetables and one of the most consumed and popular fruits in the World (Nasir *et al*., 2015). The consumption of tomatoes is very important as it plays an important role in our diet by offering varieties of nutrient in the class of protein and carbohydrates (Perveen *et al.*, 2015). Also, tomato is high in antioxidant, phenolic, vitamins and carotenoid contents (Vinha *et al*., 2014).

Due to the high value of tomato in the daily food intake of people in Nigeria, the production of tomato has become an integral part of agricultural production in Nigeria with reduced dependence in imports. This has increased the importance and cost of tomato seeds for planting purposes (Heder *et al*., 2010), as the seeds are predominantly used in propagating tomato in Nigeria with no alternative means of propagation, despite it being a plant that can be propagated from the

vegetative parts (Cardozo *et al*., 2018). In south American countries, the use of vine cutting in propagating tomato to circumvent the excessive cost of purchasing new tomato seed for planting is prevalent (Heder *et al*., 2010; Souza and Gentil, 2013).

Despite the success stories on the applicability of vine cutting technology in the production of tomato, there are little or no report on its applicability in tomato production in Nigeria. Hence, farmers will have to revert to seed companies on each planting occasion despite the high cost of purchasing the seeds. However, Nigeria being a country with two weather extremes (dry and wet), the success of the vine cutting technology will largely depend on the weather condition of the farm environment and the substrates being used in the cultivation, considering that tomato being cultivated in a soilless environment had shown superior performance to the tones grown in the soil (Maboko *et al*., 2009). This situation can be ameliorated with the continued use of the hydroponics system in a controlled environment (Cardozo *et al*., 2010). Hence, this study aims to exploit the vine cutting technology in propagating tomato using the hydroponics system at different growth stages of tomato.

2. Materials and methods

Three varieties of Tomato seeds (Red Cherry Large-RCL, Roma and San Marzano-SM) and twenty-four troughs of drip system hydroponics troughs were purchased from the Soilless farmlab seed company, Abeokuta. Also, one local variety of tomato was purchased from the Bodija market. Cocopeat in block form was purchased from Afri-Agri company, Lagos. The buffered cocopeat blocks was dissolved in water. The cocopeat was used to fill in the hydroponics troughs with perforations beneath for drainage purposes. Each of the hydroponics troughs contains 8 litres of the substrate in 4 segments of 2 litres capacity each. The tomato seeds were sown directly in the hydroponics troughs and watered. After two weeks, they were thinned to one per trough segment. At one, two and three months respectively, vines (3 nodal segments) were cut from the tomato stands (12 vines per genotype), which was planted in another hydroponics trough in three replicates. At 7 days after cutting, samples of the cut vines were taken out to view the roots formed. Poultry droppings was sourced from Ajayi farm, Ibadan. The poultry manure was allowed to dry for one week, 1 g of the poultry manure was ground into fine particles and liquefied by soaking them in 1 Litre of water for two days. For the plants fertigation, 100 ml of the nutrient was used to fertigate each plant once per week and watering was done every 3 days till harvest. Data were collected on the percentage survival of cut vines, days to the formation of new shoot (DTNSF), Number of new shoots (NNS) at 2, 3 and 4 weeks respectively, days to 50 % flowering, number of fruits and fruit weight at harvest. Data collected were analyzed using ANOVA and differences in the treatment means were separated using Least Significant Differences (LSD) at 5 % level of significance.

3. Results and discussions

The result obtained on the effect of vine cutting on the performance of four varieties of tomato showed no significant differences among the genotypes, however, the days taken by the genotypes to form new shoots, the number of new shoot formed at 2, 3 and 4 weeks old, days to 50 % flowering, number of fruits produced and the fruit weigh were all significant. Also the age effect on the growth and yield parameters were significant, while the interactions between the genotypes and age of vine cutting were only significant on the number of days taken to form new shoots, number f new shoots at 4 weeks old and the number of fruit formed respectively (Table 1).

Table 1: ANOVA table for the effect of vine cutting period on the growth and yield of different varieties of tomato grown in the hydroponics system

Source of variation	% Survival	DTNSF	NNS2	NNS3	NNS4	DT50%F	NOF	FW
Genotype	47.74ns	6.39**	2.30**	3.19ns	8.24**	21.52**	7.81*	509.73**
Age	3528.65**	25.56**	15.25**	50.58**	80.06**	198.90**	12.65*	83.03*
Genotype*Age	125.87ns	3.03*	0.61ns	1.00ns	4.95*	5.31ns	7.03*	22.72ns

DTNSF: Days to new shoot formation, NNS2: Number of new shoot at 2 weeks, NNS3: Number of new shoot at 3 weeks, NNS4: Number of new shoot at 4 weeks, DT50%F: Days to 50% flowering, NOF: Number of fruits and FW: Fruit weight.

