PERFORMANCE OF COMMERCIAL HYBRID TOMATO CULTIVARS IN COCOPIT AND ROCKWOOL SUBSTRATE MEDIA IN GREEN HOUSE CONDITION

Surendra Lal Shrestha[1] and Won-Hee Kang[2]

[1] Senior Scientist, Horticulture Research Division, NARC, Khumaltar

e-mail: shsurendra@hotmail.com

[2] Professor, Kangwon National University, Republic of Korea

ABSTRACT

Three weeks old seedlings of four commercial hybrid tomato cultivars; Adhoration, Anamay, Bay and Temptation were grown on cocopit and rockwool media with five replications on split plot design as substrate main plot and cultivars subplot in green house condition at Hwacheon, South Korea. Transplanting was done on June 21, 2012 with spacing of 30 cm between plant and 45 cm between rows. Nutrients and water was supplied through drip irrigation. Plants were trained as single stem and fruits harvested up to two meter height. The major objective of this experiment was to evaluate the potentiality of cocopit substrate and find out the most suitable cultivar for commercially growing. Result showed that plants grown on cocopit were vigorous, lesser number of leaves below first truss, higher average weight of fruit and bigger size as compared to rockwool substrate, and effect of cultivars was significant on days to flowering, plant vigor, plant height, number of leaves, internode length, number of flowers and fruits on second truss, days to maturity, powdery mildew disease, fruit characteristics and yield. However, no any interaction effect between substrate and cultivars was observed. Hence, cocopit which is organic and renewable substrate and yield at par to rockwool can replace rockwool. On the basis of overall characteristics, Bay showed superior performance and selected for commercial cultivation.

Key words: *Biodegradable, hybrid cultivar, keeping quality, water holding capacity, yield*

Introduction

Tomato (Lycopersicon esculentum L.) belongs to solanaceous family. It is one of the most consumed vegetables in the world where it is the second most important vegetable crop after potato (Panthee and Chen, 2010). 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).

Today, in many countries, soilless culture techniques are used for production especially in greenhouses (Celikel, 1999). Since soilless culture is increasing for growing different vegetable crops, researchers had used to explore various media; i.e. Fasella and Zizo (2005) evaluated perlite, perlite mixed with coirdust in cut flower production, Tehranifar et al. (2007) compared peat and cocopit, sand and perlite on straw berry production, Djedidi et al. (1997) used perlite and zeolite mixture on tomato. Issa et al. (1997) used perlite and zeolite in different ratio on Gerbera cultivation, Inden and Torres (2004) studied perlite and rice hull on tomato production, Djedidi et al. (1997) studied the performance of rockwool, perlite and mixture of perlite and zeolite, Samiei et al. (2005) investigated the effect of peat moss, cocopit and date palm waste substrate on Aglonema. But comparative study between cocopit and rockwool substrates for tomato cultivation is not yet done.

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 challengedbut cocopit is an organic and renewable resource (Mohamad and Manisah, 2007). Some practical downsides to rock wool products for hydroponic systems is that leaching of non-desirable elements can occur if not properly managed by the professional grower, this is something that coir does not suffer from. The other downside to rockwool is that it is an irritant and requires careful handling by growers and their staff; no such precaution is needed with cocopit. Rockwool often have an extra cost to the grower to dispose.

The properties of growing substrates exhibit direct and indirect effect on plant physiology and production (Cantliffe et al., 2001). The physical properties of growing substrates concern with aeration, drainage and water retention capacity (Balanc, 1987; Cabrera, 2003; Lamaire et al., 1989). Hence, these growing substrates; cocopit and rockwool should have influence on the yield and quality of tomato cultivars. Therefore, comparative study need to be carried out to know the influence of these growing substrates on yield potential and quality attributes of tomato cultivars. Cultivars; Bay, Temptation, Annamay and Adhoration 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 and growing substrate for commercial production of tomatoes in greenhouse.

