ORIGINAL RESEARCH

Research on Crop Ecophysiology
Vol. 10/2, Issue 2 (2015), Pages: 113 - 122

Effect of Growing Media on the Vegetative Growth Process of F1 and F2 Tomato Varieties

ZIBA KAZEMI [1], ABOLGHASEM HASANPOOR [2*]

1- Department of Horticultural Science, Agriculture and Natural Faculty, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran

2- Iranian Plant Protection Research Institut Iran Tehran

[*] Corresponding Author Email: hasanpoor21@yahoo.com

Received:5 June 2015 Accepted: 21 June 2015

ABSTRACT

Nowadays, soilless cultivation as a modern technology for plant production with the objective of increasing quality and quantity of horticultural crops has been increasing developed. This research project was conducted to investigate the effect of perlite, cocopeat, and sand on the vegetative growth indices of tomato varieties Goldi, Santella and Vay using F1 and F2 generations. Results indicated that the highest plant total volume and weight, root wet weight and aerial parts in the second stage were obtained in 70% cocopeat + 30% perlite media for Santell F1 avariety. While the highest leaf area was obtained in 70% cocopeat + 30% perlite media for F2 Vay variety. The highest stem dimeter in the second measurement was obtained in 40% cocopeat + 40% perlite + 20% sand media for F1 Vay. Regarding some of the characteristics, only the simple effect of the tomato varieties and growing media were significant. Growing media containing more cocopeat, through providing more appropriate conditions led to better growth and development.

Keywords: Cocopeat, Santella variety, Perlite, Germination percent, Leaf area

INTRODUCTION

Tomato (*Lycopersicon esculentum* L.) fruit contains sufficient amount of carotenoid compounds, phenolic materials and high vitamin C contents and therefore has a significant nutritional value (Rao and Rao, 2003; Polenta *et al.*, 2006)

From the viewpoint of growth characteristics, fruit form and quality and also resistance to pests and diseases, tomato varieties exhibit high variabilities. Althoough tomato is a cross-prollinatod plants and its hybrid seed is very expensive, some of the farmers use seeds obtained from F_1 varieties and culture them as an open-pollinated variety that might not have a good quality (Gomez *et al.*, 2009; Olle *et al.*, 2012).

Employing the soilless system worldwide as a technology for producing crops leading to increased quality and quantity of horticultural crops, has been increasingly deployed

(Martinez and Abad, 1992). Breeding crops for soilless growing media is spreading due to numerous advantages such as better controlling of the plant nutrition, decreasing pests and diseases, increasing crop quality and quantity, better growth control and lack of dependence on soil quality (Vallance *et al.,* 2011).

The mostly used growth media are perlite, peat and cocopeat. The growing media composition should be chosen according to the plant's needs (Sajadiniya *et al.,* 2011). Cocopeat, due to better porosity compared with ordinary soil results in better growth and development of root system and consequently causes decreased ratio of shoot to root. Also its combination with other materials such as perlite or rice hull can be effective on increasing cocopeat aeration as a rooting substrate (Yan and Murphy, 2008; Awang *et al.,* 2009). Perlite as well is considered as a light, neutral, substrate with high water retention capacity, good aeration and in general it provides the appropriate growth conditions such as aeration, drainage and access to nutrients especially when combined with other substrates (Grillas *et al.,* 2001). Sand is an ordinary growing media which is devoid of nutrients and usually has a neutral reaction. Also it is not able to prevent substrate acidity modification and cathion – exchange capacity and it is the heaviest substrate for marcotting and increases the substrate aeration (Shokri *et al.,* 2014).

There are numerous reports on the effect of various growing media and their combinations on vegetative and reproductive growth of tomato (Rahimi *et al.,* 2013; Luitel *et al.,* 2012; Joseph and Muthuchamy, 2014), greenhouse grown cucumber (Bhat *et al.,* 2013) and bell pepper (Sajadiniya *et al.,* 2011). Thus, this research project was conducted with the objective of investigating the effect of various culture media like perlite, cocopeat and sand on vegetative growth indices of greenhouse-grown tomato; Goldi, Cherry and Santella variety and outdoor tomato, Vay varieties, employing F1 and F2 seeds.

