World Applied Sciences Journal 16 (10): 1380-1386, 2012
ISSN 1818-4952

Growth and Yield of Strawberries under Different Potassium Concentrations of Hydroponic System in Three Substrates

[1]Razieh Ebrahimi, [2]Mohamad Kazem Souri, [3]Fatemeh Ebrahimi and [4]Mostafa Ahmadizadeh

[1]Young Researchers Club, Jiroft Branch, Islamic Azad University, Jiroft, Iran
[2]Faculty of Agriculture, University of Tarbiat Modares, Tehran, Iran
[3]Islamic Azad University, Jiroft Branch, Jiroft, Iran
[4]Bardsir Agriculture College, Shahid Bahonar University, Kerman, Iran

Abstract: In this study effect of different types of substrate, concentrations of potassium and cultivars were evaluated on yield and quality parameters of strawberry in hydroponic system. The statistical design was split plot-factorial based on completely randomized design with three replications. The factors were three strawberry cultivars under three potassium concentrations (200, 300 and 400 ppm) of nutrient solution of KH_2PO_4, KNO_3 and K_2SO_4 and three different substrates (peat + sand + perlite, cocopeat + perlite and sand + perlite). Results showed that increasing the concentration of potassium to 300 ppm in nutrient solution increased vitamin C content, TSS, fruit number, fruit weight, yield of plant, root weight, root dry weight and length of root. Substrate cocopeat + perlite had significant effects on some growth factors. The substrate consisting cocopeat + perlite increased plant yield and fruit number. Also the highest vitamine C content, TSS and Ta was obtained in peat + sand + perlite substrate. In addition the highest total yield was obtained from Parus with 300 ppm potassium in cocopeat + perlite substrate (921.84 g/plant). Therefore if the goal is to increasing fruit production and yield per unit area, recommended the cocopeat + perlite substrate cultivation, but if consider to quality and taste of strawberry fruit, the ideal cultivation substrate was peat + sand + perlite. Also, Parus cultivar due to having the most yield was the best cultivar.

Key words: Hydroponic · Potassium nutrient solution · Strawberry · Substrat · Crop quality

INTRODUCTION

Hydroponic predicts to plants nurture in without soil environment. In this method, some materials are usually used to keep and maintain root system and the plant nutrition is done through nutrient solution which is added to the environment, the material used as growing substrate may be an organic material (peatmos, shredded bark, foam or other organic materials) or an inorganic material such as sand, perlite, vermiculite and rock wool. One of the advantages of plant nutrition in without soil cultivation process is environment control from nutrient elements point of view. On the other hand, every kind of material with every kind of density can be provided and put into the solution and maintain ion's proportion very well, but in soil it is not controllable [1]. Strawberry has more need for potassium because this element is a major component of the fruit. Size, colour, acidity of the fruit has a positive relation with potassium amount [2]. Fruits are strong consumers of potassium, so it has a great importance for maximizing the size and quality of the fruit. Also the features of different substrates in hydroponic have direct and indirect effects on plant growth and yield and different variety shows different responses [3]. Cocopeat is the best substrate for cultivation of summer crops, flowers and strawberry because it has aerial porosity and it has a good capacity of maintaining water and nutrient. Porosity existence in perlite provides aerial exchanges and soil watering and it improves soil ventilation process, due to perlite existence, gases gathered in soil are met with a high degree. Also the roots and land-based organs of the plants are able to move easily in the soil. Perlite has rich organic materials such as iron, sodium, calcium and rare inorganic materials since it has an organic feature [4]. Peat usage in plant cultivation by itself often shows nutrient elements lack and its combination with organic soil has useful effects on plant growth. It is due to peat function on effective chemical

Corresponding Author: Mostafa Ahmadizadeh, Bardsir Agriculture College, Shahid Bahonar University, Kerman, Iran.
Tel: +989194457655.

