APPLICATION OF DATE PALM PETIOLE (DATE-PEAT) IN HYDROPONIC CULTURE OF STRAWBERRY (*FRAGARİA ANANASSA*)

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ABSTRACT

According to published statistics by FAO in 2008, more than 244000 hectares of farm lands in Iran have been allocated to palm cultivation. Large amounts of palm wastage are thrown away without any usage annually. By contrast, cocopeat, which is produced from coconut trees, is imported for different purposes per annum. Thus, in order to find an alternative compound to cocopeat, an experiment was conducted with different combinations of palm leaf petioles (date-peat), cocopeat and perlite in hydroponic culture beds for strawberry, under controlled conditions. The results showed that the best combination was achieved when a mixture of two parts of perlite, one part date-peat and one part cocopeat, resulted in increased fruit yield, fruit number, chlorophyll content and leaf area. Additionally, the highest vitamin C content was observed in 3:1 ratio of perlite and cocopeat treatment. On the other hand, application of three parts of date-peat + one part of cocopeat and also three parts of cocopeat + one part of date-peat, led to increased total soluble solids however there was no significant difference between mixtures. Nowadays, the growth medium in hydroponic bed mainly consists of mixture of cocopeat and perlite. Presented results suggest that palm wastages (date-peat) could be a good alternative to be partly substitute coconut fiber for strawberries and possibly other hydroponic crops.
Keywords: Iran, Bushehr, Strawberry, Cocopeat, Date-peat, Hydroponic culture.

1. INTRODUCTION

In recent years, drought stress and water shortage is considered as a dilemma in many parts of world. Iran with semi-arid climate and average annual rainfall of 247 mm is not an exception. Therefore the use of greenhouses and soilless culture methods is an efficient strategy under these conditions. Soilless culture is defined as plant production without soil, which is often called hydroponic culture (Olympios, 1993). Compared with soil culture, soilless cultivation has higher water use efficiency and led to increase in yield (Rouphael *et al.*, 2004). These systems also lead to better water and fertilizer management (Al-Raisy *et al.*, 2010). While pests and diseases are a major problems in soil culture (Gul *et al.*, 2005), hydroponic cultures are mainly free from weed seeds and also incidence of root pathogens are lower (Cantliffe *et al.*, 2007).

Strawberry (*Fragaria ananassa*) is one of the major crops in hydroponic culture. Because of its taste, scent and high vitamin content, strawberry is well known all over the world and is common fruit in food diets (Tabatabaei *et al.*, 2006). About 0.67% of global strawberry production is from Iran, which is doubled in last two decades. Since Iran has a unique climate for strawberries, it has a potential to be one of the main world producers in future (Tehranifar and Sarsaefi, 2002). In many countries strawberry is commonly field cultivated in soil. In temperate regions such as North and Central Europe, Korea, Japan and some areas of China it is also cultivated under hydroponic conditions in greenhouses (Cantliffe *et al.*, 2007). Greenhouse production results in higher yield, forcing possibilities, better pests control and thus reducing the usage of chemicals which could be a benefit for fruits quality (Dinar, 2003). Growth media and nutrition are the most important factors in hydroponic production.

Application of organic materials as substrates for hydroponic culture media has been reported by Tilt and Bilderback (1983). Some studies express the advantage of pine leaves (Paranjpe *et al.*, 2003) and rice (Caso *et al.*, 2009) bran as media for soilless culture of strawberries. Furthermore, cocopeat in media improves water holding capacity and increases media porosity causing positive effects on physical properties (Abad *et al.*, 2002; Fornes *et al.*, 2003). The main median hydroponic systems are a mixture of perlite and cocopeat. Cocopeat is obtained from the coconut (*Cocos nucifera*) that is not grown in Iran.

The purpose of this experiment was to understand if date palm wastes (date-peat) can be an alternative for cocopeat in strawberry production.

2. MATERIAL AND METHODS

The experiment was carried out in a greenhouse located in Faculty of Agriculture and Natural Resources, Persian Gulf University, Bushehr, Iran during the 2007-2008 growth seasons. Strawberry plants (cv. Gavieta) were purchased from a valid nursery in Karaj, Iran. Preparation of culture media was performed in December, 2007. Date palm petioles, which called date-peat from now, were collected from local date orchards and cocopeat and perlite were bought from market. At beginning of the experiment, different combinations of date-peat, cocopeat and perlite were prepared. The combinations are shown in table 1. Cocopeat was not sterilized but was soaked in water for 24 hours and then placed on sieves for exuding excess water. To prepare date-peat, dried parts of petioles (called "Ghondagh" in folk culture of Bushehr province) were used. Petioles were crushed into maximum size of 1cm by grinder. Later crushed palm petioles were sterilized with water vapor. Physical and chemical properties of cocopeat and date-peat are given in table 2.

