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EFFECT OF SUBSTRATE MIXTURES AND NUTRIENT SOLUTIONS SOURCES ON STRAWBERRY PLANTS UNDER CLOSED HYDROPONIC SYSTEM

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ABSTRACT:

Current study was done for evaluation effect of substrate mixtures and nutrient solutions on growth, yield and chemical characteristics of strawberry (Fragaria×ananassa) cv. Festival in soilless culture system. Planting was done on 1st week of October during the two winter seasons of 2012/2013 and 2013/2014 under unheated double-span plastic house conditions, Central Laboratory for Agricultural Climate (CLAC), Agricultural Research Center (ARC).

Experimental treatments consisted of three substrate mixtures perlite: peat moss (1:1v/v) (M1), perlite: vermicompost (4:1v/v) (M2), and perlite: plant compost (4:1v/v) (M3) and three nutrient solutions (vermicompost-tea, animal compost-tea and mineral nutrition (control). The tested factors were arranged in factorial design with three replicates. Measured traits were number of leaves, plant height, leaf chlorophyll reading, leaf area, early and total yield, number of fruits, average number of fruit and N, P, and K percentage content of the fourth leaf.

The results show that these vegetative growth parameters, yield and leaf chemical contents responded and positively significantly to using perlite: peat-moss under this investigation. Furthermore, using mineral solution had significant effects on all measured characteristics. While, using perlite: peat-moss combined with mineral had the highest values of all measured. Adding, using perlite: peat-moss combined with vermicompost-tea was affected in plant height and leaf area. These results were reported during the two seasons.

Keywords: *Fragaria×ananassa*, growth, yield, substrate mixtures, vermicompost tea, animal compost tea, soilless culture.

INTRODUCTION:

Strawberry (*Fragaria × ananassa*) is one of the important *Rosaceae* vegetable crops grown for their fruits. It is one of the major export crops, because of its taste, scent and high vitamin content, strawberry is well known all over the world and is a common fruit in food diets. It is also cultivated under hydroponic conditions in greenhouses with climate and irrigation control, and CO^2 supply (Cantliffe *et al.,* 2007). Greenhouse production of strawberry has the advantage of increased yield per unit area, early production when market prices are high, relatively easier pest management with reduced use of chemicals, as well as better fruit quality (Cantliffe *et al.,* 2007).

Soilless culture systems (SCSs), the most intensive production method in today's horticulture industry, are based on environmentally friendly technology, which can result in higher yields, even in areas with adverse growing conditions (Gruda, 2009). Therefore, hydroponic permits crops to be grown where the soil is contaminated in some manner or where no suitable soil exists or where contraction of agricultural land (Stanley, 1998 and Jafarnia *et al.,* 2010). It is more complete control of the environmental factors that affect plant growth and yield (root environment, fertigation, light temperature, aeration, humidity, etc.) (Jensen, 1999 and Jafarnia *et al.,* 2010).

Concerning suitable mixtures of substrate in soilless culture within greenhouse systems, prolong harvesting duration, out of season strawberry production and increase in yield (Takeda, 1999 and Jafarnia *et al.,* 2010). Material properties of substrate display direct and indirect effects on plant physiology and production (Cantliffe *et al.,* 2001 and Jafarnia *et al.,* 2010). Where, the use of different organic and inorganic substrates allows the plants better nutrient uptake, sufficient growth and development to optimize water and oxygen holding (Verdonck *et al.,* 1982; Albaho *et al.,* 2009 and Ameri *et al.,* 2012).

Application of organic materials as substrates for hydroponic culture media was reported by Tilt and Bilderback (1983) and Hesami *et al.,* (2012). However, peat has been the best substrate for hydroponic culture (Lieten, 2001). Due to high cost and not easy availability of peat moss, producers usually try to alter it by other substrates (Lieten, 2001; Jafarnia *et al.,* 2010). So, it is recommended to use the substrate mixtures with higher percentage of perlite had better performance and are recommended for strawberry cultivation (Roosta and Afsharipoor, 2012). Where, the environmental and ecological concerns in the recent years led to minimize or against the use of peat because its harvest is destroying endangered wetland ecosystems worldwide (Robertson, 1993 and Abul-Soud *et al*., 2015). At the same time, the need to produce local substrate instead of importing it drove many researchers to develop different substrates to play the role of peat moss. Several studies revealed that peat can be substituted with various compost types without any negative effects on a variety of crops raised in these substrates (Eklind *et al.,* 2001; Hashemimajd *et al.,* 2004 and Abul-Soud *et* *al.,* 2015). According to them, type of media has to be determined based on necessities of producers and market places (Jafarnia *et al.*, 2010).

Vermicompost could be an environmentally friendly substitute for peat in potting media with no detrimental effects on seedling performance and fruit quality of tomato. So, differences of vermicompost effects between crop varieties, especially the latter finding should be considered when giving recommendations on the optimum proportion of vermicompost amendment to horticultural potting substrates (Zaller, 2007a and b). Whereas, main objective was to find suitable composition of such media which could be helpful in future to minimize fruiting time and to enhance the quality attributes of strawberry fruits. It was observed that best growing media were those which had maximum percentage of organic matter, total nitrogen, available phosphorus and potassium etc. Utilization of suitable manure is also a good source of essential nutrients. It influenced reproductive and quality relevant parameters of strawberry plant efficiently (Ayesha *et al.*, 2011). The use of compost in soilless culture is a viable alternative to resolve the environmental problem of vegetable waste (Mazuela *et al.*, 2012).