Materials and Methods

Three weeks old seedlings of four commercial hybrid varieties; Bay, Temptation, Annamay and Adhoration were grown on rockwool and cocopit substrate media with five replications on randomized complete block design (RCBD) in greenhouse condition at Deep sea water research farm at Hwacheon. The size of cocopit mat and rockwool mat was 105x20x10 cm dimensions that were appropriate for 3 plants. Transplanting was done on June 21, 2012 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 280 and 200 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 meter height. Some characteristics of fruits include total soluble solid (TSS), titratable acid content and vitamin C content were measure. 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 30 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. Datawere analyzed with MSTATC program and comparison of means was determined by Duncan system. The major objective of this experiment was to evaluate the potentiality of cocopit substrate and find out the most suitable cultivar for commercially growing.

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

Substrates	BD (g.cm3)	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

Results and Discussion

Effect of Growing Substrates

Vegetative and flowering parameter

Effect of growing substrates was significant on number of leaves below first truss, plant uniformity, plant vigor, plant height, number of leaves, internode length, and number of flowers on second truss. However, there was no any interaction between substrates and cultivars. Tomato plants grown on rockwool substrate had higher number of leaves below first truss, more uniform, more vigorous and higher total number of leaves but plants grown on cocopit substrate was taller and had longer internode length (Table 3.2). The faster growth of the cultivars on cocopit should be due to improved rooting, that was also mentioned in www.dutchplantain.com. There was no any difference between rockwool and cocopit on days to flowering, maturity and foliage density.

Fruit parameter

Effect of growing substrates on fruit parameter was mostly i.e. average weight of fruit, fruit width, perimeter, flesh thickness, total soluble solid content, number of trusses and yield per plant was not significant except fruit length and number of fruits per plant. This result is also supported by the study of Ghehsarehet al. (2011) who did not find any significant difference among the substrates he tested. Likewise, interaction between growing substrate and cultivar was not significant on average weight of fruit, fruit length, width, flesh thickness, number of trusses, number of fruits per plant and yield. However, interaction was noticed on fruit perimeter and brix (Table 3.3).

Cultivars Performance

Vegetative and flowering parameter

Cultivars were significantly different on days to flowering, plant vigor, plant height, leaves number per plant, internode length (cm), flowers and fruit set number in second truss, days to maturity and powdery mildew. However, cultivars were not different significantly on number of leaves below first truss, plant uniformity, foliage density, stem pubescence, number of sepals in a flower.Cultivar Anamay and Bay were significantly early flowering; 15.3 and 16.7 days respectively. The tallest plants were measured in Anamay (229.2 cm) followed by Bay (225.2 cm) whereas Temptation (183.2cm) was significantly shorter, but leaves number per plant was significantly higher in Temptation (24.5). Internode length (7.8cm) in Temptation was significantly shorter than other tested cultivars. Number of flowers (15) in second truss of cv. Bay was significantly higher. In addition to this, number of fruits in 2nd truss was also higher in Bay (12.3). Anamay was significantly early maturing (54.1DAP) among the cultivars whereas Temptation matured very late (60.3DAP). Adhoration was least affected by powdery mildew (Table 3.2).

Table 2. Analysis of variance (ANOVA) on effect of growing substrates on growth parameter of tomato (Lycopersicon esculentum Mill.) cultivars.

Source	Days to flowering	Leaves below 1st truss (#)	Plant uniformity (1-10)	Plant vigor	Plant height	Leaves (#)	Foliage density
Substrates (S)	ns	*	*	*	**	**	Ns
Cultivars (C)	**	ns	ns	*	**	*	Ns
S x C	ns	ns	ns	ns		ns	Ns
Substrates (S)							
Cocopeat	17.9	6.8	9.1	9.0	219.7	21.6	7.7
Rockwool	17.1	7.1	9.7	9.6	207.5	25.1	7.9
Cultivars							
Adhoration	18.3b	6.8	9.0	8.9b	216.8b	23.0b	7.5
Anamay	15.3c	6.1	9.4	9.7a	229.2a	23.1b	7.8
Bay	16.7c	7.1	9.8	9.7a	225.2ab	22.7b	8.5
Temptation	19.9a	7.8	9.5	8.9b	183.2c	24.5a	7.4

Plant uniformity: 1-very poor, 10-excellent

Fruit parameter and keeping qualtiy

Majority of the fruits in Bay and Temptation had three locules. Difference between cultivars was significant on most of the fruit parameter; average weight of fruit, fruit width, perimeter, brix, flesh thickness, number of trusses per plant and yield per plant except fruit length. Shrestha and Sah (2014) had also found significant variation among the tested cultivars at central region, Nepal. The highest average weight of the fruit (47.3g) was obtained in Temptation followed by Bay (44.7g) whereas the Anamay had the least weight (36.4g).

