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Growth, Yield and Quality of Tomato (*Lycopersicon esculentum*) Cultivars through Stem Cuttings on Coco Substrate under Greenhouse Condition

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Abstract *— Two weeks old rooted cuttings of three commercial hybrid varieties; Triple plus, Temptation and Campairo were grown on cocopit substrate media with five replications on randomized complete block desigh (RCBD) in greenhouse condition at Mendel School Research Farm,Hwacheon. Transplanting was done on June 9, 2013 with spacing of 30 cm between plant and 45 cm between rows. Plants were trained as single stem and harvesting of the fruits were done upto 2.5 meter height. The major objective of this experiment was to evaluate their performance on stem cuttings. On the basis of overall characteristics, Triple plus showed superior performance; early flowering, higher plant uniformity, vigorous plant, higher leaf density, less powdery mildew infection, distinct stem pubescence, earlier fruit set, bigger size of fruits with thicker flesh, higher yield of fruits in tons per hectare and per plant, as compared to other cultivars has been selected and recommended for commercial cultivation through stem cuttings. It was followed by Temptation. Beside this, stem cuttings is an alternative planting materials in all the tested cultivars where apical branches during pruning could be used as alternative planting materials for tomato cultivation.*

Keywords— fruit yield, hybrid varieties, performance, RCBD, stem cutting.

I. INTRODUCTION

Tomato (*Lycopersicon esculentum* L.) is important most consumed vegetable crops in the world where it is the second most important vegetable crop after potato (Panthee and Chen 2010). It belongs to solanaceae family. Korea is also the largest supplier of fresh tomato in Japanese market. It is fast emerging vegetable and cash crop in Korea. The estimated tomato production area was 6,144 hawith the total production of 408,170 ton (MFAFF, 2008). Tomato production is in increasing order and most of the exporting tomatoes are from green house where major cultivating cultivars are exotic hybrid cultivars.

Hybrid cultivar consists of first generation (F1) progenies from a crossed produced through controlling the pollination between two inbred lines. Hybrid cultivar exploits the phenomenon of hybrid vigor or heterosis. Hybrid seed is used for the commercial production of a number of crops. Commercial hybrids in a number of crops like maize, sorghum, pearl millet, cotton, rice etc. have been revolutionized the crop breeding programs (Melchninger, 1993; Messmer *et al*., 1995).

Most of the commercially grown cultivars are hybrid and seeds are quite expensive. Generally plants are trained as single stem and most of the axillary branches are frequently removed. As these axillary branches produce roots easily and becomes ready within 7-10 days for transplanting, may become as an alternative planting materials if performs better where commercial tomato cultivation is done widely in Korea. Today, in many countries, soilless culture techniques are used for production especially in greenhouses (Celikel, 1999). Most of the tomato growers in green house are using soilless culture i.e. cocopit or rockwool as growing substrate for tomato production where rockwool is not biodegradable, inorganic and non-renewable resource (Allaire *et al*., 2005), andsynthetic material derived from Molton Rock which impact on environment (Carbon Emissions as well as Disposal in particular) is increasingly being challenged but

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cocopit is an organic and renewable resource (Mohamad and Manisah, 2007). Plants are supplied water and nutrient solution is provided through drip (spikelet) system where sometime, plants died due to spikelets blockage and lack of water. It is commonly happening and farmers need to replant as early as possible where preparing seedlings take place 15 days longer than rooted stem cuttings. Propagation by cutting is inexpensive, rapid and simple and does not require the special technique necessary in grafting , budding or micro-propagation (Heartman 1993). But performance of rooted stem cuttings is not yet studied with these commercial varieties because there may have been varietal response. According to Thompson and Kelly (1957) soil and weather can not bring the plant higher yield than is bound up in the capabilities of planted seed. The advantage of vegetative propatation is readily apparent. Heterozygous material may be perpetuated without alteration (Janic Jules, 1979).