MATERIALS AND METHODS

This research project was conducted in 2014 in the greenhouse of Isfahan Agricultural Research and Natural Resources Center. The experiment was conducted as a 3×6 foctorial in randomized complet block design with 4 replications. Tomato seeds of Goldi, Cherry, Santella and Vay F1 and F2 generations were sown in trays filled with 3 selected media.

Nutrient solutions as mentioned below were added to the growing media one week following appearance of the real primary leaves and then based on identifying the time of plant requirements. The employed nutrient solutions included nitrogen, phosphorous and potassium (10-50-10) at 1/1000 ratio, nitrogen nutrient solution phosphorous – potassium (12-12-36) at 1/1000 ratio, Topsin M nutrient solution at the concentration of 0.2 gr/1000, 1/1000 potassium monophosphate nutrient solution, 1/1000 calcium nitrate nutrient solution, along with 1/100 micronutrients and amino acids.

Culture media were cocopeat – perlite (30:70%), cocopeat – perlite – sand (20: 40: 40%) and cocopeat – perlite – sand (40: 30: 30%). Traits were measured once or twice at two growth stages 10 days apart. Plant height, stem diameter , leaf surface, root and shoot wet weights, total plant weight and volume (amount of translocated water, Khallili Rad *et al.,* 2010), percentage of seed germination, wet and dry weights of root and shoot at maturity were measured, Leaf area was measured employing a leaf area meter device. following complete plant growth.

Electric conductivity of the saturated extract (ECe) was assessed using the ohmmeter device model 644 and pH of beds was assessed employing the pH-meter, Model 262 (Baruah and Barthakur, 1997). Cathion – exchange capacity was evaluated using the sodium acetate method (Rhoades, 1982). Absorbable potassium assessment (Soluble and exchangeable) was done by the film photometer device (Kudsen and Peterson, 1982). Soil absorbable phosphorous was also measured by the Sherwood spectrometer model Sectra 320 at the 880 nanometer wavelength and by using the drawn standard curve it was changed to the phosphate concentration (Olsen and Sommers, 1982).

Cocopeat and Perlite used in the experiment were analysed separately (Tables 1-5).

Table 1. Composition and Chemical Characteristics of cocopeat

Fe (mg/kg)	Mn (mg/kg)	Zn (mg/kg)	Cu (mg/kg)	Mg (%)	Ca (%)	K (%)	P (%)	N (%)	pH	EC (ds/m)	Oc (%)
40	0.36	0.24	0.04	4	12.5	1.44	0.07	0.41	6.1	3.06	32.5

Table 2. Chemical composition of perlite

Na_2O	K_2O	CaO	Fe_2O_3	Al_2O_3	SiO_2
2.5-5	2-5	0.5-2	0.5-2	10-14	72-76

Table 3. Some of the perlite properties

Melting point (°C)	Hardness	Heat conduction (W/m.k)	Form	pH
1100	5.5-7	360	Spherical	7-7.02

Table 4. Physical characteristics of cocopeat and perlite media

Growing media	Cathion exchange capacity (meq/100g)	Bulk density (g/cm^3)	Humidity retension capacity (%)	Total porosity (cm^3/Cm^3)
cocopeat	120	0.15	712	0.97
perlit	0	0.32	374	0.88

Table 5. Some of the properties of sand

Porosity volume percentage (%)	EC (ds/m)	pH
24	1.05	8

Data analysis was performed employing SAS software and comparison of means was done using the Duncan test at 5% probability level.

RESULTS

Variance Analysis

Based on the results variance analysis, intraction effect of growing media and tomato varieties on leaf area, wet root weight, shoot weight, stem diameter and total plant weight in the second measurement and the total bush volume were statistically significant. For other characters, only the main effects of growing media or tomato varieties were significant. (Tables 6 and 7) .