The percentage survival of the vines cut from the genotypes were statistically same, however, RCL had the highest survival of 81.25%. The RCL took on average of 9.17±0.27 days to form new shoots which was significantly lower than the rest genotypes. Also, the number of new shoots formed by RCL at 4 weeks old (13.57±0.31) was significantly higher than the LV (36.25±0.31) and SM (11.25±0.31) but Roma (12.50±0.31). The days taken to reach 50 % flower production by SM (38.75±0.53), Roma (38.25±0.53) and RCL (39.33±0.53) were significantly higher than LV (36.25±0.53). The number of fruits

produced by Roma (5.75±0.41) and RCL (5.83±0.41) were significantly higher than LV (4.08±0.41), however, SM (5.17±0.41) and LV are not significantly different from each other. However, the fruit weight of the LV (23.98±1.09) was significantly higher than the rest genotypes (Table 2).

Table 2: Growth and yield performance of different genotypes of tomatoes cultivated through vine cutting in hydroponics system

Genotypes	% Survival	DTNSF	NNS2	NNS3	NNS4	DT50%F	NOF	FW
SM	77.08a	10.50a	2.83b	5.75b	11.25c	38.75a	5.17ab	17.33b
Roma	77.08a	10.58a	3.08b	6.42ab	12.50ab	38.25a	5.75a	19.68b
RCL	81.25a	9.17b	3.67a	7.00a	13.57a	39.33a	5.83a	8.52c
LV	79.17a	10.75a	2.67b	6.25b	11.83bc	36.25b	4.08b	23.98a
LSD(0.05)	16.64	0.79	0.58	0.73	0.88	1.52	1.18	3.13
SE	5.79	0.27	0.2	0.26	0.31	0.53	0.41	1.09

Means with same letter down the group are not significantly different from each other at 5 % level of significance. SE: Standard error, LSD: Least significant differences, SM: San marzano, RCL: Red cherry large, LV: local variety. DTNSF: Days to new shoot formation, NNS2: Number of new shoot at 2 weeks, NNS3: Number of new shoot at 3 weeks,NNS4: Number of new shoot at 4 weeks, DT50%F: Days to 50% flowering, NOF: Number of fruits and FW: Fruit weight.

The results obtained on the effect of plant age on the growth and yield of tomato varieties grown in hydroponics system is presented in Table 3. The result showed that the percentage of vine survival was highest for the ones cut at one month old of plant growth (93.75±5.02) which was significantly higher than the ones cut at two (78.13±5.02) and three (64.06±0.52) months old plants respectively. However, the number of days taken to form new shoots by the plants was lowest from the two months old plants (8.81±0.24) before cutting, and it was significantly lower than the plants cut at one month (10.75±0.24) and three months (11.19±0.24) old plants respectively.

The number of new shoots formed by the plants at 4 weeks' old was highest from the vines cut from the two months old plants (13.75±0.27) which was not significantly higher than the vines cut from the one month old plants (13.19±0.27), but they were both significantly higher than the vines cut from the three months old plants (9.63±0.27). Also, the number of days taken by the cut vines to form 50 % flowering was lowest in the vines cut at 3 months old (34.31±0.46) and it was significantly lower than the rest age periods. The number of fruits produced by the cut vines was highest from the two months old plants (5.81±0.36) which was not significantly different from the vines cut from the one month old plants (5.63±0.36), but they were both significantly higher than the number of fruits produced from the cut vines from the three months old plants (4.19±0.36). However, the weight of the fruits obtained from the one-month old cut vines (20.01±0.94) which was significantly higher than the vines cut from the two and three months old plants.

Table 3: Effect of plant age on the growth and yield parameters of tomato varieties grown in hydroponics system

Age (month)	% Survival	DTNSF	NNS2	NNS3	NNS4	DT50%F	NOF	FW
One	93.75a	10.75a	3.69a	7.56a	13.19a	38.88b	5.63a	20.01a
Two	78.13b	8.81b	3.56a	7.19a	13.75a	41.25a	5.81a	16.13b
Three	64.06b	11.19a	1.94b	4.31b	9.63b	34.31c	4.19b	15.99b
LSD(0.05)	14.41	0.68	0.5	0.64	0.76	1.32	1.02	2.71
SE	5.02	0.24	0.18	0.22	0.27	0.46	0.36	0.94

Means with same letter down the group are not significantly different from each other at 5 % level of significance. SE: Standard error, LSD: Least significant differences, SM: San marzano, RCL: Red cherry large, LV: local variety. DTNSF: Days to new shoot formation, NNS2: Number of new shoot at 2 weeks, NNS3: Number of new shoot at 3 weeks, NNS4: Number of new shoot at 4 weeks, DT50%F: Days to 50% flowering, NOF: Number of fruits and FW: Fruit weight.