processes in providing nutritious elements and their balance [5]. Seyyedi [6] studied the effect of four kinds of nutrient solution in hydroponic cultivation system on the quantitative and qualitative traits of Silva strawberry showed that potassium increase up to 3 meq/L in nutrient solution increases soluble solid material, Ta and vitamins C. Haghigat-Afshar [7] studied four cultivars using five nutrient solution in hydroponic cultivation system and reported that the shoot dry weight and its proportion to the dry weight of the root reached to the maximum amount respectively from 0 to 0.25 mili molar and from 0.25 to 0.5 mili molar with ammonium nitrogen increase and it remained stable after ammonium nitrogen increasing. Farzaneh *et al.* [8] studied the effect of different nitrogen and potassium levels on yield and density of nitrogen and potassium of tomato leaf in perlite cultivation environment and reported that the most yield of fruit was gained due to 200 mg/L nitrogen consumption and higher levels of nitrogen reduced the yield and different levels of potassium did not have a significant effect on the yield. Hartz *et al.* [9] studied different levels of potassium on the quality of muskmelon, they found that 240 mg/L potassium level cased a significant increase in total sugar, TSS, glutamic acid, aspartic acid and acetate volatile components in fruit flesh, which has an effect on its taste and flavour. Mashhadi-Jafarloo *et al.* [10] showed that the most strawberry yield was obtained in 100% coconut substrate and cocopeat-subs + perlite (50% + 50%) placed in the next stages.

Ercisli *et al.* [11] reported that the effect of different cultivation substrate was statistically significant on the growth and development of strawberry. The most primary roots in each plant, the length of the longest root string and the most gorget in each shoot was obtained respectively from perlite substrates, finpeat + perlite and peat by themselves in both cultivars. Shoot length, the number of shoot in the plant, leaf area, root weight and dry weight of root among different cultivars in substrate was different. Moosavi [12] studied the effect of substrates and different nutrient solutions on the quantitative and qualitative traits of capsicum annum in hydroponic system and announced that pure perlite substrate has caused significant decrease in total yield, commercial yield, fruit weight, fruit calcium amount, growth indices, water content in the leaves and it has increased tiny fruit percentage. The substrates which contain 50-75% perlite caused the production of the highest yield in capsicum annum. Javanpoor-Heravi *et al.* [13] reported that ammonium nitrogen increasing reduces the yield, C vitamin, acidity and being soluble in fruit solid material in Hamra cultivar of tomato. Also according to the results, soil and substrates that had soil in their combination had a significant effect on the most of quantitative and qualitative traits of the plant. The research was designed and performed according to strawberry growers need to increase the quality of produce fruits and maximum life of fruiting plant.

MATERIALS AND METHODS

The research was done in greenhouse condition in the form of split plot-factorial based on completely randomized design with three replications, including three cultivars of strawberry including Camaosa, Silva and Parus and three different potassium concentration from sources such as KH_2PO_4, KNO_3 and K_2SO_4 and three substrates: Peat + Sand + Perlite (2:1:2), cocopeat + Perlite (1:2) and sand+big grain perlite in three replications. In this experiment number 1 nutrient solution Hogland was used as stock. That is, 136.1 g KH_2PO_4, 505.5 g KNO_3, 1180.5 g Ca $(NO_3)_2$ $4H_2O$ and 439 g $MgSO_4$ $7H_2O$ were solved in 1000 litre. Less consuming elements' amount was the same in different solutions which contained 2.86 g H_3BO_3, 1.81 g $MnCl_2$, 0.22 g $ZnSO_4$, 0.08 g $CuSO_4$ and 0.02 g H_2Moo_4 sub-nutriment were solved in 1 litre water and were used as sub-nutriment stock (1ml for 1 litre). To provide iron, 5g Fe-EDTA (iron clot) was solved in 1 litre water [1]. The critical difference of used nutrient solution was related to the kind of nutritive potassium source and proportion between KH_2PO_4 and KNO_3 compared to K_2SO_4 so that in A_1 solution (control) the amount of provided potassium from KH_2PO_4 salt and KNO_3 was 200ppm. In A_2 solution, the amount of provided potassium of KH_2PO_4 salt and KNO_3 and K_2SO_4 was 300pm and in A_3 solution, potassium nutrient solution was provided from KH_2PO_4 salt and KNO_3 and K_2SO_4, It was 400ppm (Table 1) and PH was adjusted 5.8±0.2. The water's PH had been adjusted on 6. Average night temperature in the experiment was 18±2 and average day temperature was 25±2°C. Relative humidity in the greenhouse vacillated between 60-70. In this plan, the plants were put in experiment condition for 3 months and their quantitative and qualitative features were evaluated.