Compost tea soaked in water for a period of time with the aim of transferring soluble organic matter, beneficial micro-organisms and macro- and micro-nutrients into solution. The best method of compost tea production is currently under debate. It can be prepared aerobically (aerated tea) or anaeraobically (non-aerated tea). It should be a permitted organic amendment provided if it was made from a permitted compost source. Generally, compost and compost tea used as amendments for strawberries produced fruit of equal quality but treatments did not provide sufficient N to plants and yield was lower than expected. Compost tea treatments provided similar amounts of most macro-and micronutrients compared to MSWC, ruminant compost, and fertilizer treatments and subsequently to strawberry plants (Hargreaves *et al.*, 2009a and b).

Obviously, with decreasing concentrations of vermicomposts and vermicompost teas there was less microbial activity in the teas. Probably the presence of plant growth regulators in the teas can influence plant growth significantly independent of nutrient availability. Clearly, no practical problems such as adverse growth effects in the use of vermicompost teas were found at any of the dilutions tested. Therefore, another critical contribution of the increases in microbial diversity and activity, as well as their role in nutrient cycling is the production of plant growth-influencing materials and the protection of plants from pathogenic organisms by competition and antagonism (Arancon *et al.,* 2007). However, growth media and nutrition are the most important factors in hydroponic production (Tilt and Bilderback, 1983 and Hesami *et al.*, 2012). Accordingly, the need for optimizing the soilless culture inputs and maximize the production with concerns on the environmental impacts led to the development of the ecology soilless culture system via alternating the peat moss by vermicompost and replace the chemical nutrient solution by organic sources of nutrient solution (Abul-Soud *et al.,* 2015).

Therefore, the objective of this study was to determine the effect of three different substrate mixtures combined with three different nutrient solutions under A-shape technique system on growth and superior yield from unit area of strawberries grown under unheated double-span plastic house condition in close system of soilless culture.

MATERIALS AND METHODS

The experimental was carried out at station of Central Laboratory for Agricultural Climate (CLAC), Agriculture Research Center (ARC), Egypt. This study was conducted in the two winter successive seasons of 2012/2013 and 2013/2014 under unheated double-span plastic house conditions in closed systems of substrate soilless culture in A-shape.

Plant material

Strawberry fresh transplants were cultivated on 1st week of October by using strawberry cv. Festival in both seasons of the study (2012/2013 and 2013/2014). Fresh transplants were obtained from Strawberry Improvement Center, Faculty of Agric., Ain Shams University, Shoubra El-Kheima. Fresh transplants with three to four leaves were transplanted. Seedlings were dipped in Rhizolex solution at rate of 2 gram per liter before transplanting. They are transplanted directly into PVC pipes. The transplants plant spacing was 25 cm.

Experimental materials

A-shape system of soilless culture was used to presented substrate systems. A metal A- Shape frame (0.9 m width and 1.3 m height) included three levels of PVC pipes on two sides. The PVC pipes holed every 25 cm. The A-shape performed plant density 24 plants per square meter. The PVC pipes were filled with different studied substrates for illustrating substrate culture system and the cultivated strawberry plants were irrigated by using drippers of 4 liter per hour capacity.

This system had a sloping 1%. Different nutrient solutions pumped via submersible pump (110 watt). The drainage collected back to the tanks of different systems in close type of soilless culture. The fertigation was programmed depend on the system (8 times / day for substrate culture).

Experimental treatments

The experiment included two factors, namely, 3 substrates mixture (as shown in Table 1) and 3 sources of nutrient solutions (vermicompost-tea, animal compost-tea and chemical nutrient solution of El-Behairy (1994) as a control. The EC level of all nutrient solutions was adjusted at 1.5 mmhos^{-1}, under unheated plastic house condition. The experimental design was a factorial design with 3 replicates. The sources of nutrient solutions were assigned as main plots and substrate mixtures as subplots.

1-The substrates

The physical and chemical properties of different substrates mixtures (average two seasons) are illustrated in Table 1. Bulk density (BD), total pore space (TPS), water hold capacity % (WHC) and air porosity % (AP) were estimated according to Wilson (1983) and Raul (1996). The pH of the potting mixtures were determined using a double distilled water suspension of each potting mixture in the ratio of 1:10 (w: v) (Inbar *et al.*, 1993) that was agitated mechanically for 2 hrs and filtered through Whatman No.1 filter paper. The same solution was measured for electrical conductivity (EC mmhos^{-1}) with a conductance meter that was been standardized with 0.01 and 0.1M KCl.

2-Preparing of compost tea

Two sources of vermi or animal compost-tea were prepared by soaking 6 kg of each compost in water tank (120 liter) to get the concentrated extractions that were going to be used as nutrient solutions after dilution. Filtration was made before using the animal or vermi compost-tea to get the clear solution for fertilizing strawberry and to prevent the dust included in the drippers.

The animal compost was from cattle farm at Nubaria, vermicompost from Central Laboratory for Agricultural Climate "Integrated Environmental Management of Urban Organic Wastes Using Vermicomposting Project" and the plant compost was from commercial compost – El Neil.