Therefore careful selection of good planting material is one of the most important factors of growing crop. Cultivars; Triple plus, Temptation and Campairo are widely grown hybrid tomato cultivars in Korea and these were introduced from Europe. All of these cultivars are indeterminate in growth habit but varies in yield, growth, fruit size and pre and post-harvest quality characters. Therefore, this study was carried out to find out superior cultivars propagating through rooted stem cuttings for commercial production of tomatoes in greenhouse.

II. MATERIALS AND METHODS

Two weeks old rooted stem cuttings of three commercial hybrid varieties; Triple plus, Temptation and Campairowere grown on cocopit substrate media with five replications on randomized complete block desigh (RCBD) in greenhouse condition at Mendel School Research Farm, Hwacheon. Seedlings of these three cultivars were transplanted in April last week that is the normal season of transplanting time in green house condition, and these have pruning time after one month. Auxillary branches (stem cuttings) were collected from these seedlings during pruning as planting materials in this experiment. Stem cuttings were sown on moist sand with attaching commercial rootex powder at rooting part. Transplanting of these rooted stem cuttings was done on June 9, 2013 with spacing of 30 cm between plant and 45 cm between rows. Drip irrigation was used for supplying water and nutrients. Average temperature of day night was 28^0 and 20^0 C respectively. Irrigation, nutrient supply, pest and disease control, training, pruning and all other cultural practices were similar to all treatments. Some physic-chemical properties of the media are shown in Table 3.1 which was analyzed before planting. Bulk density (BD), porosity and water holding capacity of substrates were calculated according to the methods described by Verdonck and Gabriels (1992). Plants were trained as single stem and harvesting of the fruits were done upto 2.5 meter height. Data were collected on its vegetative characters; plant height, plant vigor, number of leaves, reproductive characters; number days to flowering, number of flowers per truss, number of fruits set per truss, yield characters; number of fruits per plant, weight of fruits per plant, fruit keeping quality characters; weight loss percent 20 and 40 days after harvest. Fruit characteristics were calculated from individual ten fruits per treatments. Individual fruit was weighted by digital balance and total soluble solid percent (TSS) was measured by a hand held refractometer (Agro, Japan), and fruit length, fruit width and pericarp thickness was measured by vernier calipers. Data were analyzed with MSTATC program and comparison of means was determined by Duncan system. The major objective of this experiment was to evaluate their performance on stem cuttings.

Table.1: Physical properties of the growing substrates before planting the tomato (Lycopersicon esculentum Mill).

Substrates	BD ($g.cm^3$)	pH	EC ($ds.m^{-1}$)	Porosity (%)	WHC (%)
Cocopit	0.16	6.6	2.7	58.0	90.5
Rockwool	0.08	6.8	2	92	52.5

BD, Bulk density; EC, electrical conductivity; WHC, water holding capacity

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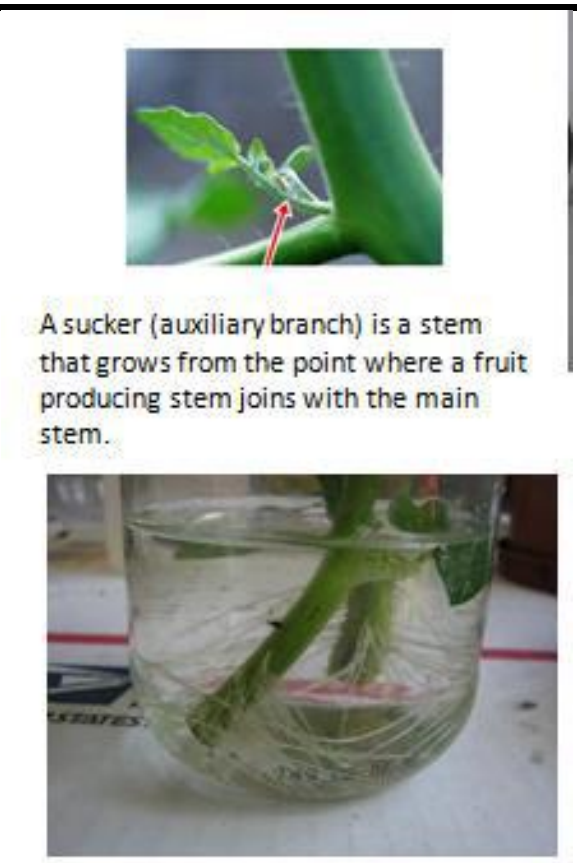