Measured Parameters Include: Number of leaves, wet and dry weight of shoot, wet and dry weight of root, root length, shoot/root, number of fruit, total yield, average fruit weight, vitamin C, titratable acidity of fruit (Ta) and total soluble solids (TSS). Finally, for analysing the data and drawing graphs we used SAS and Excel software's.

Table 1: Solution of potassium nutrition.

	K in Hogland (ml/l) 200ppm	K in Hogland (ml/l) 300ppm	K in Hogland (ml/l) 400ppm
KH_2PO_4	1= 39mg/l	1= 39mg/l	1= 39mg/l
KNO_3	4.2=164mg/l	5=196mg/l	5=196mg/l
$Ca(NO_3)_2$ $4H_2O$	5.4	5	5
K_2SO_4	-	0.85=66.47 mg/l	2.11= 165mg/l

RESULTS AND DISCUSSION

Analysis of variance showed that interaction between potassium nutrient solution substrate with no. of leaves and leaf area was significant in 1% level of probability (Table 2). The most number of leaves were obtained from (200 ppm coco-peat + Perlite) treatment with an average of 26.00 and the least amount of treatment (400 ppm peat + sand + perlite) with an average of 15.00 was obtained (Table 3). The most leaf area was obtained from (200 ppm coco-peat + pelite) treatment with an average of 115.69 cm^2 and the least amount was gotten from (200 ppm sand + large grain perlite) treatment with an average of 81.03 cm^2 (Table 3). Better exchange of elements and especially cations inside coco-peat and perlite substrate is effective on nutrient elements absorption and plant growth [14]. It seems that increase of leaf number and plant height in treatments which are a mixture of perlite, was an indicator of proper growth of plant in these substrates [3].

Interaction of potassium nutrient solution and substrate in wet weight of shoot and leaf had a significant difference in 1% level (Table 2). The most of wet weight of shoot was obtained from (200 ppm coco-peat + perlite) with an average amount of 50.22 g and the least amount was gotten from (400 ppm peat + sand + perlite) with an average of 31.96 g (Table 3). One of proper growth symbols in the plants possesses more subsidiary shoot and leaves, it is gotten due to proper substrate existence and compatible with the plant and correct and principle based nutrition. Cocopeat + perlite substrate has excellent features so it gives the opportunity to the plant to absorb oxygen very well and grow in a proper way and improves water consumption and maintains oxygen and finally increases growth development.

Analysis of variance showed that interaction between potassium nutrient solution and substrate was not significant with shoot dry weight, but significant difference was observed among different levels of substrate in 1% level (Table 2). Cocopeat + perlite with an average of 12.90 g had the most shoot dry weight and peat + sand + perlite substrate with an average of 10.17 g had the least shoot dry weight (Table 4). High growth development in the plants increases biomass in the plant, in fact, more biomass will lead in more dry weight. Cocopeat has aerial porosity and it has capacity of water and nutrient maintenance. Perlite has little cation exchange capacity but has more water absorption power, these two factors are both effective on nutrient solution maintenance capacity inside substrate and proper distribution of humidity in the root which finally leads into more growth of the plant [14]. The interaction of potassium nutrient solution and substrate in wet and dry weight of the root had a significant difference in 1% level (Table 2). The most dry and wet weight of the root was resulted from (300 ppm coco-peat + perlite) treatment with

Table 2: Analysis of variance for strawberry traits under different potassium concentrations of hydroponic system in three substrates.

