Middle East Journal of Applied Sciences
Volume: 13 | Issue: 04| Oct. – Dec. | 2023

EISSN: 2706 -7947 ISSN: 2077- 4613
DOI: 10.36632/mejas/2023.13.4.48
Journal homepage: www.curresweb.com
Pages: 692-700

Producing Hot Pepper in Pots Using Different Substrate Mixtures

Neveen E. Metwally[1], Wafaa R. Hamed[1] and Enass N. Eissa[2]

[1]Central Laboratory for Agricultural Climate (CLAC), Agricultural Research Center, Ministry of Agriculture and Land Reclamation, Egypt.
[2]Arid Land Agricultural Graduate Studies and Research Institute (ALARI), Ain Shams University, Egypt.

Received: 25 Oct. 2023 **Accepted:** 10 Dec. 2023 **Published:** 25 Dec. 2023

ABSTRACT

In substrate culture, determine the suitable raw materials that can be used as a substrate even alone or mixed together for vegetable production it's not an easy process; because of the potential impacts of these substances, which may have an impact on plant development and productivity directly or indirectly. Consequently, select the best substrate mixture that consists of various materials is imperative to plant productivity. In this context, an experiment has been carried out in the rooftop garden of Central Laboratory for Agricultural Climate (CLAC), Agricultural Research Center, Ministry of Agriculture and Land Reclamation, Dokki, Giza, Egypt during two summer seasons of 2021 and 2022. The aim of this work was to determine the most suitable substrate mixture for producing hot pepper. Different substrate mixtures have been examined in this experiment with regard to both growth and yield of hot pepper, their description was as follow; mixture of perlite : coco peat 1:1 v/v (PeCo), mixture of sand : rice husk 1:1 v/v (SRh), mixture of sand : coco peat 1:1 v/v (SCo) and mixture of sand : coco peat : rice husk 1:1:1 v/v/v (SCoRh).The obtained results indicated that mixture of perlite : coco peat recorded the highest values for plant hight, number of leaves per plant, fresh and dry weights of aerial parts, root fresh and dry weights and yield per m^2.Furthermore,a close result have been recorded by mixture of sand : rice husk. For that, both substrate mixtures (mixture of perlite: coco peat and mixture of sand: rice husk) can be considered as a suitable substrate mixture for producing hot pepper grown in pot system.

Keywords: Hot pepper,substrate culture, pot system, substrate mixtures, roof gardens

1. Introduction

It is commonly known that in situations where significant soil and water issues (such as chemical residues in soil, water salinity, soil-borne pests, and water scarcity) could make conventional soil production challenging, soilless culture provides an alternative to soil culture. The primary benefits of soilless culture include easier and more precise control over the production elements which will lead to increase the productivity, less labor requirements, no need for soil sterilization, and the ability to grow more crops annually (Tuzel *et al.,* 2008).

Globally, as civilization has advanced, soil farming has faced significant obstacles, including a decrease in the amount of available land. In addition, the soil cultivation will face increasingly difficult challenges because of the quickening pace of urbanization and industrialization, as well as the dangers posed by climate change and its unfavorable consequences. In these conditions, feeding the entire population with soil production will be complicated in the near future. In order to meet these issues, soilless culture is inevitably becoming more important in the current scenario. The fastest-growing area of agriculture is soilless culture, which may provide a boost to food production in the future. Future soil growth conditions are projected to make the soilless culture sector grow tremendously as well. By applying a soilless cultivation method with artificial substrates, water and nutrients could be used more

Corresponding Author: Neveen E. Metwally, Central Laboratory for Agricultural Climate (CLAC), Agricultural Research Center, Ministry of Agriculture and Land Reclamation, Egypt.
E-mail: neveen2000eg@yahoo.com

effectively, and the amount of pesticides needed to manage pests and diseases could be reduced. High yields, quick harvesting, consistent exceptional quality, and high nutrient content are characteristics of plants grown in soilless culture (Hussain *et al.,* 2014).

Popular local crops could be grown using soilless culture at a fair price while adhering to food safety regulations (Paul, 2000). Soilless agriculture can assist in managing production systems to effectively use natural resources and reduce malnutrition, as well as in addressing the problems posed by climate change (Butler and Oebker, 2006).