Table 6. Results of variance analysis of the effects of growing media and variety on some of the tomato vegetative characters

Sources of variation	Degree of freedom	Mean Squares			
		Plant height in the 1st stage	Plant height in the 2nd stage	Stem diameter in the second state	Leaf area
Replication	2	2.61	16.34	0.248	1374876
Growing media	2	0.385ns	3.20ns	0.19*	331360ns
Tomato varieties	5	3.01**	20.47**	0.129*	4052898**
Growing media x Variety	10	0.169ns	0.69ns	0.06*	3127322**
Error	34	0.526	2.20	0.055	344128
Coefficient of variability	-	22	22.1	8.7	11.5

ns, * and **: non significance and significance at 0.05 and 0.01 probability levels, respectively.

Table 7. Results of variance analysis of effect of growing media and variety on some of the vegetative characters of tomato varieties

Sources of variation	Degree of freedom	Mean Squares				
		Wet root weight in the second stage	Total plant weight in the second stage	Total plant volume	Shoot wet weight in the second stage	Seed germination
Replication	2	0.0194	0.278	0.748	0.548	609.8
Growing media	2	0.10042**	0.283**	1.36ns	0.133ns	1069.2**
Tomato varieties	5	0.0427**	0.266**	0.739ns	0.103ns	547.1**
Growing media x Variety	10	0.06376**	0.916**	2.45**	0.282**	149.63ns
Error	34	0.00323	0.0444	0.469	0.075	147.1
Coefficient variation	-	7.5	7.66	19.5	14.9	14.1

ns, and **: non significance and significance at 0.01probability level, respectively.

Means Comparison

Based on comparison of means, the effect of tomato varieties on the plant height at the first and second stages of measurments was significant. The highest plant height was obtained in the first and second growth stages for F1 Santella variety (4.37 and 9.38cm, respectively) and the last values were abserved for Vay variety (2.75 and 5.4cm, respectively) (Figure 1).

The highest and lowest stem diameters were observed in 40% cocopeat + 40% perlite + 20% sand media for F1 Vay (3.02mm) and in the 70% cocopeat + 30% perlite for the F2 Santella variety (2.16mm).

Although no significant difference was found between some of the treatments (Figure 2), the highest leaf area was observed in 70% cocopeat + 30% perlite media for F2 Vay variety treatment (3065cm^2) (Figure 3).

The highest total plant weight in the second stage was observed in 70% Cocopeat + 30% Perlite media for F1 Santella and 40% cocopeat + 40% pertlite + 20% Sand in the F1 Vay variety (3.62gr and 3.57gr, respectively). The least total plant weight in the second stage was observed in 70% cocopeat + 30% perlite media for F2 Santella (2.1gr), (Table 8).

According to the obtained results, the highest and the lowest total plant volumes were observed in the 70% cocopeat + 30% perlite media for F1 Santella variety (5 mm^3), in 70% cocopeat + 30% perlite in the F2 Santella vaiety and in 30% cocopeat + 30% perlite + 40% sand media for F1 Vay variety (2mm^3) (Table 8).

The highest root and shoot wet weights in second stage was observed in the 70% cocopeat + 30% perlite media for F1 Santella variety (1. 03gr and 2.507gr, respectively), while the lowest values in the second stage was observed in the 30% cocopeat + 30% perlite + 40% Sand for F2 Goldi variety (0.487gr) and in 70% cocopeat + 30% perlite media for F2 Santella variety (1.36gr). The highest seed germination rate was observed for F1 Santella variety (97.04%) and the lowest percentage was observed for F2 Goldi variety (75.56%). Also, the highest seed germination rate was observed in 40% cocopeat + 40% perlite + 20% sand growing medium (90.74%) and the lowest rate was seen in 70% cocopeat + 30% perlite growing medium (77.04%) (Figures 4 and 5).