		Means square							
S.O.V	D.F	Leaf number	Leaf area	Shoot fresh weight	Shoot dry weight	Root fresh weight	Root dry weight	Root length	Shoot /root
Potassium Concentrations)A)	2	59.86**	204.39$^{n.s}$	65.33$^{n.s}$	0.04$^{n.s}$	115.38**	7.07**	6.08$^{n.s}$	4.61**
E (a)	6	45.61	1073.74	650.98	44.11	260.64	5.03	28.76	0.35
Substrat)S(	2	390.08**	2178.30**	526.39**	59.54**	627.88**	16.69**	25.37**	5.47**
Cultivar)C(	2	0.16$^{n.s}$	67.73$^{n.s}$	1.49$^{n.}$	0.22$^{n.s}$	0.04$^{n.s}$	0.02$^{n.s}$	0.19$^{n.s}$	0.00$^{n.s}$
A×S	4	39.38**	988.41**	213.84**	8.37$^{n.s}$	188.01**	4.98**	12.97*	3.23**
A×C	4	0.84$^{n.s}$	28.53$^{n.s}$	1.22$^{n.s}$	0.02$^{n.s}$	0.37$^{n.s}$	0.00$^{n.s}$	0.16$^{n.s}$	0.00$^{n.s}$
S×C	4	1.56$^{n.s}$	13.91$^{n.s}$	4.12$^{n.s}$	0.03$^{n.s}$	0.16$^{n.s}$	0.21$^{n.s}$	0.28$^{n.s}$	0.00$^{n.s}$
A×S×C	8	1.05$^{n.s}$	21.39$^{n.s}$	1.20$^{n.s}$	0.08$^{n.s}$	0.32$^{n.s}$	0.01$^{n.s}$	0.39$^{n.s}$	0.00$^{n.s}$
E (b)	48	5.46$^{n.s}$	180.81	31.24	2.72	18.11	0.42	3.98	0.28
C.V	(%)	12.58	14.16	13.14	14.72	13.95	12.83	11.75	12.94

**,* and Ns, significant at 1, 5% level of probability and non-significant, respectively.

Table 2: Continue

S.O.V	D.F	Means square						
		Ta	TSS	Taste (TSS/ Ta)	Vitamin C	Total fruit number	Fruit weight	Total plant yield
Potassium Concentrations)A)	2	0.00 $^{n.s}$	0.15 $^{n.s}$	0.68 $^{n.s}$	226.06**	1450.08**	26.25**	275977.48**
E (a)	6	0.00	1.08	4.12	116.92	569.23	83.26	220440.57
Substrat)S(	2	0.00*	0.80**	4.18**	247.08**	3654.23**	220.26**	333026.17**
Cultivar)C(	2	0.00 $^{n.s}$	0.00 $^{n.s}$	0.00 $^{n.s}$	0.30 $^{n.s}$	0.09 $^{n.s}$	0.00 $^{n.s}$	141.04 $^{n.s}$
A×S	4	0.01 $^{n.s}$	0.10 $^{n.s}$	0.37 $^{n.s}$	81.55 $^{n.s}$	37.01 $^{n.s}$	8.14 $^{n.s}$	1940.37 $^{n.s}$
A×C	4	0.00 $^{n.s}$	0.00 $^{n.s}$	0.00 $^{n.s}$	0.27 $^{n.s}$	2.20 $^{n.s}$	0.06 $^{n.s}$	5.85 $^{n.s}$
S×C	4	0.00 $^{n.s}$	0.02 $^{n.s}$	0.01 $^{n.s}$	0.08 $^{n.s}$	0.82 $^{n.s}$	0.06 $^{n.s}$	28.51 $^{n.s}$
A×S×C	8	0.00 $^{n.s}$	0.00 $^{n.s}$	0.02 $^{n.s}$	0.12 $^{n.s}$	1.82 $^{n.s}$	0.17 $^{n.s}$	22.08 $^{n.s}$
E (b)	48	0.00	0.05	0.31	25.23	71.22	4.57	7747.15
C.V	(%)	9.89	12.87	13.69	13.11	13.45	13.42	12.72

**,* and Ns, significant at 1, 5% level of probability and non-significant, respectively.

Ta: Titratable Acidity; TSS: Total Soluble Solids.