Substrate culture is one of soilless systems. Substrates are materials other than soil used to grow plants in it. These may consist of inorganic materials like perlite, sand, gravel, vermiculite and expanded clay or organic materials like peat, coconut coir, and tree bark (Grunert *et al.,* 2008 and Vaughn *et al.,* 2011). In addition, Nair *et al.,* (2011) reported that substrates can be used individuals or as mixtures such as peat and perlite or peat and compost…etc.

The type of growth material used in greenhouse crop production is one of the most crucial cultivation inputs, possibly the most crucial (Angin *et al.,* 2011).

The most popular kind of substrate used in soilless growth systems in pots or containers is perlite. Granules of perlite are made of a silicone mineral that occurs in volcanoes and is incredibly light. You can add this medium to growing mediums to improve the substrate's drainage and aeration (Hussain *et al.,* 2014).

One of the significant agricultural waste products utilized as a growing medium for plants is rice husk, a byproduct of the milling industry (Tran *et al.,* 1999). Moreover, Awang *et al.* (2009) stated that a valuable agricultural waste product used as a planting substrate is rice husk; it makes up 20% of the weight of rice. Because of its good chemical and physical qualities and light weight, rice husk is regarded as an excellent growing medium.

Shredded coconut husks are used to make coco peat, an entirely organic material. As the seed floats in the ocean, the coconut husk protects it from the sun and salt and provides a hormone-rich, fungus-free milieu that accelerates germination and rooting when the seed lands on land. Coconut coir, which is steam sterilized and finely shredded, provides plants with an optimal rooting medium while simultaneously providing defense against fungi and root diseases. Coir is also a fully renewable resource, in contrast to peat moss, which is quickly running out due to overuse (Hussain *et al.,* 2014).

For plants that need a proper growing environment with loose soil, sand is a useful growing medium. Overflowing water will not seep into the sand the way it would in clay, but instead cause runoff. Since sand is lightweight and easy for root plants to expand in, it produces more vegetables for root plants like potatoes and carrots (Hussain *et al.,* 2014).

Hot pepper is a widely utilized vegetable and spice crop for both domestic and commercial purposes (Khan *et al.,* 2012).

For that the aim of this work was to determine the most suitable substrate mixture for producing hot pepper.

2. Materials and Methods

An experiment has been carried out in the rooftop garden of Central Laboratory for Agricultural Climate (CLAC), Agricultural Research Center, Ministry of Agriculture and Land Reclamation, Dokki, Giza, Egypt during two summer seasons of 2021 and 2022.

Seedlings of hot peppers (*Capsicum annuum*) have been cultivated in pots system in the first week of April 2021 and replicated in the same time at 2022.

2.1. Description of the cultivation system

The pots system used in this research was made up of a wooden table (100 cm length, 100 cm width, and 10 cm depth). The entire depth of the tables has been padded with 0.7 mm-thick black polyethylene sheets with a drainage tube on one side. Under this tube, plastic tank have been put under each table to collect the excess irrigation water. 12 black polyethylene pots have arranged on the entire depth of the table. Each pot was filled with 5 liters of the tested mixtures. Each pot has holes in the bottom for release the excess drainage. Drip irrigation system have been used to deliver water and nutrients to each pot, a slope about 1% have been made to collect the excess drainage solution and return it back to the tank using the drainage tube. The used nutrient solution was described by (El-

Behairy, 1994). EC varied between 2.0 and 2.5 m.mhos^2 thought experimental time. The EC was adjusted to the necessary level using a digital EC meter.

2.3. Treatments

4 different substrate mixtures have been examined in this experiment with regard to both growth and yield of hot pepper, their description was as follow:

1. Mixture of perlite : coco peat 1:1 v/v (PeCo).
2. Mixture of sand : rice husk 1:1 v/v (SRh).
3. Mixture of sand : coco peat1:1 v/v (SCo).
4. Mixture of sand : coco peat : rice husk 1:1:1 v/v/v (SCoRh).

2.4. Measurements

Throughout the experiment, different measurements have been recorded, like; plant height, number of leaves, fresh weights of aerial parts and root, dry weights of aerial parts and root, yield per m^2, percentage of (nitrogen, phosphorus, potassium) in leaves

Nitrogen, phosphorus and potassium percentages were determined using methods described by (A.O.A.C., 1990).

2.5. Experimental Design and Statistical analysis

The experiment was arranged in complete randomized blocks design with three replicates. The collected data were analyzed using ANOVA statistical analysis as described by (Snedicor and Cochran, 1980) and means were compared by determining the least significant difference (L.S.D) at a probability level of 0.05.