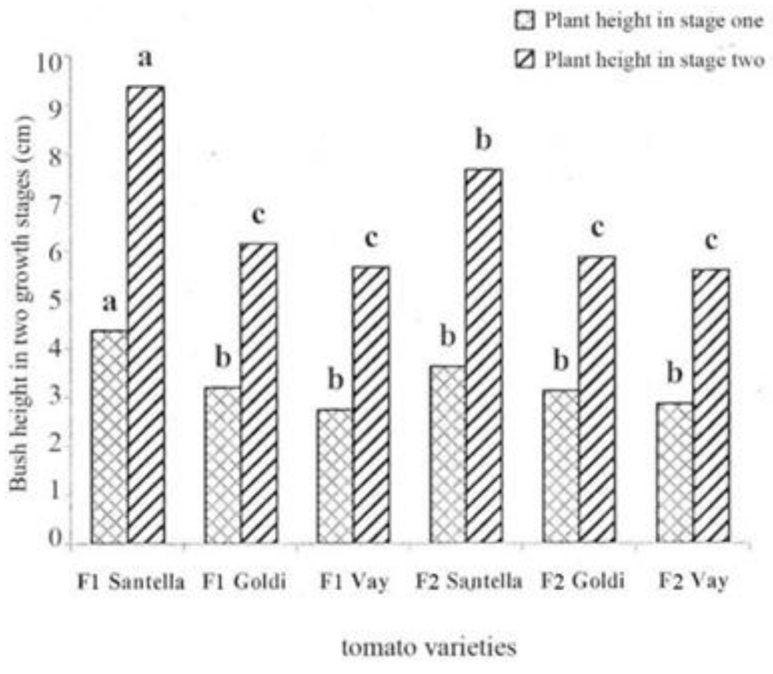

Figure 1. Effect of tomato varieties on plant height at two stages of growth. Means with at least one common letter show no significant differences at 5 percent probability level according to Duncan test

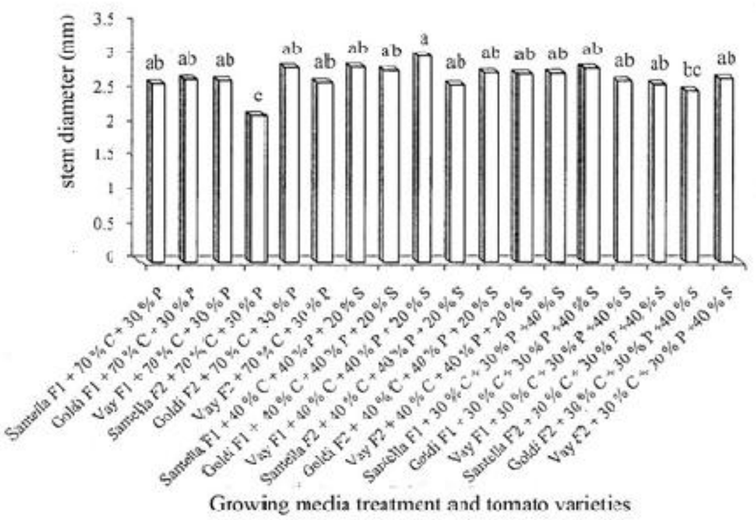

Figure 2. Comparison of intraction effects of growing media and tomato varieties on stem diameter in the second stage. Means with at least one common letter have no significant differences at 5% probability level according to Duncan test. Cocopeat (C), Perlite (P), Sand (S)