Table 3: Mean comparison of interaction solution of potassium nutrition and substrates on studied traits.

Substrat/ Potassium Concentrations	Leaf number	Leaf Area (cm^2)	Shoot weight (g plant^{-1})	Root weight (g plant^{-1})	Root dry weight (g plant^{-1})	Root length (cm)	Shoot/root
sand+perlite+peat/200	14.66e	86.69c	41.29cd	26.00bc	2.23de	16.88bc	4.92ab
cocopeat+perlite/200	26.00a	115.69a	50.22a	34.31ab	3.37b	16.90bc	3.80bc
sand+perlite/200	17.33cd	81.03d	39.26d	24.29c	2.05e	17.91ab	4.87ab
sand+perlite+peat/300	17.55cd	98.71bc	44.78bc	28.44b	3.18bc	16.72bc	3.60bc
cocopeat+perlite/300	23.66b	96.06bc	45.35abc	37.85a	4.53a	19.16a	3.47c
sand+perlite/300	17.33cd	98.99b	39.47d	26.90bc	2.77cd	16.00cd	4.05b
sand+perlite+peat/400	15.00e	93.60bc	31.96d	24.34c	1.90e	14.88d	5.11a
cocopeat+perlite/400	19.00c	102.52b	47.08ab	35.07ab	4.06ab	18.11ab	3.65bc
sand+perlite/400	16.55de	81.32d	43.13bcd	36.24ab	4.12ab	16.33bcd	3.42c

Values with the same superscript letters are non-significantly different at P < 0.05.

Table 4: Mean comparison of substrates effect on studied traits.

Substrat	Shoot dry weight (g plant^{-1})	Ta (g/100cc)	TSS (Brix)	Taste (TSS/ Ta)	Vitamin c (mg/100cc)	Total fruit number	Fruit weight (g)	Total yield (g plant^{-1})
sand+perlite+peat	10.17±2.09 b	0.46±0.06ab	2.07±0.45a	4.46±1.02a	41.18±5.2a	59.59±9.9b	16.37±3.7b	656.3±155.1b
cocopeat+perlite	12.90±2.3a	0.45±0.04b	1.86±0.2b	4.09±0.4b	35.15±3.07b	75.59±13.4a	12.89±3.7c	816.3±181.3a
sand+perlite	10.53±3.3b	0.49±0.02a	1.72±0.4c	3.68±0.7c	38.56±3.5ab	52.96±13.8c	18.55±4.2a	602.9±184.7c

Values with the same superscript letters are non-significantly different at P < 0.05.

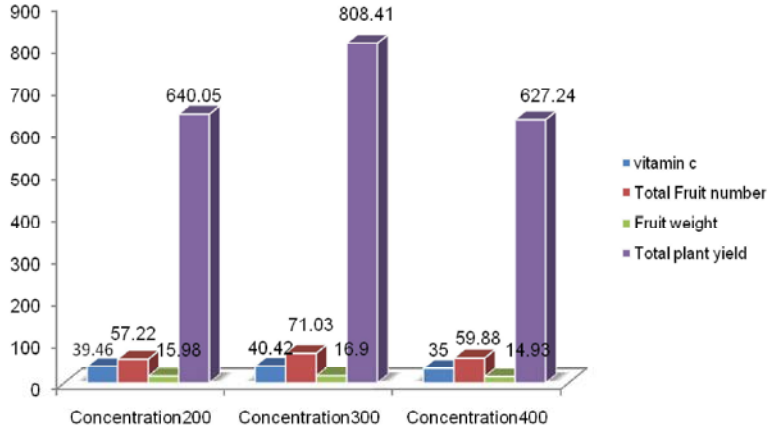

Fig. 1: Effect of potassium concentrations on quality traits in strawberry cultivars.