The EC of the different nutrient solutions were adjusted by using EC meter to the required level (1.5 mmhos^{-1}) during different stages of growth of the two seasons. The chemical composition of vermicompost-tea, animal compost-tea and chemical nutrient solution were illustrated in Table 2.

Table 1: The physical and chemical properties of different substrates mixture of the two studies seasons.

Substrate	Physical				Chemical	
	BD (kg/l)	TPS (%)	WHC (%)	AP (%)	EC (mmhos^{-1})	pH
Perlite:Peat moss (1:1(*v/v*)) (M1)	0.140	65.25	52.8	12.5	0.20	5.0
Perlite:Vermicompost (4:1(*v/v*)) (M2)	0.277	62.87	43.34	19.53	1.7	7.2
Perlite:Plant compost (4:1(*v/v*)) (M3)	0.275	60.92	44.14	16.78	4.84	8.4

*Bulk density= (BD) kg/l, total pore space= (TPS) **%**, water hold capacity= (WHC) % and air porosity= AP %

Table 2: The concentration of different nutrient solutions (ppm).

Nutrient solution source	Mineral	Vermi-compost tea	Animal compost tea
N	135	110.13	158.63
P	33.75	15.80	17.44
K	225	152.56	94.29
Ca	135	100.61	72.86
Mg	45	50.38	30
Fe	2.7	10.07	7.50
Mn	0.75	0.60	0.83
Cu	0.375	0.15	0.11
Zn	0.113	0.15	0.10
B	0.188	0.19	0.38
Mo	0.009	-	-
pH	7.2	7.8	7.5

- The measuring unit for EC is 1.5 mmhos^{-1}

Data recorded

Samples of three plants of each experimental unit were taken to determine growth parameters at 240 days after transplanting date (DAT) of the end two growing seasons, viz., plant height, number of leaves/plant, leaf chlorophyll reading (by using Minolta Chlorophyll Meter SPAD-501), and total leaf area/plant (by using LI 3000 portable area meter (*LI-300 portable area meter produced by LI- COR, Lincoln, Nebraska, USA*). Also, samples of 24 plants of each experimental unit (m^2) were taken to determine fruit parameters, viz., early yield/m^2 (determined as weight of all harvested fruits during November, December and January), total yield/m^2 (calculated as the fresh weight of all harvested fruits all over the growing season (from 30th

November until 28th May), average fruit weight and average number of fruit/m^2 were recorded. In addition, the fourth upper leaf of strawberry plants in each treatments were taken as samples (oven dried at 70° C for 3 hrs) then ground in a blender and were digested using sulfuric acid and hydrogen peroxide as described by Chapman and Pratt (1961). Leaf N, P and K contents were determined. Nitrogen, phosphorous and potassium in the acid digested solution were determined applying Micro-Kjeldahle for N, colorimetric method using spectrophotometer for P and by flame photometer for K (Chapman and Pratt, 1961).

Statistical analysis

It was done by computer, using SAS program for statistical analysis. The differences among means for all traits were tested by LSD at 5 % level of probability according to the procedure described by Snedecor and Cochran (1981).

RESULTS

Vegetative growth characteristics:

The different applied substrate mixtures, nutrient solutions and their interactions affected the vegetative parameters of strawberry plants such as number of leaves, plant height, leaf chlorophyll reading and leaf area/plant at 240 days after transplanting individual in the two tested seasons (Table 3).

The positive effect of the substrate mixture on the vegetative parameters. It is clear that the highest values with substrates mixture M1 (perlite: peat moss (1:1 *v/v*)) while, the lowest values in this respect were recorded with M2 (perlite: vermicompost (4:1 *v/v*)) during the two seasons.

Concerning, nutrient solutions source, chemical nutrient solution led to increase the vegetative growth parameter compared to the other sources. The lowest effect of nutrient solutions was obtained with animal compost-tea which was significantly different in the two seasons.

Regarding to the effect of interaction among treatments on vegetative parameters, (No of leaves/plant, plant height and leaf chlorophyll reading) the combination between M1 combined with mineral nutrient solution gave the highest values in both seasons. However, the highest values of total leaf area were obtained by using M1 combined with vermi-tea. Conversely, using M2 combined with animal compost-tea had a significant negative effect on the studied plant growth parameters, i.e. number of leaf/plant, plant height, leaf chlorophyll reading and total leaf area. Whereas, the lowest values of number of leaves and total leaf area were caused using M2 combined with vermi-tea and animal tea with no significant differences between them. These results were true during the two study seasons.

Yield characteristics:

Data for the influence of substrate mixtures and nutrient solutions as well as their interactions on early yield, total yield, average fruit weight and total fruit number per m^2 are presented in Table 4.

Regarding substrate mixtures, data indicate that M1 treatment resulted in the highest yield characteristics. The lowest yield characteristics were obtained by using M2. It's notable that the illustrated trend of results was confirmed during both studied seasons.

The obtained results in Table (4) revealed that nutrient solutions source significantly affected yield characteristics in the two growing seasons. Where, mineral nutrient solution gave the highest value of yield characteristics. While, the lowest values in this regard was obtained by using animal compost-tea.