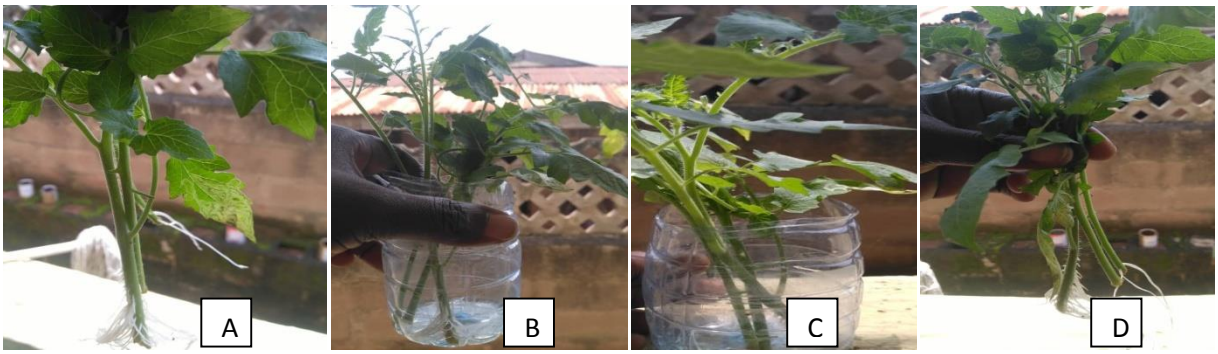

Figure 1: A: Red Cherry large vine rooting, B: Local variety vine rooting, C: Roma tomato vine rooting and D: San Marzano tomato vine rooting at 7 days after cutting from mother plant

Tomato is one of the most cultivated and consumed vegetable in the World (Fernandes *et al*., 2002). This has led to the development of various varieties to adapt to different environmental conditions by creating a broader genetic base (Bai and Lindhout, 2007). However, the intentional and periodic breeding approach in creating a new and improved variety comes with its own cost effect of the producers and consumers. Due to the importance of tomato in our daily food, all year-round production of tomato is of great importance and these places a competitive demand on the improved tomato seeds for planting, thereby increasing the cost of purchasing the seeds by farmers (Cardozo *et al*., 2018). Hence, the cultivation of acquired tomato seeds should be well optimized.

Different varieties perform differently due to the differences in their genetic makeup. In this study, there were above 70 % survive in the vine cut from the genotypes; however, the RCL had the highest survival. This finding is surprising as there is dearth of information on the cultivation of cherry tomato in Nigeria, and relevant information regarding its cultivation has been in Europe and South America (Miccolis *et al*., 2007). This shows that the Cherry tomato can adapt favorably in Nigeria. The production of new shoot shows that the cut vines has fully developed root system, which is being used to obtain nutrients from the system for its continual growth (Voogt, 1993). In this study, all the varieties evaluated developed new shoots within 10 days' interval, and the highest number of new shoot formation from cherry shows how fast it adapted to Nigerian climate.

The number of fruits produced by the varieties showed that the three exotic varieties of San Marzano, Red Cherry Large and Roma produced higher number of fruits compared to the Nigerian local variety, however, the fruit size of the Nigerian local variety was higher than them. This shows a high degree of adaptation by the local variety. Also, it took a shorter time to flower. Apart from Roma and san Marzano, the RCL was actually bred to be small in size and the fruit being eaten directly as vegetable (Major and Salesh, 2017).

On the optimum period (age of tomato plant) to cut the vines, this study has shown that the highest plant recovery will be attained at one month of the plants growth, which decreases in the survival percentage as the plants gets older. Although, the 78 % success obtained at 2 months old before cutting is also good. This shows that the plants are highly totipotent at the younger stage of their life cycle and loses it gradually as they grow older (Cassells and Gahan, 2006). This active growth reflected in the high fruit weight obtained from the cut vines at one month old. However, short time taken by the cut vines at 3 months old showed that the plants has reached full physiological maturity at the point the vines were cut as some plants had developed fruit already.

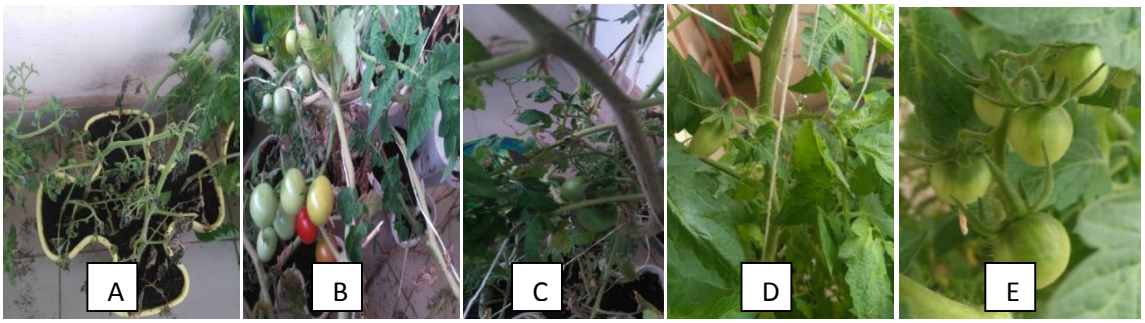

Figure 2: A: Cut vines of cherry large tomato at 4 days after cutting, B: Cherry large tomato fruit development, C: Roma tomato fruit development, D: San Marzano tomato fruit development and E: Local variety tomato fruit development.

4. Conclusion

From this study, it can be concluded that though the local variety gave the highest fruit size, the exotic varieties had also shown high adaptability to Nigerian climatic condition. However, the best time to cut the vines will be at 1 month old; however, cutting at 2 months old is still profitable, as more vines has developed to be cut at then.

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