an average of 37.85 and 4.53 g, respectively (Table 3). Root is responsible for providing necessary water and organic material for plant growth, it is an important growing organ. Substrate has a direct effect on development and performance of root system [15]. Cocopeat and perlite substrate cause better exchange of elements especially cations inside substrate and they distribute humidity properly around root, it is finally effective in roots' system formation and plant growth [14]. Also potassium reinforces the root [16]. Root length showed a significant difference (5%) among studied treatments, so that the most root length was gotten from (300 ppm coco-peat + perlite) treatment with an average of 19.16 cm and the least amount was obtained from (40 ppm peat + sand + perlite) treatment with an average of 14.88 cm (Table 3). Coco-peat and perlite substrates have a proper aerial porosity, when perlite exists, the roots and land organs of the plant are able to move easily in the soil [4]. The results of analysis of variance showed the significant interaction between potassium nutrient solution and substrate in 1 percent level about shoot/root (Table 2). The most shoot/root was o btained from (400 ppm peat + sand + perliet) treatment with an average of 5.1 and the least shoot/root was resulted from (400 ppm sand + large grain perlite) with an average of 3.42 (Table 3). The researches about this subject showed that the size and length of root has a direct relation with shoot. Shoot/root changes during growth stages under environmental factors' effect. Competition for photosynthetic products between shoot and root plays an important role [16].

Interaction between potassium nutrient solution and substrate did not significant on the qualitative traits of strawberry, but analysis of variance potassium nutrient solution showed that there was no significant difference among different proportions of nutrient solution potassium from Ta, TSS and taste indicator proportion point of view (Table 2). It seems that potassium does not have any effect on chemical parameters of fruit quality [17]. But there was a significant difference in 1% level between different proportions of potassium nutrient solution in the amount of vitamin C (Table 2). The most vitamin C was gotten from 300ppm concentration with an average of 40.42 mg/100g and the least amount was gotten from 400ppm treatment with an average of 35.00 mg/100g (Figure 1). Average concentration of vitamin C was different between 84.70-32.40 mg/100g in different strawberry cultivars. Usually, genotype has more effect on the amount of qualitative parameters of strawberry compared to cultivation techniques [17]. The results of analysis of variance showed that there was a significant difference among potassium nutrient solution from the number of fruit point of view (Table 2). The most fruit number was in the plants fed with A_2 solution (300ppm) with an average of 71.03 and the least fruit number was gotten from 200ppm treatment with an average of 57.22 fruit (Figure 1). Using potassium fertilizer improved leaf area development, chlorophyll content and productive parameters and the number of fruit [18]. A significant difference was also observed among different proportions of potassium nutrient solution in fruit weight average was obtained from 300ppm concentration with an average of 16.90g (Table 2 & Figure 1). Potassium level increases in plants with the possibly increasing fruit weight and its quality [19]. Also there was a significant difference between different proportions of potassium in total yield in 1% level (Table 2). The most total yield was gained in 300ppm concentration with an average of 808.41g and the least total yield belonged to 400ppm treatment with an average of 627.24g (Figure 1). Inadequate amount or more amount of potassium influences the quality and yield of fruit negatively [20]. According to the results of analysis of variance in taste indicator and amount of vitamin C, a significant difference was observed among different levels of substrate in 1 % level (Table 2). Peat + sand + perlite substrate had the most taste indicator proportion with a average of 4.46 and sand + large grain perlite substrate had the least taste indicator proportion with an average of 3.68 (Table 4). Sugar proportion to acid is considered as taste and flavour indicator, an increase in this proportion make the fruit sweeter and its decrease make the fruit sour. Peat + sand + perlite substrate with an average of 41.18 mg/100g had the most vitamin C and cocopeat + perlite with an average of 35.15 mg/100g had the least vitamin C (Table 4). Substrate chemical features may be effective on total content of vitamin C and fruit quality [19]. Fruits cultivated in organic and inorganic substrates (sand and perlite) have significantly more calcium and vitamin C and less iron compared to organic substrates [21].