Fig.1: Stem cuttings give roots very fast

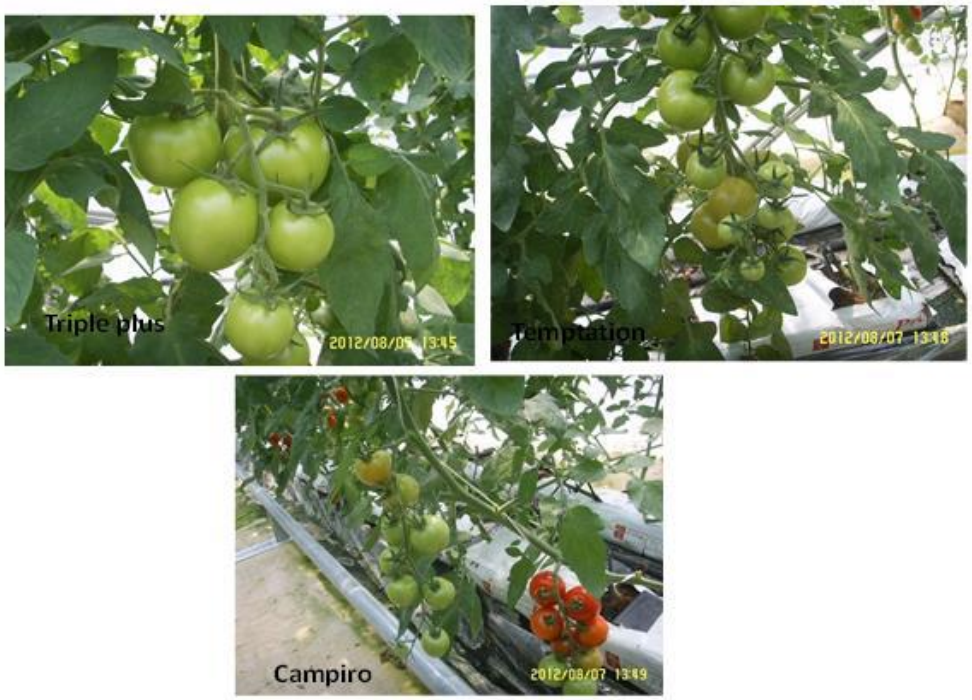

Fig.2: F1 hybrid commercial varieties

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III. RESULTS AND DISCUSSION

Vegetative and flowering parameter

Significant variation among the three cultivars; Triple plus, Temptation and Campairo were noticed on plant uniformity, foliage density, total number of leaves, stem pubescent, inter node length and response to powdery mildew disease. But not significant differences on number of nodes to first truss, plant height and plant vigor. In Triple Plus; plant uniformity (6.7), foliage density (10), stem pubescence (6.7), plant vigor (9.4), and inter node length (10.6 cm) was higher as compared to other cultivars. Beside this it was least affected by the infection of powdery mildew disease (6.0) whereas in Campairo ; plant uniformity (5.7), foliage density (7.3), number of nodes to first truss (6.0), stem pubescence (5.7) and plant vigor (9.1) was least. But these parameters in Temptation were recorded in between (Table 3). The faster growth of plants on cocopit should be due to improved rooting media that was also mentioned in www.dutchplantain.com.