3. Results

3.1. Plant height

Data in fig (1) presents the impact of substrates mixtures on plant height. Data of the first season indicated that the highest plant height values were obtained from plants grown in PeCo followed by SRh, SCo and SCoRh respectively. Differences among treatments were significant. Data recorded similar trend in the second season except the difference between PeCo and SRh was not significant.

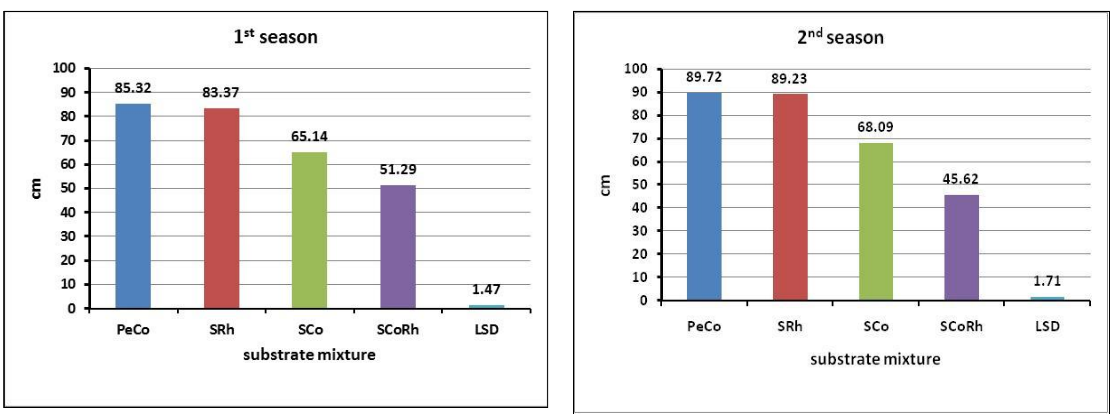

Fig. 1: Impact of substrate mixtures on plant height (cm) of hot pepper grown in pots system on rooftops during seasons of 2021 and 2022.

3.2. Number of leaves

Data in fig (2) presents the impact of substrates mixtures on number of leaves per plant. In both seasons, data illustrated that PeCo recorded the highest number of leaves per plant followed by SRh, and SCo respectively. However, SCoRh recorded the lowest number of leaves. Data also indicated that there were significant differences among treatments in both seasons.

Middle East J. Appl. Sci., 13(4): 692-700, 2023
EISSN: 2706 -7947 ISSN: 2077- 4613 *DOI: 10.36632/mejas/2023.13.4.48*

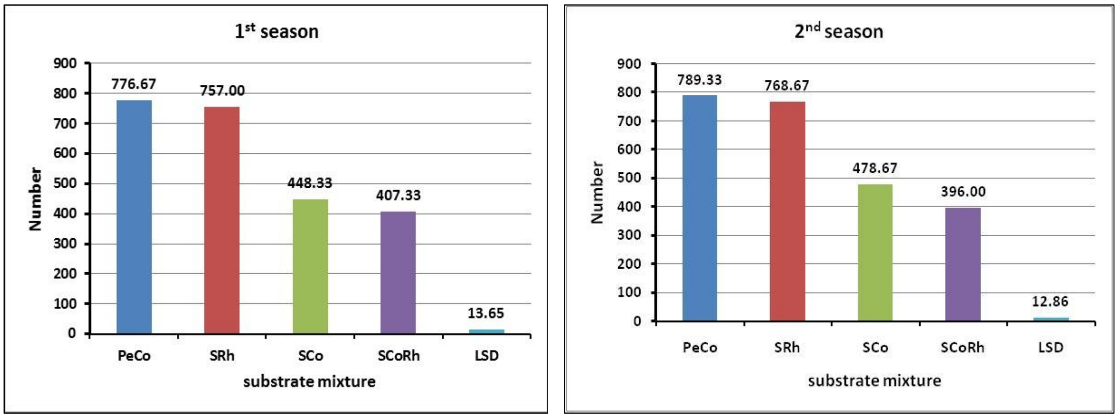

Fig. 2: Impact of substrate mixtures on number of leaves per plant of hot pepper grown in pots system on rooftops during seasons of 2021 and 2022.