Comparisons of substrate mixtures and nutrient solutions showed that the highest yield characteristics was obtained by using M1 combined with mineral nutrient solutions. In addition, using M1 combined with vermi-tea and with animal compost-tea and M3 (perlite: plant compost (4:1 *v/v*)) combined with mineral nutrient solutions gave the same positive effect on average fruit weight during both season of the study. Using M2 combined with animal compost-tea had the lowest value of yield characteristics. The results were related in the two seasons.

Chemical characteristics:

Application of substrate mixtures, nutrient solutions and their interaction affected significantly the chemical characteristics of strawberry plants such as N, P and K content percentage in the fourth leaf at season's end at 240 day after transplanting are presented in Table 5.

Significant and positive significant effect of M1 on macroelements was found. While, the lowest N, P and K in leaf percentage value of was recorded by using M2. Further, application of mineral nutrient solution produced significantly higher percentages of nitrogen, phosphorus and potassium in the fourth leaf of strawberry plants. Moreover, the leaf chemical characteristics were significantly decreased by using animal compost-tea.

Table (5) illustrated the effects of interaction between substrate mixtures and nutrient solutions on leaf chemical characteristics. The data indicate that the highest value of N, P and K content percentage in the fourth leaf were found by using M1 combined with mineral nutrient solution. While, the lowest concentrations of these elements were recorded by using M2 combined with animal compost-tea.

Table 5: Effect of nutrient solutions source and substrate mixtures on macronutrient concentration of the fourth leaf of strawberry plants at 240 days after transplanting in the two end winter seasons of 2012/2013 and 2013/2014:

	1st season				2nd season			
Substrate mixtures	**Nutrient solutions** source							
	Vermi.-tea	**Animal -tea**	**Mineral**	**Mean**	**Vermi.-tea**	**Animal -tea**	**Mineral**	**Mean**
				N%				
M1	2.69b	2.68c	2.78a	**2.71A**	2.46b	2.26c	2.55a	**2.42A**
M2	2.10h	1.94i	2.59e	**2.21C**	1.85h	1.48i	2.12d	**1.82C**
M3	2.32f	2.31g	2.63d	**2.42B**	1.98f	1.94g	2.09e	**2.00B**
Mean	**2.37B**	**2.31C**	**2.67A**		**2.10B**	**1.89C**	**2.25A**	
				P%				
M1	0.400b	0.370c	0.430a	**0.400A**	0.523b	0.470c	0.547a	**0.513A**
M2	0.200h	0.170i	0.320e	**0.230C**	0.367f	0.240g	0.452d	**0.353C**
M3	0.281f	0.260g	0.325d	**0.289B**	0.410e	0.368f	0.455d	**0.411B**
Mean	**0.294B**	**0.267C**	**0.358A**		**0.433B**	**0.359C**	**0.485A**	
				K%				
M1	3.28b	2.93c	3.49a	**3.23A**	3.23b	2.93c	3.34a	**3.17A**
M2	2.77h	2.62i	2.82e	**2.74C**	2.70h	2.61i	2.84e	**2.72C**
M3	2.79f	2.78g	2.90d	**2.82B**	2.78f	2.71g	2.89d	**2.79B**
Mean	**2.95B**	**2.78C**	**3.07A**		**2.90B**	**2.75C**	**3.02A**	

M1 =perlite: peat moss (1:1(v/v)), M2= perlite: vermicompost (4:1(v/v)), M3= perlite: plant compost (4:1(v/v)), vermi.-tea= vermicompost tea, animal-tea= animal compost tea.
* Different letters indicate significant difference at 5% and level of probability according to LSD.

DISCUSSION

Nowadays, using mixture of peat moss and perlite is one of the mostly used substrate for production of hydroponic strawberries in developing countries (Hochmuth *et al.,* 1998 and Jafarnia *et al.,* 2010). The substrate is a medium in which roots can grow, also protected plant as physical support (Ameri *et al.,* (2012). It can be constituted of pure materials or mixtures. This is because this capacity leads to higher capacity of nutrients and better water management (Hochmuth *et al.,* 1998; Ameri *et al.,* 2012 and Rostami *et al.,* 2014). Table (2) presented the lowest EC and pH found in substrate perlite: peat-moss mixture (1:1 *v/v*). This results may be to raise available nutrients for absorption. These substrates with positive responses had good aeration (Ebrahimi *et al.,* 2012b) and low tension water potentials (Ercisli *et al.,* 2005). The growth and development of plants were affected by aeration (Ebrahimi *et al.,* 2012b), pH (Martínez *et al.,* 2013) and cation exchangeable capacity