Table.2: Vegetative characteristics of three commercial hybrid tomato cultivars

Cultivar	Plantt uniformity	Foliage Density	node to 1st truss (#)	Powdery mildew	Tot. leaf (#)
Triple plus	6.7 a	10a	7.5	6 b	14.2 b
Temptation	6 ab	7.7 b	6.3	6.7 b	18.5 a
Campairo	5.7 b	7.3 b	6	8b	17 a
CV%	5.4	6.9	12.1	7.6	3.8
F-test	*	**	ns	*	**

Table.3: Vegetative characteristics of commercial hybrid tomato cultivars

Cultivar	Plant ht. 54DAP (cm)	Stem pubescense	Plant vigor	Internode (cm)
Triple plus	197.2	6.7 a	9.4	10.6
Temptation	197.5	6 ab	9.1	7.7
Campairo	199.5	5.7 b	9.1	9.7
CV%	3.8	5.4	4.9	9.4
F-test	Ns	*	ns	*

Flowering and Fruit set parameter

No significant difference observed among the cultivars on days to; flowering, fruit setting, second inflorescence appearance and fruit set percent in second truss. However, number of flowers in second truss, fruit set number and percent in in second truss and days to fruit maturity was significantly different among the cultivars (Table 4). Temptation gave early flowering (13 days after planting (DAP)) followed by Triple plus (13.5 DAP) but fruit set was earliest (21 DAP) in Triple plus followed by Temptation (22.5 DAP). However, second inflorescence was appeared earliest (20.3 DAP) in Campairo followed by Temptation (21 DAP). Likewise, number of flowers in second truss (9.8) was significantly higher in Campairo and Temptation (9.0) as compared to Triple plus (6.0). Similarly, number of fruit set in second truss was significantly higher in Temptation (7.9) and Campairo (7.8) as compared to Triple plus (4.7). Similarly, highest fruit set percentage was calculated in Temptation (86.5) followed by Campairo (79.3). As far as fruit maturity is concerned, matured fruits were harvested significantly earliest (56 and 56.7 DAP) in Campairo and Temptation respectively as compared to Triple plus (62.3 DAP) (Table 4).

Table.4: Flowering and fruit setting behavior of commercial hybrid tomato cultivars

Cultivar	Flowering DAP	Fruit set DAP	2nd inflorescense DAP	Flowers no. second truss	Fruit set (no.) 2nd truss	Fruit set (%)	Matured fruit (DAP)
Triple plus	13.3	21.8	23	6 b	4.7 b	78.7	62.3 a

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Temptation	13	22.7	21	9 a	7.9 a	86.5	56.7 b
Campairo	14.3	23.5	20.3	9.8a	7.8 a	79.3	56 b
CV%	4.9	9.8	9.1	6.8	14.9	13.9	20.2
F-test	ns	ns	Ns	**	*	ns	**

Fruit yield parameter

Effect of variety was significant on yield attributing characters; total number of truss, total number of fruits, fruit yield per plant, marketable fruit yield and marketable fruit percentage. But, difference between Temptation and Campairo on the above parameter was not significant. As plant was cut after 2.5 meter height, total number of truss (5.8), total number of fruits per plant (27.3) and marketable fruit percent was significantly lower in Triple plus as compared to other rest varieties. Hence, it showed that as the number of fruit set in second cluster increased, total number of fruits per plant was also increased.. (Table 5).

Table.5: Yield characteristics of commercial hybrid tomato cultivars

Cultivar	Tot. truss (#)	Tot.fruits (#)	yield (g/plant)	Marketable (%)	Marketable Yield (g/plant)
Triple plus	5.8 b	27.3 b	3320.2 a	82.8 b	2753.9 a
Temptation	7a	51 a	1896.2 b	82.9 b	1577.5 b
Campairo	7a	54.2 a	1895 b	93.4 a	1768.8 b
CV%	5.2	10.5	16.4	4.22	18.6
F-test	*	**	*	*	*