The number of fruit, fruit weight and performance showed a significant difference in various substrates in 1% level (Table 2). The most total fruit number with an average of 75.59 was gotten from cocopeat + perlite substrate and sand+ large grain perlite with an average of 52.96 had the least total fruit number (Table 4). Complete nutrition and suitable substrate increase growth development and in some cases increase the number of flowering and fruit in the plants. Yield and other growth traits of plant may be due to suitable conditions existence around root in perlite substrate from ventilation and water

maintenance [14]. Sand + large grain perlite had the most fruit weight with an average of 18.55g and coco-peat + perlite had the least average fruit weight with an average of 12.89 (Table 4). One of important parameters in studying statistical treatments is total yield and obviously one of the effective factors set in quantitative improvement of this parameter is nutrition and suitable substrate, cocopeat + perlite had the most total yield with an average of 816.38 g and sand + large grain perlite substrate had the least total yield with an average of 602.97 (Table 4). Cocopeat + perlite probably provide a better environment for root growth and prevent water tension and more water consumption and increases more fruit production [22]. Also the results of variance analysis showed that there was no difference among Camarosa, Silva and Parus cultivars in the studied traits (Tables 2). Analysis of variance showed that interaction between potassium nutrient solution and cultivars, interaction between cultivars and substrate, also interaction between cultivars, nutrient solution and substrate was not significant on the studied traits (Tables 2).

CONCLUSION

Suitable nutrition of greenhouse strawberry plants is more considerable and finding a proper nutrient solution allocated to hydroponic units has great importance too, in order to get maximum yields and obtain suitable efficiency, in feeding strawberry plants, giving optimized potassium was really important. According to the total results of substrates, cocopeat + perlite substrate had the most effect on growth traits of strawberry. The most leaf number, leaf surface, wet weight and dry weight of shoot, dry and wet weight of root and root length were gotten from cocopeat + perlite substrate. Also, the most fruit number and total yield was obtained from cocopeat + perlite substrate. The most leaf number, shoot/root, taste indicator, the number of total fruit, fruit diameter and average fruit weight was obtained from Camarosa cultivar. Parus had the most average in leaf weight, leaf area, TSS and yielde. Wet and dry weight of shoot, root dry and wet weight, root length and vitamin C were the most in Silva cultivar. As conclusion, we can conclude that 300 ppm potassium concentration in Hogland nutrient solution is proper for strawberry, so it improved the yield and the qualitative and quantitative traits of fruit and plant of the strawberry, cocopeat + perlite substrate had the most effect on strawberry growth features. Also the most fruit number and total yield was obtained from this substrate. But the most vitamin C, TSS, Ta and taste indicator was gotten from peat + sand + perlite substrate. Strawberry taste is a mixture of sweetness, acidity and essence. The fruit which has more aromas has usually high level of Ta and TSS. It can be concluded that cocopeat + perlite substrate had positive effects on growth feature of the plant and strawberry performance. Peat + sand + perlite substrate is more effective on the qualitative features of strawberry. So, if the goal is producing more fruit and the increase of yield in surface unit, coco peat + perlite is suggested but if the quality and taste of fruit is considered, Peat + sand + perlite substrate is more ideal. Also, Parus cultivar due to having the most yield was the best cultivar.

REFERENCES

1. Arzani, M., 2007. Cultivation without soil (Hydroponic), commercial and house-made. Isfahan Industrial Press. First Publication.
2. Behnamiyan, M. and S. Masiha, 2002. Strawberry. Sotoudeh Press. First Publication.
3. Tabatabaei, J. and R. Mohammad Rezaei, 2006. The effect of different substrate cultivation on the growth and performance of greenhouse cucumber in watery cultivation system (hydroponic). J. Agricultural Sci., 16(2): 35-44.
4. Djedidi, M., D. Gerasopoulos and E. Maloupa, 1999. The effect of different substrates on the quality of F. carmello tomatoes (*Lycopersicom esculentum* Mill.) grown under protection in a hydroponic system. Cahier option Mediterranneenes, 31: 379-383.
5. Bunt, A.C., 1988. Media and mixes for container grown plants. Academic Division of Boston: Unwin Hyman Ltd. pp: 297.
6. Seyyedi, A., 2005. The effect of nutrient solution's potassium and density of cultivation on the quality and quantity of Selva Strawberry in hydroponic cultivation system. M.Sc. Theses on Plant Protection, Tehran University, Iran.
7. Hagigat-Afshar, M., 2004. Effect of source and amount of nitrogen upon nitrate circulation on different organs and the performance of different cultivars of strawberry. M.Sc Theses on Horticulture. Tehran University, Iran.
8. Farzaneh, N., A. Golchin and K. Hashemi Majd, 2009. The effect of different levels of nitrogen and complement potassium of nutrient solutions on performance and the concentration of nitrogen potassium of tomato leaves. Abstracts of the first National Congress of hydroponics and greenhouse production. Isfahan University of Technology, Iran.