Five liter plastic pots were filled up with different prepared culture media and planted with 3-4 leaves strawberry plants on the first days of January. In order to prevent drought stress, plants were irrigated with equal water volumes, immediately. To reduce the error, we minimized the effect of fertilizer by using a

fixed nourishing solution for plants (common nutrition formula of Hoagland and Arnon), which is used in California University (Hoagland and Arnon 1950). In order to reduce error, an open solution nutrition system was used. Moreover, equal amounts of nutrition solution were added to each pot. At beginning of flowering, complete NPK fertilizer (20:20:20) was added into the nutrition solution with final concentration of 5:1000. During whole growth stages, nutrition solution pH was adjusted on 6.5 and EC was fixed on 3.3mmhos.cm^{-1}. These parameters were monitored daily by portable devices. Pots were irrigated three times per month with distilled water to prevent salts accumulation and salinity stress induction. Premature flowers, dried leaves and runners were eliminated during growth season.

Table 1. Different substrate combinations in the experiments

Symbol	Treatment
P	perlite
C	cocopeat
D	date palm petiole (date-peat)
P1C1	1 part perlite+ 1 part cocopeat
C1D1	1 part cocopeat + 1 part date-peat
P1D1	1 part perlite + 1 part date-peat
P3D1	3 parts perlite + 1 part date-peat
P3D1	3 parts perlite + 1 part cocopeat
C3D1	3 parts cocopeat + 1 part date-peat
C3P1	3 parts cocopeat + 1 part perlite
D3P1	3 parts date-peat + 1 part perlite
D3C1	3 parts date-peat + 1 part cocopeat
P1D1C2	1 part perlite + 1 part date-peat + 2 parts cocopeat
P1D2C1	1 part perlite + 2 parts date-peat + 1 part cocopeat
P2D1C1	2 parts perlite + 1 part date-peat + 1 part cocopeat

Fruits with 60-70% reddish pink color were harvested and transferred to laboratory. In order to determine the effect of treatments on fruits, some qualitative and quantitative characteristics such as fruit yield, fruit size, fruit number, leaf chlorophyll content, leaf area and number of leaves were assayed.
Leaf chlorophyll content was measured using portable chlorophyll meter (SPAD502, Japan) at flowering stage. For this purpose, chlorophyll content was measured in three same leaves of each pot and average content was presented as chlorophyll content per pot. Additionally, three leaves from the each plant were selected and leaves area were measured by portable leaf area meter (CI_202, USA). Leaves number of each pot were counted simultaneously.
Fruit number was registered at harvest time. Fruits weight was weighed using a digital scale. Fruit volume was determined via Water displacement technique (Arzani *et al.* 1999).

Table 2. Some physical and chemical properties of cocopeat and date-peat media.

	Ability to maintain moisture (times of dry weight)	Ec ($mmhos.cm^{-1}$)	pH
Date-peat	7	7.09	6.51
Cocopeat	8.5	1.30	6.67

The experimental design was randomized complete blocks (RCBD) including 15 treatments and 4 replications. All data were subjected to MSTAT-C software for analysis of variance and Duncan's Multiple Range (DMRT) Test was used for means comparison.

3. RESULT

Table 3. Effect of different combinations of culture media on quantity traits of strawberry grown in hydroponic culture

Treatment	Yield ($gr.plant^{-1}$)	Fruit volume (cm^3)	Fruit number (-)	Chlorophyll (-)	Leaf area (cm^2)	Leaf number (-)
P	46.58 h	7 bcd	7 d	48.3 a	177.3 abc	33.25 a
C	49.52 g	7.25 bcd	6.75 d	43.97 ab	166.3 abcd	15.2defgh
D	20.8 k	13.25 a	2.75 h	39.05 b	125.7 d	10.5 hi
P1C1	80.97 b	7.25 bcd	10.75 b	44.17 ab	179.9 abc	15.2 defgh
C1D1	22.05 k	5.25 bcd	4.5 fg	43.95 ab	139.4 cd	14 fgh
P1D1	60.75 d	9.75 d	6.5 de	44.9 a	168 abcd	13.5 ghi
P3D1	76.82 c	7.25 bcd	10.75 b	46.53 a	166.8 abcd	26.75 b
P3C1	60.92 d	7.5 bcd	8.5 c	47.33 a	183.6 abc	24.25 bc
C3D1	52.6 f	7.75 bcd	7 d	46.5 a	165 abcd	18.75 def
C3P1	34.85 i	9.5 bc	3.75 g	46.65 a	180.7 abc	26.5 b
D3P1	46.65 h	10 b	4.75 fg	45.2 a	144.6 bcd	15 efgh
D3C1	49.33 g	7 bcd	7 d	48.65 a	187 ab	17.2 defg
P1D1C2	27.1 j	7.25 bcd	4 g	47.42 a	177.4 abc	19.7 cde
P1D2C1	44.38 h	8 bcd	5.5 ef	44.6 ab	178 abc	16.5 defg
P2D1C1	88.88 a	6.5 cd	13.75 a	47.4 a	201.4 a	20 cd