(Rostami *et al.,* 2014). It influenced vegetative growth and reproductive relevant parameters of strawberry plant efficiently (Ayesha *et al.,* 2011). Where, The low bulk density of the media has been due to its small number of pores, leading to its increased water conservation capacity and total pore space, whereas the substrate have a significant effect on the vegetative growth, yield parameter and chemical characteristics. However, Ebrahimi *et al.,* (2012a) showed that cocopeat + perlite substrate had the most effect on chlorophyll SPAD indicator in the old and young leaves of strawberry. In addition, Ebrahimi *et al.,* (2012b) found using cocopeat + perlite substrate improved the yield and qualitative and quantitative traits of fruit and plant of the strawberry. Also, perlite/ peat moss substrate 100%:0% ratios (v/v) produced the highest number of leaves the number of fruits. In addition, perlite/ peat moss substrate 80%:20% and 60%:40% ratios (v/v) increased the number of fruits as well as total yield. According to the type of media has to be defined based on necessities of producers and market places (Jafarnia *et al.,* 2010). Ameri *et al.,* (2012) showed that for better growth and consequently higher yield, suitable substrate that will have high water holding capacity, suitable bulk density and better porosity must be chosen. Also, Tariq *et al.,* (2013) observed that plants grown in peat moss at both planting densities moderately (30 x 60 and 15 x 30) increased the plant height, leaf area, number of fruits, fruit size and average fruit weight. In addition, fresh and dry weight of leaves, number of leaves and fruit yield were significantly increased.

In contrast, these properties of perlite: vermi or plant compost mixture (4:1 v/v) in (Table 1) presented the highest EC and pH. Alexander, (2009) show that such compost tends to have high pH, high conductivity, and potential for organic and/or mineral pollutants and therefore can be problematic for use growing media at high inclusion rates. These properties due to low ability to absorb nutrients. In addition, the high bulk density of the media has been due to its large number of pores, leading to its decreased water conservation capacity and total pore space whereas the substrate did not have a significant effect on the vegetative growth and yield parameters. Electrical conductivity increased sharply with leaching despite the use of compost in soilless culture is a viable alternative to resolve the environmental problem of vegetable waste (Mazuela *et al.,* 2012). Also, the vermicompost with perlite mixtures generally recorded the lowest yield (Abul-Soud *et al.,* 2015). Although much effort has been dedicated to the conflicting results indicate the need to open up new lines of research, defining a clear and objective concept of vermicompost, and clarifying the conditions and sources of variability in the biological effects. A case study is presented in which the direct and indirect effects of vermicompost on plant growth, as well as variability in the plant responses (Lazcano and Domínguez, 2011). However, there seem to be distinct differences between specific vermicomposts and composts in terms of their nutrient contents, the nature of their microbial communities, and their effects on plant growth (Atiyeh *et al.,* 2000). Also, there appear to be major differences between the effects of the vermicomposts and composts that were used in our study, in terms of their influence on tomato plant growth, depending upon the source of the parent waste material used in their production Atiyeh *et al.,* (2000).

On the other hand, the positive effect of inorganic fertigation on the vegetative growth, yield and chemical characteristics, it may be because that the availability of nutrients increased the photosynthesis process in plants that not only promoted the vegetative growth but also reproductive growth and chemical characteristics (Ayesha *et al.,* 2011). Therefore, mineral nutrient was adjusting for the changes in ion concentration and EC (1.5 mmhos^{-1}) of recirculating nutrient solution in closed-loop soilless culture on the basis of balance equation for nutrient uptake by hydroponically-grown plants (Trejo-Téllez and Gómez-Merino, 2012). Where the mineral nutrient supplied might be in proper balance, caused excellent and normal plants in all growth stages, produced the highest yield characteristics compared favorably with the other nutrient solutions (vermi- and animal compost tea).

While, vermi or animal compost-tea tends to had high pH, high conductivity, and potential for organic and/or mineral pollutants and therefore can be problematic for use growing media at high inclusion rates. Where, one of the main drawbacks of closed soilless systems is the accumulation of ballast ions in the recirculating nutrients solution, which may results in an increase in electrical conductivity (EC) (Pardossi *et al.,* 2011). In addition, compost tea used as amendments for strawberries produced treatments did not provide sufficient N to plants and consequently the yield was lower than expected. The latter results suggest a low N mineralization rate in municipal solid waste compost (Hargreaves *et al.*, 2009 b).

These lowest results may be own to high pH and EC of animal compost-tea compared to mineral fertilizer. Increased N rate in animal compost-tea has not been found to affect yield and in some cases it has reduced yield. Addition, vermin-tea used as amendments for strawberries produced fruit with good quality but treatments did not provide sufficient N to plants and yield was lower than expected. These results led to suggest a low N mineralization rate in vermi-tea as prepared by Hargreaves *et al.,* (2009b). Moreover, research-based information on N fertility management in organic strawberries is lacking (Muramoto *et al.,* 2004). In addition, with decreasing concentrations of vermicomposts and vermincompost teas there was less microbial activity in the teas (Arancon *et al.,* 2007). While, chemical nutrient solution increased availability of mineral nutrients, so it improved product fruits. Therefore, organic fertilizers alone cannot be used in conventional hydroponic systems, which generally only use inorganic fertilizers, because organic compounds in the hydroponic solutions generally have phytotoxic effects that lead to poor plant growth (Shinohara *et al.*, 2011). Vermicomposts have a fine particulate structure and contain nutrients in forms that are readily available for plant uptake, when all required nutrients were supplied. However, there seem to be distinct differences between specific vermin composts and composts in terms of their nutrient contents, the nature of their microbial communities, and their effects on plant growth. These results agree with those obtained by Atiyeh *et al.,* (2000). The (vermi- and animal) compost tea supplied might be not in proper balance, caused to poor plant growth in all growth stages and produced lower yield characteristics. In particular, the results of Hargreaves et al., (2009a) were similar to effective using non-aerated compost teas on strawberries.