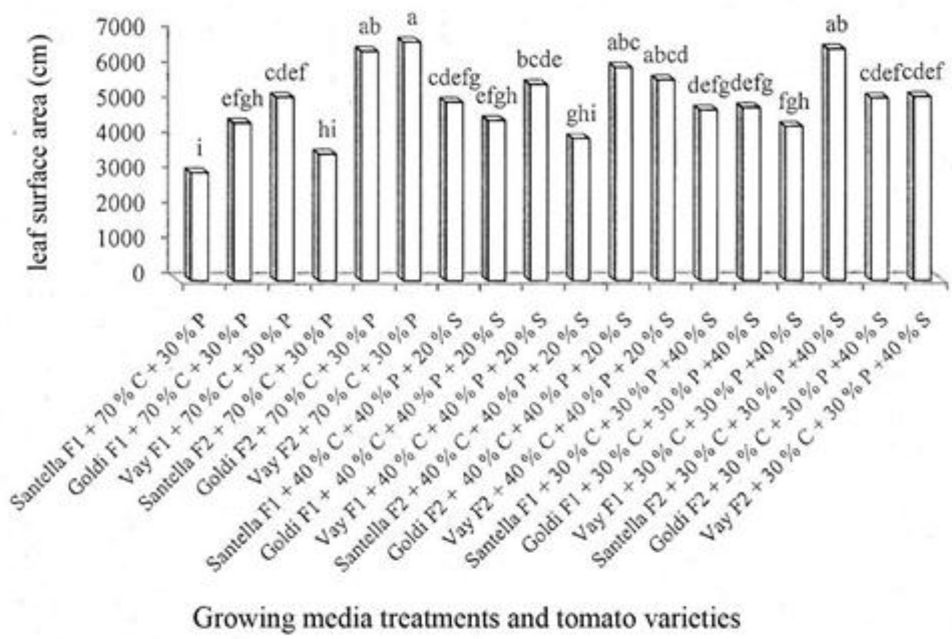

Figure 3. Comparison of interaction effects of growing media and tomato varieties on leaf area. Means with at least one common letter have no significant difference at 5% probability level according to Duncan test. Cocopeat (C), Perlite (P), Sand (S)

Table 8. Mean comparison of interaction effects of growing media and variety on some of the potato growth properties

Treatments	Root wet weight in the second stage (gr)	Total plant weight in the second stage (gr)	Total plant volume (mm^3	Shoot wet weight in the second stage (gr)
SantellaF1+70%C+30%P	1.03^{a}	3.62^{a}	5^{a}	2.507^{a}
GoldiF1+70%C + 30%P	0.747^{de}	3.01^{cd}	4^{ab}	1.937^{bcd}
VayF1+70%C+30%P	0.73^{de}	0.92^{cd}	4^{ab}	1.863^{bcde}
SantellaF2+70%C+30%P	0.687^{cfg}	2.1^{g}	2^{c}	1.36^{e}
GoldiF2+70%C+30%P	0.953^{ab}	2.84^{cde}	3.7^{ab}	1.85^{bcde}
VayF2+70%C+30%P	0.893^{bc}	2.82^{cde}	2.7^{bc}	1.733^{bcde}
SantellaF1+40%C+40%P+20%S	0.727^{de}	2.34^{fg}	4^{ab}	1.883^{bcde}
GoldiF1+40%C+40%P+20%S	0.74^{de}	2.5^{efg}	4^{ab}	1.713^{bcde}
VayF1+40%C+40%P+20%S	0.607^{fg}	2.47^{efg}	3.7^{ab}	1.92^{bcd}
SantellaF2+40%C+40%P+20%S	0.753^{de}	2.82^{cde}	3.7^{ab}	1.71^{bcde}
GoldiF2+40%C+40%P+20%S	0.607^{fg}	2.71^{def}	3.3^{b}	1.84^{bcde}
VayF2+40%C+40%P+20%S	0.897^{bc}	3.57^{a}	4^{ab}	2.213^{ab}
SantellaF1+30%C+30%P+40%S	0.603^{g}	2.3^{g}	3^{bc}	1.613^{cde}
GoldiF1+30%C+30%P+40%S	0.643^{ab}	3.39^{ab}	2.7^{bc}	1.873^{bcde}
VayF1+30%C+30%P+40%S	0.66^{efg}	2.24^{g}	2^{c}	1.413^{de}
SantellaF2+30%C+30%P+40%S	0.81^{ce}	3.19^{bc}	4^{ab}	2.07^{abc}
GoldiF2+30%C+30%P+40%S	0.487^{h}	2.27^{g}	3.7^{ab}	1.69^{bcde}
VayF2+30%C+30%P+40%S	0.713^{def}	2.42	4^{ab}	1.713^{bcde}

In each column mean with at least on common letter show no significant difference at 5% probability level according to Duncan test. Cocopeat (C), Perlite (P), Sand (S).