Fruit characters and keeping quality parameter

Difference between cultivars was significant on most of the fruit parameter. Even though Temptation and Campairo are not significantly different on most of the fruit parameter; average weight, size measurement, flesh thickness, number of locules and brix reading, Triple Plus had significantly higher average fruit weight (144.3gm), longer fruit length (6.1cm), width (6.4cm), perimeter (21.1cm), flesh thickness (0.85cm), number of locules (4.1) and lower brix (4.5) reading (Table 6) as compared to Temptation and Campairo. As far as yield is concerned, eventhoug Triple plus had significantly less number of trusses (5.8) and total number of fruits (27.3) per plant, total yield per plant (3320.2 g), marketable yield (2753.9g) per plant was higher due to big size of fruits (Table 5). Shrestha and Sah (2014) had also found significant variation among the tested cultivars in central region, Nepa.

Table.6: Fruit characteristics of commercial hybrid tomato cultivars

Cultivar	fruit wt. 67DAP (g)	Fruit Length (cm)	Width (cm)	Perimeter (cm)	Brix	Felshthickness (cm)	Locule (#)
Triple plus	144.3 a	6.13 a	6.42 a	21.1 a	4.52 b	0.85 a	4.1 a
Temptation	51.5 b	4.1 b	4.82 b	15 b	5.53 a	0.57 b	2.5 b
Campairo	44.3 b	4.01 b	4.28 b	14.28 b	5.53 a	0.58 b	2.3 b
CV%	6.4	1.7	8.19	1.94	4.7	5.53	7.33
F-test	**	**	**	**	*	**	**

The lowest TSS content (4.52 Brix) was recorded in Triple plus, that was reflected on its taste where Temptation and Campairo had good taste. Fruits of Triple plus was green color in immature stage and deep red in matured stage had least number of seeds in the fruit (73). Tomato fruits after 20 and 40 days keeping at room temperature, weight loss percent was higher in Triple plus followed by Campairo (Fig. 3) and least were in Temptation. Likewise, shrinkage on fruit skin was not visible and distinct among these varieties up to 20 days keeping but rotten spots was distinct in Triple plus. But, after 40 days, shrinkage and rotten spot was least recorded in Temptation as compared to other cultivars (Fig 4).

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Table.7: Fruit and keeping quality characteristics of commercial hybrid tomato cultivars

Cultivar	Imature fruit color	Fruit shoulder	Fruit shape	Fruit color	Taste	Seed/fruit (#)
Triple plus	Green	Fair	Oval	Deep red	Fair	0.85 a
Temptation	Light green	None	Globose	Blood red	Good	0.57 b
Campairo	Light green	None	Globose	Deep red	Very good	0.58 b