Whereas, all the analyzed macronutrients contents attained increasing leaves concentrations for inorganic (mineral) treatment, but the organic treatment was resulted in the general decrease in all analyzed macronutrients contents of leaves. Where, leaf N content was lower in strawberry plants treated with compost than those given fertilizer (Preusch *et al.,* 2004). Potassium percentage in the leaves were obtained when nitrogen fertilizer (as an inorganic and organic compost manure). These results may be due to the quick absorption of mineral K fertilizer (Awad *et al*., 2010). Subsequently, increased addition of K had a positive effect on the growth and yield of strawberry and increased leaf concentration of K. In addition, Systems using other N sources may have a P deficit (Nelson and Janke, 2007), therefore requiring compost tea supplementation for optimal plant growth compared with balanced mineral nutrient solution. The concentrations of N, K and P in leaves and the yield was significantly higher in hydroponic than in aquaponic (except for the substrate of sole perlite). The highest P level was obtained in the substrate of 50% perlite + 50% cocopeat in hydroponic treatment (Roosta and Afsharipoor, 2012). Subsequently, these results may be caused to an increase in pH from all treatments (Hargreaves *et al*., 2009a).

Conclusively, from these results of this experiment, for better vegetative growth and consequently higher yield and chemical contents, proper substrate that will have high water hold capacity, suitable bulk density and better porosity must be chosen. Among substrate mixtures, using perlite: peat-moss, which consequently had high vegetative growth, yield and chemical characteristics. Also, among nutrient solutions source, mineral nutrient solution, had high values for different physical and chemical characteristics. The end, using perlite: peat-moss combined with mineral nutrient solution was the best interaction treatment for the measured properties.

REFERENCES

Abul-Soud, M.A.; M.S.A. Emam and N.G. Abd El-Rahman (2015). The potential use of vermicompost in soilless culture for producing strawberry. *Int. J. of Plant Soil Sci.,* 8(5): 1-15.

Albaho, M.; N. Bhat; H. Abo-Rezq and B. Thomas (2009). Effect of three different substrates on growth and yield of two cultivars. *Eur. J. Sci. Res.,* 28(2): 227-233.

Alexander, (2009). An assessment of the suitability of backyard produced compost as a potting soil. *Compost Science & Utilization*, 17(2), 74-84.

Arancon, N.Q.; C.A. Edwards; R. Dick and L. Dick (2007). Vermicompost tea production and plant growth impacts. Biocycle advancing composting , organics recycling and renewable energy. 419 state avenue, Emmaus, PA 18049-3097. 610-967-4135. *www.biocycle . net.*

Ameri, A.; A. Tehranifar; G. H. Davarynejad and M. Shoor (2012). Effect of substrate and cultivar in quality of Strawberry. *J. Biol. Environ. Sci*., 6(17): 181-188.

Atiyeh, R.M.; S. Subler; C.A. Edwards; G. Bachman; J.D. Metzger and W. Shuster (2000). Effects of vermicomposts and composts on plant growth in horticultural container media and soil. *Pedobiologia,* 44: 579–590.

Awad, El. M. M.; R. A. Mohamed and H. El. Asfour (2010). Effect of compost, foliar spraying with potassium and boron on growth, yield and fruit quality of strawberry. *J. Plant Production, Mansoura University*, 1(8):1101-1112.

Ayesha, R.; N. Fatima; M. Ruqayya; H. Faheem; K.M. Qureshi; I.A. Hafiz; K.S. Khan; U. Ali and A. Kamal (2011). Influence of different growth media on the fruit quality and reproductive growth parameters of strawberry (*Fragaria* × *ananassa*). *J. Med. Plants Res*., 5(26): 6224-6232.

Cantliffe, D. J.; J.Z. Castellanos and A.V. Paranjpe (2007). Yield and quality of greenhouse-grown strawberries as affected by nitrogen level in coco coir and pine bark media. *Proc. Fla. State Hort. Soc*., 120:157–161.

Cantliffe, D.; J.N. Shaw; E. Jovicich; J.C. Rodriguez; I. Secker and Z. Kaechi, (2001). Passive ventilate high-roof greenhouse production of vegetables in a humid mild winter climate. *Acta Horticulture*, 559: 515-520.

Chapman, H.D. and F.P. Pratt (1961). Ammonium vandate-molybdate method for determination of phosphorus. In: *Methods of Analysis for Soils, Plants and Water*. 1st Ed. California: California University, Agriculture Division.pp.184-203.

Ebrahimi, R., F. Ebrahimi and M. Ahmadizadeh (2012a). Effect of different substrates on herbaceous pigments and chlorophyll amount of strawberry in hydroponic cultivation system. *American-Eurasian J. Agric. & Environ. Sci*., 12 (2): 154-158.

Ebrahimi, R., M.K. Souri, F. Ebrahimi and M. Ahmadizadeh (2012b). Growth and yield of strawberries under different potassium concentrations of hydroponic system in three substrates. *World Applied Sci. J.*, 16 (10): 1380-1386.

El-Behairy, U. A. (1994). The effect of levels of phosphorus and zinc in the nutrient solution on macro and micronutrients uptake and translocation in cucumber (*Cucumus sativus* L.) grown by nutrient film technique. Ph. D thesis, London University p.299.