Table 3. Analysis of variance (ANOVA) on effect of growing substrates on growth parameter of tomato (Lycopersicon esculentum Mill.) cultivars.

Source	Stem pubesence	Sepal (#)	Locules (#)	Internode (cm)	Flowers no. in 2nd truss	Fruits no. in 2nd truss	Days to maturity	Powdery mildew[z]
Substrates (S)	ns	ns	ns	**	*	ns	ns	**
Cultivars (C)	ns	ns	**	**	**	**	**	**
S x C							ns	ns
Substrates (S)								
Cocopeat	7.8	5.2	2.3	9.3	12.3	11.2	57.8	6.0
Rockwool	7.7	5.4	2.5	8.3	12.4	12.3	57.6	5.1
Cultivars								
Adhoration	7.9	5.3	2.2b	9.2a	13.0b	12.2ab	58.6b	3.8c
Anamay	7.4	5.1	2.1b	8.9a	12.9b	10.2c	54.1d	5.8b
Bay	7.6	5.4	2.6a	9.3a	15.0a	12.3a	57.8c	5.8b
Temptation	8.2	5.4	2.6a	7.8b	12.3b	11.3bc	60.3a	7.0a

z 1: none, 9: dead

The amount of TSS in tomato juice has no significant differences in organic and inorganic substrates.Similar result was obtained by Islam et al. (2002).Ghehsareh (2011) had also mentioned thatcoco peat and perlite were sufficient substrates for growing of some plants, especially for vegetables. Thus, growers use these materials as growing media in greenhouses. Djedidi et al.(2001) observed performance of tomato cultivar on five different substrates, the tomato plants that grow in perlite and zeolite with 2:1 ratio had best distribution of fruit size, total soluble solid and sensorial quality and so highest dry matter of fruit was found in perlite substrate.

As the average size of the fruits in Anamay (36.4g) is lower, fruit length, width and perimeter is also shorter as compared to other cultivars. The longest fruit perimeter (14.5cm) was measured in Temptation followed by Bay (14.2cm). The highest total soluble solid content was recorded in Adhoration (6.0brix). Flesh thickness of Adhoration and Bay (0.67cm) was significantly thicker than other cultivars. Total number of trusses and fruits per plant was least in Temptation; 5.5 and 57.9 respectively. The highest total number of fruits per plant (69.2) was harvested in Bay followed by Adhoration (66.7). As far as harvested fruit yield is concerned, Bay gave significantly higher yield per plant (3595 g) followed by Temptation (3207gm).

Table 4. Analysis of variance (ANOVA) on effect of growing substrates on fruit yield and quality of tomato (Lycopersicon esculentum Mill.) cultivars.

Source	Av.wt. (g)	Length (cm)	Width (cm)	Perimeter (cm)	Brix	Flesh thickness (cm)	Number of trusses	Total #/ plant	Yield g/ plant
Substrates (S)	ns	*	ns	ns	Ns	ns	ns	**	ns
Cultivars (C)	**	ns	*	*	**	**	**	**	**
S x C	ns	ns	ns	*	*	ns	ns	ns	ns

Substrates (S)									
Cocopeat	43.5	3.9	4.3	14.1	5.6	.59	6.1	58.6	2711
Rockwool	40.3	3.7	4.2	13.7	5.7	.63	6.3	68.9	2856
Cultivars									
Adhoration	39.3bc	3.8a	4.3a	13.8ab	6.0a	.67a	6.0b	66.7ab	2313c
Anamay	36.4c	3.7a	4.0b	13.1b	5.8ab	.54b	6.6a	61.9a	2018c
Bay	44.7ab	3.9a	4.4a	14.2a	5.6b	.67a	6.6a	69.2a	3595a
Temptation	47.3a	3.9a	4.3a	14.5a	5.2c	.56b	5.5c	57.9d	3207b