3.3. Fresh weight of aerial parts

Data in fig (3) illustrate the impact of substrates mixtures on fresh weight of aerial parts per plant. In both seasons, data indicated that PeCo recorded the highest fresh weight of aerial parts then SRh, and SCo respectively. While, the lowest value for fresh weight of aerial parts was obtained from SCoRh. Data also indicated that there were significant differences among treatments in both seasons.

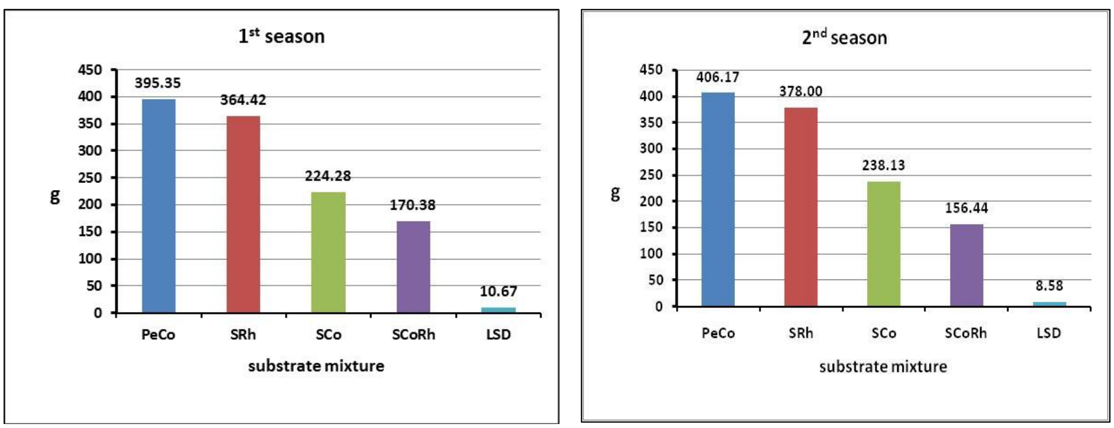

Fig.3: Impact of substrate mixtures on fresh weight of aerial parts per plant (g) of hot pepper grown in pots system on rooftops during seasons of 2021 and 2022.

3.4. Root fresh weight

Data in fig (4) present the impact of substrates mixtures on root fresh weight per plant. In the first season, data showed that PeCo recorded the highest root fresh weight followed by SRh, and SCo respectively. While, the lowest value for root fresh weight was obtained from SCoRh. In addition, all differences among treatments were significant. In the second season, similar trend was recorded except that there was no significant difference between PeCo and SRh.

3.5. Dry weight of aerial parts

Data in fig (5) present the impact of substrates mixtures on dry weight of aerial parts per plant. First season data showed that PeCo recorded the highest dry weight of aerial parts followed by SRh, then SCo and SCoRh respectively. There were significant differences among treatments. In the second season, data illustrated the same trend except that the highest dry weight was obtained by SRh instead of PeCo.

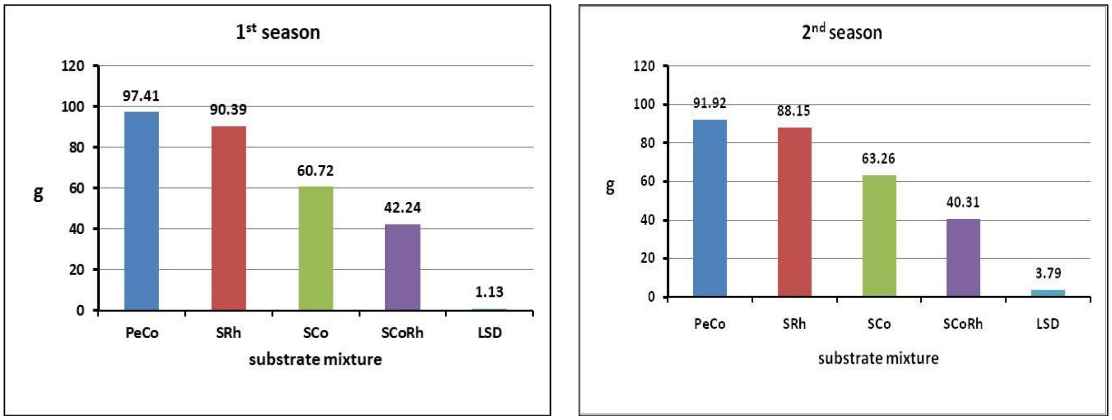

Fig. 4: Impact of substrate mixtures on root fresh weight per plant (g) of hot pepper grown in pots system on rooftops during seasons of 2021 and 2022.