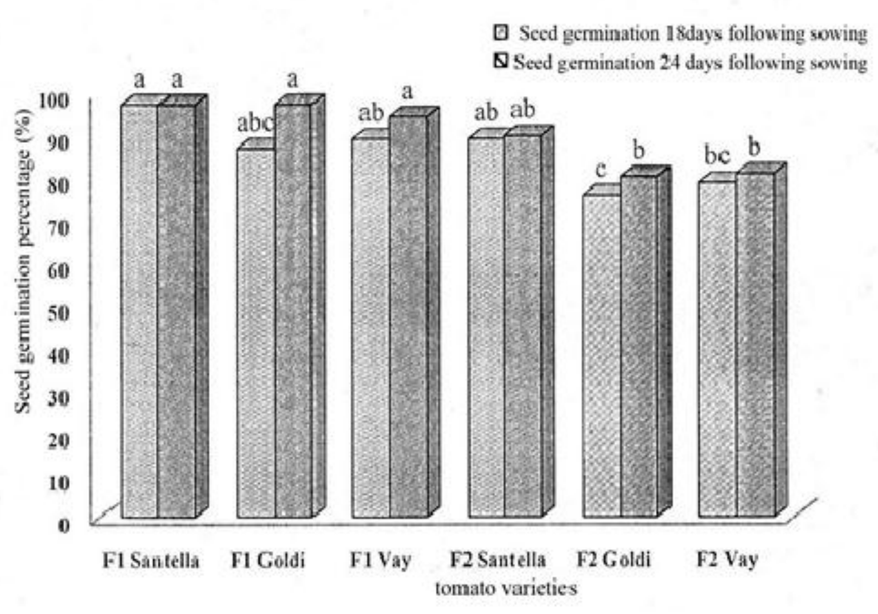

Figure 4. Comparison of main effects of tomato varieties on seed germination percentage. Means with at least one common letter show no significant difference at 5% probability level according to Duncan test.

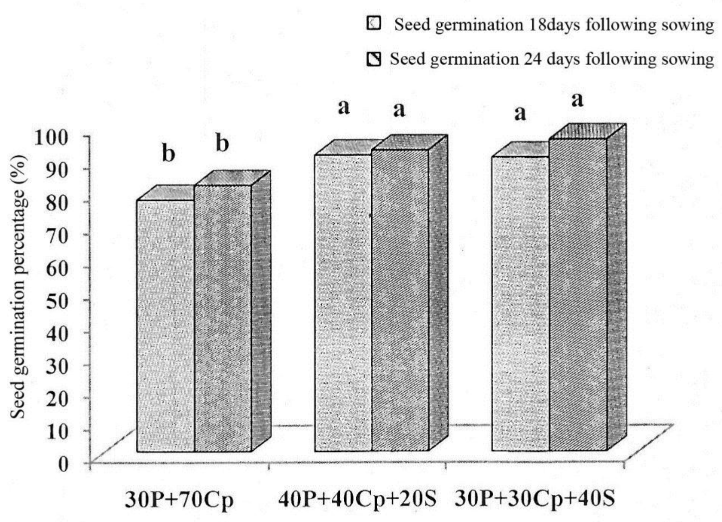

Figure 5. Comparison of main effects of growing media on seed germination percentage in tomato varieties. Means with at least one common letter show no significance difference at 5% probability level according to Duncan test.

DISCUSSION

Various raw materials are used as growing media for growing crops, ornamentals and garden plants. Growing media either as pure materials or in combination with each other, provide appropriate physical and chemical conditions for plants. Various varieties do not grow similarly in growing media and differ from the view point of vegetative growth and subsequently their reproductive properties (Manzari Tavakoli *et al.,* 2014). Results obtained in this research indicated that intraction effect of growing media and verity on some of the studied characters were significant. However, regarding some other characters only the main effects of growing media and/or tomato varieties were significant.