Vitamine C content was highest in Adhoration (66mg/100ml) followed by Temptation (47.8mg/100ml). Likewise titratable acidity was also highest in Adhoration (16.6g/100ml) followed by Bay (14.1g/100ml) (Fig. 3.1). Tomato fruits after 30 days keeping at room temperature, shrinkage and rotting was higher in Temptation among the cultivars. No any rotting symptoms observed in Adhoration and Bay, however Anamay had light rotting (Fig. 3.3). Similarly, Temptation had highest weight loss percent (9.6%) after 30 days keeping at room temperature followed by Adhoration (9.3%), whereas Bay had least weight loss (8.2%). Least number of seeds (23) per fruit were counted in Adhoration followed by Bay (33).

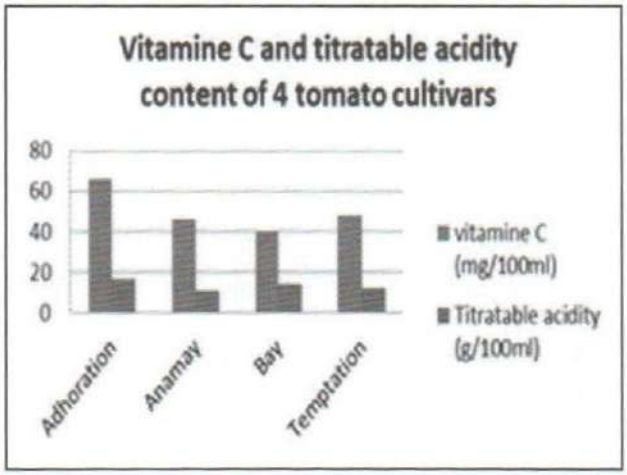

Figure 3.1. Vitamin C and titratable acidity content of four cultivars after 30 days keeping at room temperature

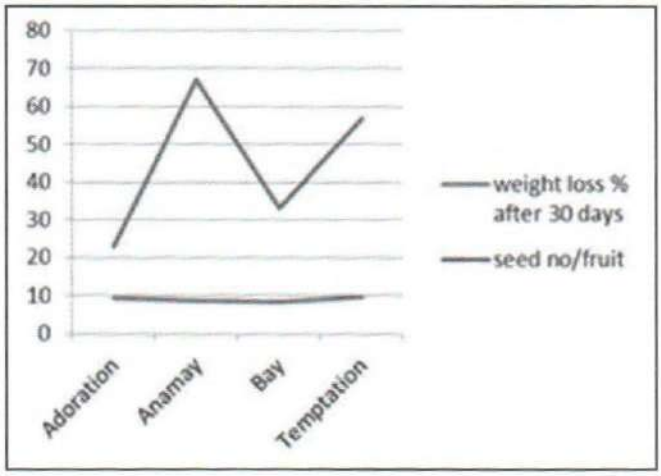

Figure 3.2. Seed content per fruit and weight loss of four tomato tomato cultivars

Conclusion

Cocopit which is organic and renewable substrate and yield at par to rockwool can replace rockwool. On the basis of overall characteristics, among the cultivars; Bay showed superior performance; early flowering, higher plant uniformity, vigorous plant, fast growth (taller plant and longer internode), more number of flowers and fruit set in second truss, medium size of fruits with thicker flesh, higher number of trusses in the same height of the plant, higher yield of fruits in number and weight, minimum weight loss as compared to other cultivars. Hence it has been selected for commercial cultivation in Hwacheon condition.

References

Allaire, S.E., J. Carnon, C. Menard and M. Dorais, 2005. Potential replacements for rockwool as growing substrate for greenhouse tomato. Can. J. Soil. Sci. 85:67-74.

Blanc, D.,1987. Soiless culture. Collective work. INRA. Paris. p. 478.

Cabrera, R.I., 2003. Fundamental of container media management. Part 1. Physical properties. The State Univ. of New Jersy Agric. Exp. Station.