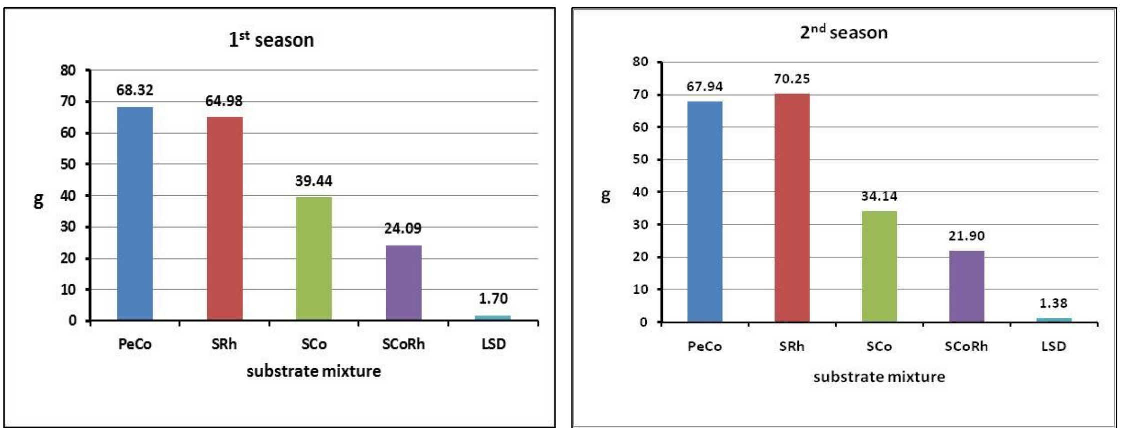

Fig. 5: Impact of substrate mixtures on dry weight of aerial parts per plant (g) of hot pepper grown in pots system on rooftops during seasons of 2021 and 2022.

3.6. Root dry weight

Data in fig (6) illustrate the impact of substrates mixtures on root dry weight per plant. Data from first season indicated that PeCo recorded the highest root dry weight values followed by SRh, and SCo respectively. While, the lowest value for root dry weight was obtained from SCoRh. Data clarified that there were significant differences among treatments except the difference between PeCo and SRh. In the second season, data shows similar trend except that SRh recorded higher values than PeCo, even so the difference between them still not significant.

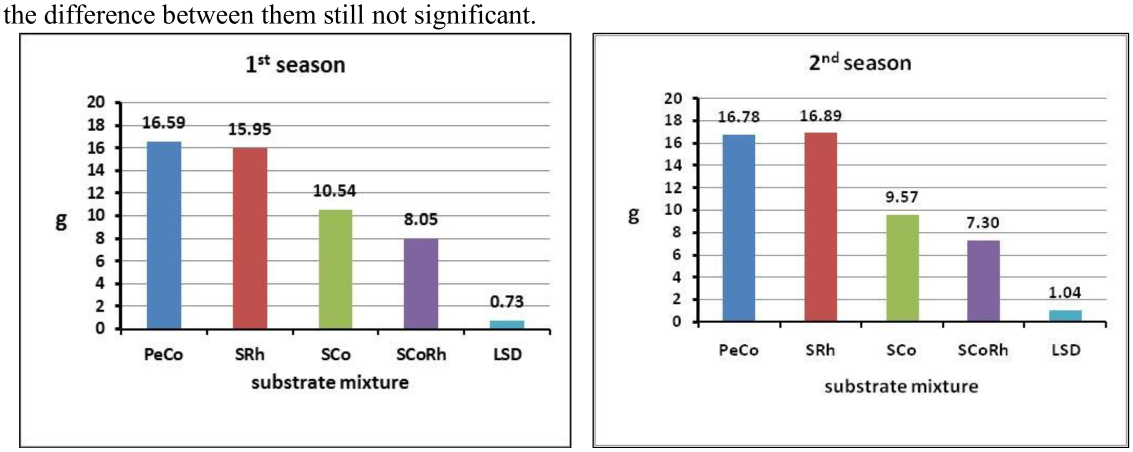

Fig. 6: Impact of substrate mixtures on root dry weight per plant (g) of hot pepper grown in pots system on rooftops during seasons of 2021 and 2022.