– P: perlite; C: cocopeat; D: date-peat
– Means with similar letter(s) are not significant at the 5% probability level

– **Fruit yield and volume**

The results revealed that treatment P2D1C1 (2 parts of perlite + 1 part date-peat + 1 part cocopeat) had significant better effect on fruit yield than the other treatments, and fruit yield noticeably increased. Regarding fruit yield P1C1 treatment (1 part perlite + 1 part cocopeat; (control treatment)) was second best. The treatments D (Date-peat) and C1D1 (1 part cocopeat + 1 part date-peat) had the lowest fruit yield (Table 2). The largest and smallest fruits were related to D and C1D1, respectively (Table 2). However, C1D1 was not significantly different

from the other treatments except for D. Treatment P2D1C1 had the highest fruit number compared with the other treatments. Vice versa, treatment D had the lowest fruit number (Table 2).

– **Chlorophyll content, leaf area and leaf number**

Date-peat as only substance of the growing media resulted in lowest chlorophyll content of the treatments, but could not be distinguished from treatments C, P1C1, C1D1 and P1D2C1 (Table 3). Changing substances in culture media had effect on leaf area. Treatment P2D2C1 could, with the highest leaf area, be clearly separated from treatment D, D3P1 and C1D1 which had the lowest areas. Also treatment D3C1 had a large leaf area and was ranked the second. Growing in a media consisting of date-peat (D) was not successful and reduced leaf area dramatically. The maximum leaf number was observed in those pots which were filled with perlite only. Treatments P3D1 and C3P1 had the highest leaf number. Leaf number generally decreased when date-peat were added.

4. DISCUSSION

In general, obtained results showed that application of organic matter in combination with perlite, increased fruit yield, which is in agreement with Tehranifar *et al.* (2007). They studied effect of seven growth media on quality and quantity of three strawberry cultivars grown in hydroponic conditions where cocopeat and peat produced the highest fruit yield. On the other hand perlite, as an effective material to improve porosity, showed an important role in improving growth media based on organic material. The highest yields here were obtained by treatments P2D1C1 and secondly by P1C1. This indicates that the higher level of date palm petiole (date-peat) has high ability for moisture saving and can be an important substance in commercial hydroponic production. Increased yield in treatment P2D1C1 can be related to the high leaf area in spite of a relative low leaf number. The high leaf area caused by this treatment may be the reason to a high level of assimilates causing a high flower/fruit production and finally, higher yield. On the other hand, date-peat as the only substance in the media had diverse effects on fruit yields. As for application of non composted date-peat in this experiment, it seems that, probably it contained some growth inhibitors with adverse effects on fruit production. This possible negative inhibitory effect was reduced adding perlite or crushed petiole combined with cocopeat and perlite, avoiding that the concentration of inhibitory compounds reduced growth and yield. There was a negative correlation between fruit volume and fruit size but it was not linear. In treatment D, lowest fruit number observed, while fruit volume was the highest. In P2D1C1, regardless of high fruit number, fruit volume decreased, however because of good vegetative growth, decrease in fruit volume was not significant.

The negative effect of date-peat on chlorophyll content and leaf number probably may be eliminated after composting. On the other hand combination with cocopeat, perlite or both of them can reduce the adverse effect of non composted

date-peat. According to treatment P2D1C1, leaf number was the highest when data were compared with other treatments. High leaf number in treatment P (perlite) can be linked to negative correlation between high vegetative and non vegetative growth.

Effect of different culture media on fruit quality did not follow a specific pattern. In the other words, the rate of soluble solids in fruit juice, vitamin C and acid content varied between media combinations; however culture media with high organic matter content had better quality due to ratio of vegetative growth (data are not shown). As a matter of fact, high energy consumption in treatments like P1C1 and P2D1C1 lead to decreased TSS and vitamin C levels in fruit juice(data are not shown). In addition, acid contents were low in these treatments, which are as a result of fruit ripening, obviously, acid content decreases in fruits as a result of fruit ripening.

5. CONCLUSIONS

The summary of the experiments shows that combination of organic matter as a moisture retainer, and perlite as a proper material for soil porosity in the growth media, results in higher yield and acceptable quality. Giving that plants growing in P1C1 and P2C1D1 media had the highest yield, moderate TSS in fruit juice and low acid content in this study. Since applied date-peat was not composted, it probably contained some inhibitory substances. Possibly, beforehand composting could have decreased the negative effects of unknown substances when growing strawberries in hydroponic systems, and as so could have a potential as an appropriate material for full substitution of cocopeat.

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