Eklind, Y.; B. Raemert and M. Wivstad (2001). Evaluation of growing media containing farmyard manure compost, house hold waste compost or chicken manure for the propagation of lettuce (*Lactuca sativa* L.) transplants. *Biol. Agric. Hortic*., 19:157–181.

Ercisli, S., U. Sahin, A. Esitken and O. Anapali (2005). Effects of some growing media on the growth of strawberry cvs. Camarosa and Fern. *Acta Agrobotanica*, 58, z.1: 185-191.

Gruda, N. (2009). Do soilless culture systems have an influence on product quality of vegetables? *J. of Appl. Botany and Food Quality*, 82: 141 – 147.

Hargreaves, J.C., M.S. Adl and P.R. Warman (2009a). Are compost teas an effective nutrient amendment in the cultivation of strawberries? Soil and plant tissue effects. *J. Sci. Food Agric.*, 89: 390–397.

Hargreaves, J.C., M.S. Adl and P.R. Warman (2009b). The Effects of municipal solid waste compost and compost tea on mineral element uptake and fruit quality of strawberries. *Compost Sci. & Utilization*, 17(2): 85-94.

Hashemimajd, K, M. Kalbasi, A. Golchin and H. Shariatmadari (2004). Comparison of vermicompost and composts as potting media for growth of tomatoes. *J. of Plant Nutr*., 27:1107-1123.

Hesami, A.; S.S. Khorami; F. Amini and A.B. Kashkooli (2012). Date-peat as an alternative in hydroponic strawberry production. *African J. of Agric. Res.*, 7(23): 3453-3458.

Hochmuth, R.C.; L. L. Davis; T. Crocker; D. Dinkins, and G. J. Hochmuth (1998). Evaluation of two soilless growing media and three fertilizer programs in outdoor bag culture for strawberry in north Florida. *Proc. Fla. State Hort. Soc*., 11:341-344.

Inbar, Y., Y. Hadar and Y. Chen (1993). Recycling of cattle manure: The composting process and characterization of maturity. *J. of Environ. Quality,* 22: 857-863.

Jafarnia, S., A. Hatamzadeh and A. Tehranifar (2010). Effect of different substrates and varieties on yield and quality of strawberry in soilless culture. Adv. in *Environ. Biol*., 4(2): 325-328.

Jensen, M.H. (1999). Hydroponics worldwide. Acta Horit., 481: 719-729.

Lazcano, C. and J. Domínguez (2011) The use of vermicompost in sustainable agriculture: impact on plant growth and soil fertility. In: *Soil Nutrients*. Editor Mohammad Miransari, pp. Nova Science Publishers, Inc. chapter 10, Pp. 1-23.

Lieten, F. (2001). Protected cultivation of strawberries in central Europe. *Proc. 5th North American strawberry Conference*, p: 102-107.ASHS Press.

Martínez, F., S. Castillo, C. Borrero, S. Pérez, P. Palencia and M. Avilés (2013). Effect of different soilless growing systems on the biological properties of growth media in strawberry. *Scientia Horticulturae*, 150: 59–64.

Mazuela, P., M. Urrestarazu and E. Bastias (2012). Vegetable waste compost used as substrate in soilless culture. En: *Crop Production Technologies*. Ed. Publisher In Tech. Pp. 179: 198. Dispo-nible en: *http://www.intechopen.com/books/crop-production-technologies/ vegetable - waste-compost-used-as-substrate-in-soilless-culture.*

Muramoto, J., S.R. Gliessman, D. Schmida, R. Stephens, C. Shennan and S.T. Swezey (2004). *Nitrogen Dynamics In An Organic Strawberry Production System*. California Organic Production and Farming in the New Millennium: A Research Symposium. The International House, University of California, Berkeley California, pp.131-134. University of California sustainable agriculture research and education program (UC SAREP) accessed at *www. sarep. ucdavis. edu/ organic/ CCBC posters. pdf*

Nelson N. O. and R. R. Janke (2007). Phosphorus Sources and Management in Organic Production Systems. *Hort. Technology*, 17 (4): 442-454.

Pardossi, A., G. Carmassi, C. Diara, L. Incrocci, R. Maggini and D. Massa (2011). Fertigation and Substrate Management in Closed Soilless Culture. Dipartimento di Biologia delle Piante Agrarie (DBPA), University Of Pisa, Italy. *Viale delle piagge,* 23, 56124 Pisa, Italy. Pp.1-63.

Preusch, P. L., F. Takeda and T.J. Tworkoski (2004). N and P uptake by strawberry plants grown with composted poultry litter. *Sci. Hortic. (Amsterdam)*, 102:91–103.

Raul, I. C. (1996). *Measuring Physical Properties*. Rutgers Cooperative Extension. New Jersey Agriculture Experiment Station, New Jersey University.

Robertson, R. A. (1993). Peat, horticulture and environment. *Biodivers. Conserv.*, 2:541–547.

Roosta, H.R. and S. Afsharipoor (2012). Effects of different cultivation media on vegetative growth, ecophysiological traits and nutrients concentration in strawberry under hydroponic and aquaponic cultivation systems. *Adv. Environ. Biol*., 6(2): 543-555.