9. Hartz, H.K., G. Miyao and R.J. Mullen, 1999. Potassium requirements for maximun yield and fruit quality of processing tomato. J. Am. Soc. Hort. Sci., 124(2): 199-204.
10. Mashhadi Jafarloo, A., L. Naseri, A. Samadi and M. Hanare, 2009. Determination of circulation and the suitable cultivation bed in hydroponic cultivation system of Selva Strawberry. Abstracts of the first National Congress of hydroponics and greenhouse production. Isfahan University of Technology, Iran.
11. Ercisli, S., U. Sahin, A. Esitken and O. Anapali, 2005. Effect of some growing media on the growth of strawberry cvs. Camarosa AND Fern. ACTA Agrobotanica, 58(1): 185-191.
12. Mousavi, M., 2004. Studying the effect of cultivation beds and different nutrient solutions on quantitative and qualitative features of capsicum annum in cultivation without soil system. M.Sc Theses on Horticulture. Tehran University, Iran.
13. Javanpour Heravi, R., M. Babalar, A. Kashi, M. Mir Abdolbagi and M. Asgari, 2005. Effect of different nutrient solution and cultivation in the watery system on quantitative and qualitative traits of HAMRA greenhouse tomatoes. J. Agricultural Science of Iran. 36(4): 939-946.
14. Nourizadeh, M., 2003. The effect of different substrate cultivation on the growth, performance and quality of greenhouse cucumber in without soil cultivation system. M.Sc Theses on Horticulture, Guilan University, Iran.
15. Abad, M., P. No guera, R. Puchades, A. Maqueira and V. No guera, 2002. Physico- chemical and chemical properties. Of some coconut dusts for use as a peat substitute for containerized ornamental plants. Biores. Technol., 82: 241-245.
16. Kholde Barin, B. and T. Eslamzadeh, 2005. The nutrition of organic and important plants. Shiraz University Press.
17. Haynes, R.J. and K.M. Goh, 1987. Effects of nitrogen and potassium applications on strawberry growth, yield and quality. Communications in Soil Science and Plant Analysis, 18: 457-471.
18. Khayyat, M., M.R. Vazifeshenas, S. Rajaee and S. Jamalian, 2009. Potassium effect on ion leakage, water usage, fruit yield and biomass production by strawberry plants grown under NaCl stress. J. Fruit Orn. Plant Res., 17: 79-88.
19. Yavari, S., S. Eshghi, E. Tafazoli and S. Yavari, 2008. Effects of various organic substrates and nutrient solution on productivity and fruit quality of strawberry “Selva” (Fragaria × ananassa Duch.). J. Fruit and Ornamental Plant Res., 16: 167-178.
20. Zeng, Q.P. and P.H. Brown, 2001. Potassium fertilization affects soil K, leaf K concentration and nut yield and quality of mature pistachio trees. Hort Sci., 36(1): 85-89.
21. Premuzic, Z., M. Bargiela, A. Garcia, A. Rendina and A. Lorio, 1998. Calcium, iron, potassium, phosphorous and vitamin C content of organic and hydroponic tomatoes. Hort Sci., 33(2): 255-257.
22. Serrano, L., R. Orozco, A. Martinez and O. Marfa, 1993. The use of fine graded perlite in bag culture II. Yield and water consumption of lettuce. Acta Horticulture. 335: 109-113.