3.7. Yield per m^2

Data in fig (7) present the impact of substrates mixtures on yield per m^2. First season data illustrated that the highest yield values was obtained by PeCo followed by SRh, and SCo respectively. While, the lowest yield value was obtained by SCoRh. In addition, there were significant differences among treatments. In the second season, similar trend was obtained except that there was no significant difference between PeCo and SRh.

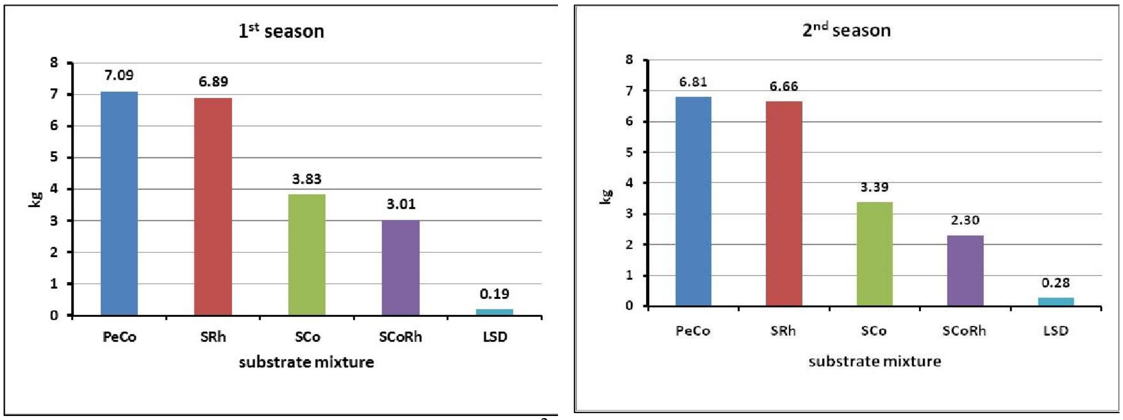

Fig. 7: Impact of substrate mixtures on yield per m^2 (kg) of hot pepper grown in pots system on rooftops during seasons of 2021 and 2022.

3.8. Percentages of nitrogen, phosphorus and potassium in leaves

Data in table 1 present the impact of substrates mixtures on percentages of nitrogen, phosphorus and potassium in leaves.

Regarding nitrogen %, first season data indicated that the highest nitrogen% was found in SRh then PeCo, SCo and SCoRh respectively. The difference between SRh and PeCo were not significant, other than that all other differences were significant. In the second season, data illustrated that PeCo recorded higher nitrogen % than SRh. Moreover, difference between PeCo and SRh was not significant & difference between SRh and SCo was not significant.

Regarding phosphorus %, first season data illustrated that PeCo recorded the highest phosphorus % followed by SRh, then SCo and finally SCoRh recorded the lowest percentage. There were significant differences among treatments. In the second season, similar trend was found except there was no significant difference between PeCo and SRh.

Concerning potassium %, first season data indicated that the highest potassium % was found in PeCo then SRh, SCoRh and SCo respectively. There were significant differences among treatments except between SCoRh and SCo. In the second season, similar trend was found except that SCo recorded a higher potassium % than SCoRh. Furthermore, there were significant differences among all treatments.

Table 1: Impact of substrate mixtures on percentages of (nitrogen, phosphorus and potassium) in leaves of hot pepper grown in pots system on rooftops during seasons of 2021 and 2022.

Substrate mixture	Nitrogen %		Phosphorus %		Potassium %	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
PeCo	3.99	3.95	0.396	0.415	3.44	3.62
SRh	4.05	3.89	0.384	0.406	3.30	3.49
SCo	3.69	3.81	0.327	0.338	2.78	2.99
SCoRh	3.09	2.99	0.303	0.301	2.82	2.76
LSD	**0.13**	**0.10**	**0.012**	**0.021**	**0.09**	**0.12**

PeCo: perlite : coco peat 1:1 v/v, **SRh:** sand : rice husk 1:1 v/v, **SCo:** sand : coco peat 1:1 v/v, **SCoRh:** sand : coco peat : rice husk 1:1:1 v/v/v.