Cantliffe , D., J.N. Shaw, E. Jovicich, J.C. Rodriguez, I. Secker and Z. Karchi,2001. Passive ventilated high-proof greenhouse production of vegetables in a humid mild winter climate. Acta Hort. 559:515-520.

Celikel, G., 1999. Effect of different substrates on yield and quality of tomato. Acta Hortic., 486: 353-357.

Djedidi, M., D.Grasopoulos and E. Maloupa,1997. The effect of different substrates on the quality of F. Carmello tomatoes (Lycopersiconescullentum MILL) grown under protection in a hydroponic system. Chaiers Options Mediterranean's, 31: 379 – 383.

Fascella, G. andG.V. Zizzo,2005. Effect of Growing Media on Yield and Quality of Soilless Cultivated Rose. Acta Hortic. (ISHS), 697: 133-138.

Ghehsareh, A.M., H.Borji and M. Jafarpour, 2011. Effect of some culture substrates (date-palm peat,cocopeat and perlite) on some growing indices andnutrient elements uptake in greenhouse tomato. African Journal of Microbiology Research Vol. 5(12), pp. 1437-1442

Inden, H. andA. Torres,2004. Comparison of four substrates on the growth and quality of tomatoes. Acta Hortic. (ISHS), 644:205-210.

Issa, M., E. Maloupaand D. Gerasopoulos,1997. Effects of the substrate on yield and quality of two gerbera vareteis grown under protection. Chaiers Options Mediterranean's., 31: 365 – 369.

Islam, S., S. Khan, T. Ito, T. Maruoand Y. Shinohara,2002. Characterization of the physico-chemical properties of environmentally friendly organic substrates in relation to rockwool. J. Hortic. Sci. Biotechnol., 72: 143 –148.

Lamaire, F., A. Dartigues, L.M. Rivieere and S. Charpentier,1989. Cultivation in pots and containers: Agronomic principles and application. INRA, Paris and PHM.

Ministry of Food, Agriculture, Forestry and Fisheries (MFAFF). 2008.Statistics of protected vegetables production. MFAFF, Gwacheon, Korea p.7.

Mahamud, S. and M.D. Manisah, 2007. Preliminary studies on sago waste as growing medium for tomato. Acta Hort. 742:163-168.

Messmer, M.M., A.E. Melchinger, R. Hermann and J. Boppenmaier, 1995. Relationship among early European maize inbreds. II. Comparison of pedigree and RFLP data. Crop Sci. 33:944

Melchninger, A.E., 1993. Use of RFLP markers for analysis of genetic relationships among breeding materials and prediction of hybrid performance. In: D.R. Boxton; R. Shibles; R.A. Rorsberg; B.L. Blad; K.H. Asay; G.M. Paulson and R.F. Wilson, (eds). "International Crop Science-I". Crop Science Society of America, Madison, WI.p. 621-628.

Panthee, D.R. and F. Chen, 2010. Genomics of fungal disease resistance in tomato, Curr. Genomics. 11(1):30-39.

Samiei L., A. Khalighi, M. Kafi, S. Samavatand M. Arghavani,2005. An investigation of substitution of peat moss with palm tree celluloid wastes in growing aglaonema (Aglaonema Commutatum Cv. Silver Queen). Iranian J. Agric. Sci., (in Persian). 36(2): 503-510.

Shrestha, S.L., and R.L. Sah. 2014. Evaluation of tomato cultivars for central Terai of Nepal. Academy of Science and Technology, Kathmandu, Nepal. Nepal Journal of Science and Technology Vol. 15(2):11-15

Tehranifar A., M. Poostchi, H. Arooeiand H. Nematti,2007. Effects of seven substrates on qualitative and quantitative characteristics of three strawberry cultivars under soilless culture. Acta Hortic. (ISHS), 761: 485-488.

Verdonck, O., D.Vleeschauwer andM.De Boodt, 1982. The influence of the substrate to plant growth. Acta Hortic. (ISHS), 126: 251-258. Yetisir H, Sari N, Aktas H, Karaman C, Abak K (2006). Effect of different substrates on plant growth yield and quality of watermelon grown in soilless culture. Agric. Environ. Sci., 1(2): 113-118.