The studied media, due to containing cocopeat, had high humidity retention and cathion exchange capacities, therefore they could provide the plant with many absorbable nutrients resulting in increased vegetative growth (Fascella and Zizzo, 2005).On the other hand, perlite has high water retention capacity and appropriate aeration and can positively effect plant growth properties (Allaie *et al.,* 2014).

According to the results obtained the effect of variety was significant on plant height such that the highest height was observed in the first and second growth stages for Santella F1 variety and the lowest values were observed for Vay F1 and F2 varieties. One of the reasons for this observation might be that possibly the Santella variety has a genetically quicker growth rate compared with others especially Vay variety.

Improved growth properties of plants grown from F1 seeds compared to F2 can be attributed to better quality of F1 seeds. It is possible that for any reason the quality of F2 seeds has been decreased due to inbreeding depration. For the same reason, these plants had the lowest growth rate and vegetative performance (Bradford, 2002). Increased stem diameter in the growing medium containing 40% cocopeat+40% perlite + 20 % sand can be attributed to more desirable conditions of this medium due to its better ability to maintain nutrient solution and decreased humidity stress (Delshad *et al.,* 1996). Our results correspond with those of Fascella and Zizzo (2005), Awang *et al.* (2009) and Allaie *et al.* (2004). These researchers stated that the more cocopeat content in the medium, the more increase in stem length of zinnia, coleus, tagetes and laurel will be seen.

Regarding the obtained results, it can be deduced that increased weight and total plant volume in Santella F1 variety can be due to strong root system spread in this variety which made in capable to absorb water and nutrients from the culture bed. On the other hand, cocopeat media due to its spongy nature, having particles of smallest size and its organic carbon reserves, has a high water retention capacity and provides the plant with appropriate nutrients which probably result in favorable conditions for increased rate of photosynthesis, development of leaves and finally increased leaf area (Noguera *et al.,* 2000); Nikrazm *et al.* 2011). Also cocopeat in combination with perlite and sand has caused improved physical and chemical properties of the media and subsequently have improved plant growth characterististics. Results of this research correspond with those of Benito *et al.* (2005) and Raviv and Leith (2008). Decreased root wet weight in the second growth stage in the medium containing high sand level in combination with cocopeat and perlite can be due to low temperature, decreased access to water and also deficiency of organic and mineral materials since in sand bed drainage is well done and water is accessible for the seedlings during a shorter time (Doroodi *et al.,* 2008). Additionally sand and perlite either alone or in combination with each other, due to containing various salts, increase the medium salinity which in turn causes undesirability of the medium, increased need to leakage, and as a result increased cost of production (Khalaj and Amiri, 2011). Results of this research correspond with those of Khalaj and Amiri (2011) on gerbera and Doroodi *et al.* (2008) on the sumach plant.

Khorshidi *et al.* (2006) stated that in the varieties with a higher root volume, due to increased root absorption capacity and availability of water and nutrients for biomass production, shoot volume increases, therefore, higher dry shoot weight in various varieties can be attributed to increased root weight and as a result augmented root absorption vigour in these varieties. Also in the F1 seeds due to seed vigour and its high nutrient content, resulting seedlings had of a more strong root system compared to F2 seeds. Results of our research correspond with those of Foscella and Zizzo (2005), Fotuhi Ghazvini *et al.* (2005) and Zaller (2007).

Since the germination stage and seedling growth and especially the germination factors play an important role in obtaining appropriate plant density (Falahi *et al.,* 2008; Aghhavani Saajri *et al.,* 2012), and regarding the differences existing between various varieties and numerous tomato varieties, selection of a high stamina which can have an appropriate appearance rate and seedling growth, can have many advantages (Badeck *et al.,* 2006; Fanasca *et al.,* 2006).