Fig. 3. Weight loss (%) during storage

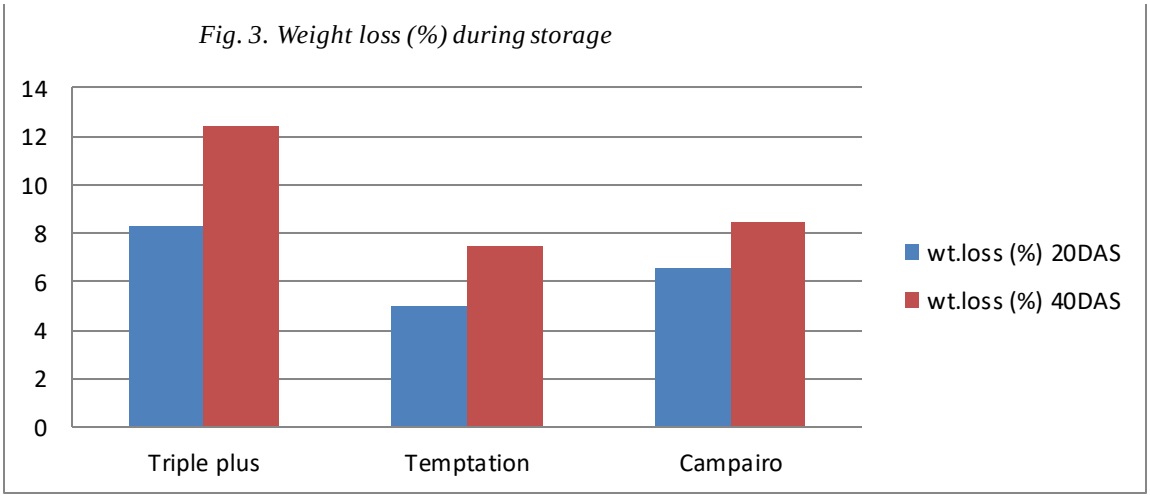

Fig. 4. Shrinkage and rotten spot during storage

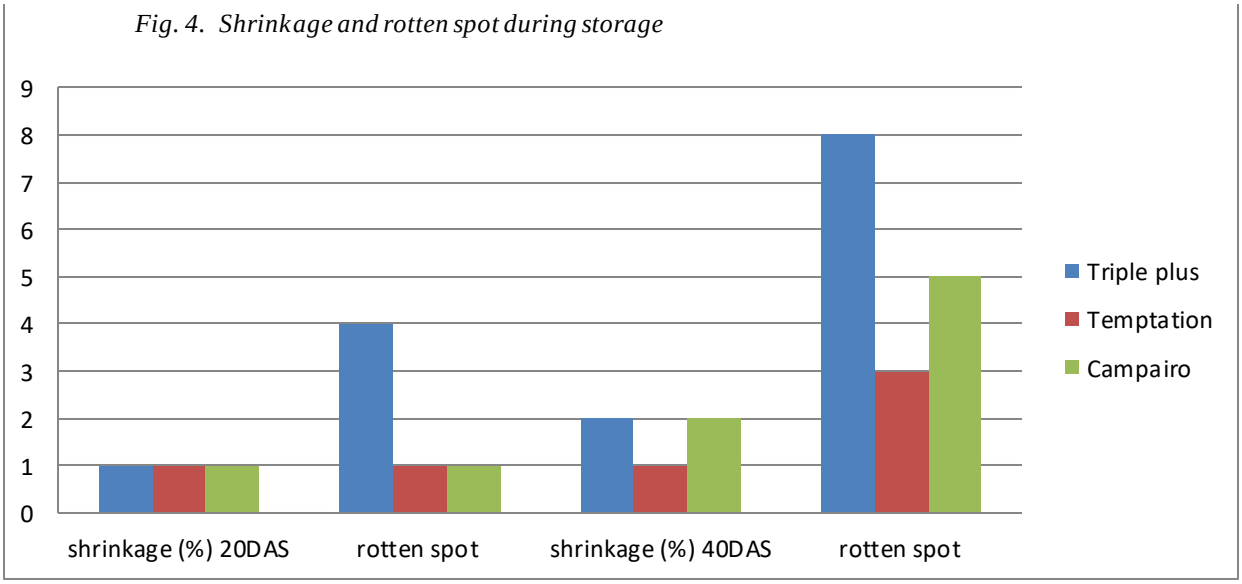

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Fig. 5. Rotting and shrinkage status of 3 cultivars after 20 days & 40 days storage at room temperature

IV. CONCLUSION AND RECOMMENDATION

- On the basis of overall characteristics, Triple plus showed superior performance; early flowering, higher plant uniformity, vigorous plant, higher leaf density, less powdery mildew infection, distinct stem pubescence, earlier fruit set, bigger size of fruits with thicker flesh, lesser number of seeds, higher yield of fruits in tons per hectare and per plant, as compared to other cultivars followed by Temptation.
- Suckers (stem cuttings) which are wasting materials could be used as propagating materials for subsequent tomato cultivation and gap filling.
- Stem cuttings planting enhance the early flowering and fruiting.

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