4. Discussion

Results clarified that mixture of perlite : coco peat"1:1 v/v" recorded the highest values for plant growth paramaters and yield. Furthermore, a close result have been recorded by mixture of sand : rice husk "1:1 v/v" . For that, both substrate mixtures (mixture of perlite : coco peat and mixture of sand : rice husk) could be considered as a suitable substrate mixture for producing hot pepper grown in pot system. Abad *et al.,* (2002) reported that the good growing medium would support the plant to grow well; it serves as reservoir for nutrients and water, allow oxygen diffusion to the roots and permit gaseous exchange between the roots and atmosphere outside the root substrate. In addition Riaz *et al.,* (2008) illustrated that growing media is known to have large effect on the plant growth characteristics. Schmilewski, (2009) reported that various ingredients have been used as a substrate for vegetable production throughout the world. The used materials were varying based on local availability. Such materials can be inorganic or organic, but growing media are often formulated from a mixture of different materials in order to achieve the correct balance of air availability and water holding capacity for the plants to be grown well (Bilderback *et al*., 2005; Schroeder and Shell, 2009).

Mixture of perlite: coco peat consisted of equal volumes from perlite and coco peat. This combination offer good aeration from perlite and good water avaiability from coco peat with maintained good environment in root zone that support the growth of plants grown in it.

Perlite is a lightweight substance made from crushed volcanic lava rocks heated to temperatures between 900 and 1000 degrees Celsius. Granules swell as a result of the heated air leaving the system and creating air gaps, which lead to significant expansion. It can be irrigated directly or by using subsurface irrigation technique because of its strong drainage capacity and capillary porosity. For the successful growth of various vegetable crops, seeds, flowers, and indoor ornamental plants, perlite is frequently used alone or in combination with other substrates like peat moss (El-Behairy, 2015).

The coconut husk is composted to create coco peat. Composting results in the decomposition of hemicellulose, cellulose, and partially lignine components, this raises the level of humic acid and CEC and changes some physical characteristics like total porosity and readily available water but decreases air-filled porosity. Following the composting process, coco peat is dried to pre determined moisture content, packed into bales, bundled, and transported. Coco peat swells to five to nine times its compressed capacity when water is added. Due to its growth characteristics that are comparable to those of peat, coco peat is frequently utilized as a substitute growing medium for soilless vegetable, cut flower, and potted plant culture (Stamps and Evans, 1997).

Moreover, El-Behairy, (2015) mentioned that substrates could be used in a separate form as agricultural substrate or may be mixed together to attain the best characteristic for the plants to be grown. In addition, Maloupa *et al.* (2001) showed that using a mix of substrates can keep ideal physical conditions for a longer time than using a single substrate. For the mixture of sand: rice husk is consists of equal volumes from sand and rice husk mixed together. The produced mixture may have appropriate characteristics to the growth of hot pepper plants than if we used each substrate individual. The rice husk has poor water holding capacity and a good aeration, when mixed with the small particles of sand it may increased the available water surround plant roots and created a good environments to plant root that helped plants to establish a good canopy holds a high yield. This supports with results that indicated that hot pepper plants grown in mixture of sand: rice husk produced high values for fresh and dry weights of root system and aerial parts. Awang *et al.* (2009) mentioned that rice husk is important agricultural waste material used as a substrate, and it's considered as a good substrate due to its light weight and good chemical and physical properties. In addition, Tsakaldimi, (2006) reported that rice husks have low water-holding capacity and high pore space. Rice husks have been used as a substitute for many substrates such as vermiculite and perlite and were reported to be effective in improving drainage or aeration of the growing media. It is remarkable that increase aeration and drainage support the growth of the root system. Vaughn *et al.* (2011) further stated that there is increased interest in using mixes of organic and inorganic components as growing substrates in soilless culture. Better plant development and yield are produced when inorganic materials are added to organic ones. Probably mixing led to increase water holding capacity of inorganic components, and increase aeration of organic components. That promotes vigorous root growth, which allows better growth of foliage and therefore increases whole yield of plants.

5. Conclusion

It could be conclouded that both substrate mixtures (mixture of perlite : coco peat and mixture of sand : rice husk) can be considered as a suitable substrate mixture for producing hot pepper grown in pot system.

References

A.O.A.C., 1990. Official Methods of analysis of the association official analytical chemists. 15^{th} ed. Published by the Association of Official Analytical Chemists, Inc. Anlington, Virginia 22201, U.S.A.

Abad, M., P. Noguera, R. Puchades, A. Maquieira and V. Noguera, 2002. Physico-chemical andchemical properties of some coconut dusts for use as a peat substitute for containerizedornamental plants. Biores. Technol., 82: 241-245.