Rostami, Z., A.M. Ghahsare and B. Kavoosi (2014). Date palm waste application as culture media for strawberry and its impact on some growth indices and yield components. *Agric. Communications*, 2(3): 15-21.

Shinohara, M., C. Aoyama, K. Fujiwara, A. Watanabe, H. Ohmori, Y. Uehara and M. Takano (2011) Microbial mineralization of organic nitrogen into nitrate to allow the use of organic fertilizer in hydroponics *Soil Sci. Plant Nutr.*, 57(2): 190-203.

Snedecor, G.W. and W.G. Cochran. (1981). *"Statistical Methods"*. 7th ed., Iowa State Univ., Press, Ames, Iowa, USA, pp. 225-330.

Stanley, D. (1998). Hydroponic strawberries avoid soil pests. *Agric. Res.*, 46(11): 10-11.

Takeda, F. (1999). Strawberry production in soilless culture systems. *Acta Hort.*, 481: 289-295.

Tariq, R., K.M. Qureshi and I. Hassan (2013). Effect of planting density and growing media on growth and yield of strawberry. *Pakistan J. Agric. Res.*, 26(2): 113-123

Tilt, K.M. and T.E. Bilderback (1983). Manipulation of physical properties of pine bark and hardwood bark container media and its effects on the growth of three ornamental specie. *Hort. Sci.*, 18: 88.

Trejo-Téllez, L.I. and F.C. Gómez-Merino (2012). Nutrient solutions for hydroponic systems. *Hydroponics – A Standard Methodology for Plant Biological Researches.* Chapter 1, P. 1 -22.

Verdonck, O., D. De Vleeschauwer and M. De Boodt (1982). The influence of the substrate to plant growth. Acta. Hort. 126: 251-258.

Wilson, G.C.S (1983). The physico-chemical and physical properties of horticultural substrate. *Acta Hort.*, 150: 19-32

Zaller, J.G. (2007a). Vermicompost as a substitute for peat in potting media: Effects on germination, biomass allocation, yields and fruit quality of three tomato varieties. *Sci. Horticult.*, 112: 191–199.

Zaller, J.G. (2007b). Vermicompost in seedling potting media can affect germination, biomass allocation, yields and fruit quality of three tomato varieties. *European J. Soil Biol*., 43: S332-S336.

تأثير مخاليط البيئات ومصادر المحاليل الغذائية علي نباتات الفراولة تحت النظام المغلق للزراعة بدون تربة

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تمت الدراسة لتقييم تأثير ثلاث مخاليط بيئة و ثلاث مصادر للمحاليل المغذية علي النمو الخضري و المحتوي الكيمائي و الانتاج لنباتات الفراوله صنف فيستيفال في نظام الزراعة بدون تربة. زرعت في ١ شهر اكتوبر خلال الموسمين الشتويين ٢٠١٢ /٢٠١٣ و٢٠١٣/٢٠١٤ تحت ظروف الصوب المزدوجة المغطاه بالشباك البلاستيكية ؛ المعمل المركزي للمناخ الزراعي ؛ مركز البحوث الزراعية.

كانت المعاملات التجريبية مكونه من ثلاث مخاليط بئية مختلفة (بيرليت: بيت موس ((١/١) حجم/حجم)؛ بيرليت : فيرمي كمبوست ((١/٤) حجم/حجم)؛ بيرليت: كمبوست نباتي (١/٤) حجم/حجم) مع ثلاث محاليل مغذية مختلفة منها منقوع الفيرمي كمبوست؛ ومنقوع كمبوست حيواني؛ بالمقارمنه بالمحلول المغذي الكيمائي). حيث صمم التجربه كتجربة عاملية بثلاث مكرارت. قد تم قياس عدد الاوراق و ارتفاع النبات و الكلوروفيل و المساحه الكلية لأوراق النبات والانتاج المبكر و الكلي و متوسط وزن الثمرة و عدد الثمار و نسبة محتوي النيتروجين والفوسفور والبوتاسيوم للورقة الرابعة.

اظهرت النتائج ان هناك استجابة معنويه فى صفات النمو الخضري والانتاجية و التحليل الكيميائي للورقه الرابعه باستخدام بيئة البيرليت : البيت موس تحت ظروف التجربة. بينما أدى استخدام المحلول المغذي الكيمائي الي حدوث تأثيرا معنويا لكل الصفات التى تم قياسها. كما ادي استخدام كلا من بيئة البيرليت : البيت موس مع المحلول المغذي الكيمائي لزياده معنويه لكل الصفات المدروسه. بالاضافة الي ان استخدام كلا من بيئة البيرليت : البيت موس مع منقوع الفيرمي كمبوست ساعد علي زياده ارتفاع النبات و المساحه الكلية لأوراق النبات.

التوصية: استخدام الخلطه البيئيه البيرليت: البيت موس ذات قدره تخزينية عاليه اعطت اعلي نمو و انتاج و صفات كيمائية. و قد ادى استخدام المحلول المغذى الكيميائى إلى زياده الصفات الطبيعيه و الكيمائية. وايضا عند استخدام الخلطه البيئيه البيرليت: البيت موس مع المحلول المغذى الكيميائى ساعد على تحسين الصفات المدروسه تحت ظروف التجربه.