It seems that since oxygen is one of the important factor influencing germination and because in porous growing media ventilation and oxygen penetration is increased (Aghhavani Shajari *et al.* 2012), germination has happened at a higher rate in the growing medium composed of 30% cocopeat + 30% perlite + 40% sand. On the other hand it is possible that in the growing medium containing sand due to better bed drainage, more appropriate conditions have been provided for seed germination.

General Conclusion

Regarding the results obtained in this research, employed growing media provided good conditions for growth and development of various tomato varieties. The influence of each of these growing media was presented regarding the effect of the studied varieties on the evaluated parameters. Amongst the employed growing media the highest influence on vegetative properties in various varieties was observed in the medium composed of 70% cocopeat + 30% perlite and using F1 seeds. The reason for this observation might be improved chemical and physical properties of growing media in presence of high cocopeat level which due to its high porosity, humidity retention and cathion-exchange capacities vegetative properties had improved. In the F2 seeds, due to deficient seed vigour, obtained seedlings had lower growth compared to F1 seeds.

REFERENCES

Aalaie M, Rousta H R, Mortazavi SN, Aalaie H,(2014). Comparison of effect of various growing media on performance and quality and quantity of *chrysanthemum morifolium* CV. Puma in two hydroponic and aqua ponic systems. Plant productions, Scientific Journalof Agriculture, 3: 116-127.

Aghhavani Shajari M, Neemati SH, Mehrbakhsh MM, Fallahi J, Haghighi Tajvar F, (2012). Evaluation of effects of growing medium and irrigation period on seedling growth indices in tomato varieties at greenhouse conditions. Horticultural Sciences Publication. (Agricultural Sciences and Industries), 1: 87-95.

Darudi H, Akbariniay M, Jallali S GH, Khosrowjardi A, (2008). Effect of cutting diameter and growing medium on marcotting and viability of sumach (*Rhus coriaria C.*). Iranian Journal of Biology, 2: 1-7.

Delshad, M, Kashi A, Babalar M, (2006). Study of possibility of substituting current hydroponic substrates with organic substrates and finding a nutrient solution appropriate for soilless cultivation of greenhouse tomato. Iranina Journal of Agricultural Sciences, 1: 176-186.

Fallahi J, Ebadi MT, Ghorbani R, (2008). Effect of osmotic and salinity on germination properties of sauge. Environmental Stresses in Agricultural Sciences, 1: 57-67.

Khalaj MA, Amiri M, (2011). Effect of various growing media on qualitative and quantitative properties of gerbera in non-rotational soilless Cultivation. Journal of Greenhouse Culture Sciences and Technologies, 2:47-54.

Khalili-Rad, Mirniyas KH, Bahrami H, (2010). Effect of various soil water amounts on root development in corn. Water and Soil Publication. 3: 557-564.

Khorshidi Benam MB, Rahimzadeh Kh oie F, Mirhadi MJ, Noormohamadi GH, (2006). Effect of drought stress on root dry weight in three potato varieties. Modern Agricultureal Science. 2: 39-49.

Sajadniya AA, Khayat M, Krimi HR, (2011). Effect of organic and mineral growing media on vegetative and ecophysiologic properties of *Coleus blumei*. Science and Technology of Greenhose Cultivations, 5: 55-60.

Shekari S, Zareie H, Alizadeh M, (2014). Effect of some marcotting media on marcotting of semiwoody cuttings of the ornamental *Callistomon viminalis* in greenhouse contitions. Science and Technology of Greenhose Cultivation, 19:173-182.

Manzari Tavakoli M, Rousta H, Hamidpoor M, (2014). Selection of appropriate growing medium for decreasing evil effects of sodium bicarbonate on gerbera in the soilless cultivation method. Greenhouse Cultivation Sciences and Technologies, 17:29-52.

Nikrazm R, Alizadeh Agirloo S, Khaligi A, Tabatabaie SG, (2011).Effect of different media on vegetative growth of two lillium varieties in the soilless cultivation system. Greenhouse Cultivation Sciences and Technologies, 6: 1-8.