Angin, I., M. Kose and R. Aslantas, 2011. Effect of diatomite on growth of strawberry. Pak. J. Bot., 43(1): 573-577.

Awang, Y., A.S. Shaharom, R.B. Mohamad, and A. Selamat, 2009. Chemical and physical characteristics of cocopeat-based media mixtures and their effects on the growth and development of *Celosia cristata*. American journal of agricultural and biological sciences, 4(1):63-71.

Bilderback, T.E., S.L. Warren, Jr.S. Owen and J.P. Albano, 2005. Healthy substrates need physicals too!. HortTechnology, 15: 747-751.

Butler, J.D. and N.F. Oebker, 2006. Hydroponics as a Hobby—Growing Plants without Soil. Circular 844, College of Agriculture, University of Illinois, Urbana.

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 the nutrient film technique. PhD thesis, London University, 299.

El-Behairy, U.A., 2015. Simple substrate culture in arid lands chapter in (soilless culture- use of substrate for the production of quality horticultural crops by Md. Asaduzzaman). P: 70-97. http://dx.doi.org/10.5772/59628.

Grunert, O., M. Perneel and S. Vandaele, 2008. Peat-based organic grow bags as a solution to the mineral wool waste problem. Mires and Peat. 3: 1-5.

Hussain, A., K. Iqbal, S. Aziem, P. Mahato and A. Negi, 2014. A review on the science of growing crops without soil (soilless culture) – a novel alternative for growing crops. Int. J. Agri Crop Sci., 7 (11): 833 - 842.

Khan, A.L., Z.K. Shinwar, Y. Kim, M. Waqas, M. Hamayun, M. Kamran and I. Lee, 2012. Role of endophyte chaetomiumglobosum lk4 in growth of *Capsicum annuum* by production of gibberellins and indole acetic acid. Pak. J. Bot., 44(5): 1601-1607.

Maloupa, E., A. AbouHadid, M. Prasad and Ch. Kavafakis, 2001. Response of cucumber and tomatoplants to different substrates mixtures of pumice in substrate culture. Acta Hort., 559: 593-600.

Nair, A., M. Ngouajio and J. Biernbaum, 2011. Alfalfa-based organic amendment in peat-compost growing medium for organic tomato transplant production. HortScience, 46: 253–259.

Pual, C., 2000. Health and hydroponic. Practical Hydroponic & Greenhouse, 53(4): 28-30.

Riaz, A., M. Arshad, A. Younis, A. Raza, and M. Hameed, 2008. Effects of different growing mediaon growth and flowering of Zinnia elegans cv. blue point. Pak. J. Bot., 40(4):1579-1585.

Schmilewski, G., 2009. Growing medium constituents used in the EU. Acta Hort., 819: 33-46. Schroeder, F. and H. Sell, 2009. Use of compost made from livestock manure as an organic substrate for cucumber (*Cucumis sativus* L.) grown in greenhouse. Acta Hort., 819: 367-372.

Schroeder, F. and H. Sell, 2009. Use of compost made from livestock manure as an organic substrate for cucumber (*Cucumis sativus* L.) grown in greenhouse. Acta Hort., 819: 367-372.

Snedicor, R.G. and W.G. Cochran, 1980. Statistical methods, sixth edition, Iowa State Univ. Press, Amer. Iowa, USA.

Stamps, R.H. and M.R. Evans, 1997. Growth of Dieffenbachia maculate Camille in growing media containing sphagnum peat or coconut coir dust. HortScience, 32(5) :844-847.

Tran, H.H., F.A. Roddick, and J.A. O'Donnell, 1999. Comparison of chromatography and desiccant silica gels for the adsorption of metal ions. I. Adsorption and kinetics. Water Research, 33: 2992-3000.

Tsakaldimi, M., 2006. Kenaf (*Hibiscus cannabinus* L.) core and rice hulls as components of containermedia for growing Pinushalepensis M. seedlings. Biores. Technol., 97: 1631-1639.

Tuzel, Y., G.B. Oztekin and A. Gul, 2008. Recent developments in protected cultivation in Turkey. 2nd coordinating meeting of the regional FAO working group on greenhouse crop production in the SEE countries. 7-11 April. Antalya. P:75-86.

Vaughn, S.F., N.A. Deppe, D.E. Palmquist and M.A. Berhow, 2011. Extracted sweet corn tassels as a renewable alternative to peat in greenhouse substrates. Industrial Crops and Products, 33: 514–517.