ACTA Acta Sci. Pol., Hortorum Cultus 13(5) 2014, 163-176

THE GROWTH OF CAMELLIA IN PEANUT SHELLES COMPOST MEDIA IN DIFFERENT CONCENTRATIONS OF POTASSIUM

Ali Mohammadi Torkashvand, Behzad Kaviani
Rasht Branch, Islamic Azad University, Rasht, Iran

Abstract. Agricultural wastes management is a step toward sustainable agriculture. Peanut shelles as remained wastes of cultivating peanut has considerable volume which its compost can be used as available sources of ornamental plants medium. A factorial experiment based on randomized completely blocks design was conducted to investigate the impact of peanut shelles compost as the growth medium of Camellia in different concentrations of potassium. Fifteen treatments, every treatment at three replicates and 45 plots were used for experiment. The rooted cuttings of Camellia were planted and periodic watering with Hoagland solution was performed two times per week. After five months, the plants growth indices and the concentration and uptake nutrients were measured. Results showed that peanut shelles compost increased growth indices than in the control. In the most growth indices, the plant indicated a better response to 40% (w/w) compost and finally 60%. The results are indicator of providing the needed potassium for plant by peanut shelles compost than in the control.

Key words: agricultural wastes, Hogland solution, plants, pot experiment

INTRODUCTION

Iran is a talented country in producing flowers and ornamental plants due to the suitable diversity of weather and 40°C difference between the coldest and warmest region, energy and cheap forces at work, enough light (more than 250 days light and 120–150 thousand lux in year), cellulose wastes and consumption markets.

Today, most ornamental plants are cultivated in soilless media which peat is as basic medium [Atieyh et al. 2000], but the use of peat is doubtful due to ecological damages to environmental and economic advantageous. These factors caused those researchers think to beds with high quality and cheap instead of peat [Krumfolz et al. 2000]. Million tons of different agriculture wastes being produced annually across the country that can has role on preparing organic materials but unfortunately major part is burned or leaved

Corresponding author: Ali Mohammadi Torkashvand, Rasht Branch, Islamic Azad University, Rasht, Iran, e-mail: m.torkashvand54@yahoo.com

somewhere and leads to environment pollution [Mohammadi Torkashvand 2010]. With increasing awareness of environmental dangerous of wastes and its sanitary landfill and decrease in the use of non-renewable sources like peat, further use of composted biosolids has been suggested in farming [Bugbee 2002, Papafotiou 2005]. Studies have shown that the peat can be replaced by organic wastes such as municipal wastes, sewage sludge, livestock manure, paper, waste of pruning and fungi beds and other organic waste after composting [Gayasinghe et al. 2010]. Application of manure, wood chips and paper wastes mixed with volcanic material in providing cultivation bed of Croton (*Codiaeum variegatum*) and Chrysanthemum showed that these materials can be used as planting bed [Cull 1981]. The bark of broad leaf and conifer trees, sewage sludge, sawdust, mushroom compost, municipal wastes compost are the materials that can be used as planting beds [Fred et al. 1997, Scharpenseel et al. 1987, Verdonck et al. 1992].

In greenhouses town of Guilan province, Iran, the medium used in the cultivation of camellia is mixture of different organic wastes such as peat, cocopeat, municipal wastes compost, tea wastes with sand and perlite that have a pH lower than 7.0. There is little literature on the impact of peat alternatives in the production of woody ornamental plants [Scagel 2003]. Larcher and Scariot [2009] suggested coconut fibers as a good partial peat substitute for potted camellia production. In Guilan province, Iran, abundant organic wastes are produced that one of the organic wastes is peanut shelles compost. The cultivation and production of peanut is dedicated in several populous countries in which the peanut is a major food crop. According to the World Food and Agriculture Organization, the most major peanut-producing countries in the world are India, China, United States, Indonesia and Myanmar. Peanut cultivation area in the world is about 22.2 million hectares that 16.3 million hectares in Asia, 7.39 million hectares in Africa, 0.7 million hectares is located in South and Central America [Maiti and Ebeling 2002, Murata 2003]. Cultivated area of peanut in Iran is about 3218 hectares which 2718 hectares is located in Guilan province. About 1980–3500 kg·ha pods is harvested and 89 327.6 tones pods is produced in Guilan. Between 35–40% of every kg yield of peanut is shelles wastes, therefore, it is estimated to produce about 3388–3873 tons peanut shelles wastes in Iran in every year [Agriculture Organization of Guilan province 2010]. Thus, there is high import of peanut in Iran. Alidoust et al. [2012] conducted a pot experiment to investigate the possibility using peanut shelles compost as appropriate bed in the cultivation of Dracaena. They reported that the potassium increased in cultivation bed proportional to the used peanut shelles compost, so potassium of 100% peanut shelles treatment increased 40 times rather than control (2:1 ratio of peat to perlite). Based on growers in greenhouses of Guilan province, camellia needs the high amount of potassium as same as nitrogen. Therefore, it has been decided that 1. To evaluate the possibility using this organic waste as a growth medium of Camellia and 2. To investigate impact of nutrient solution with different concentrations of potassium on plant growth and nutrient uptake especially K uptake.

MATERIALS AND METHODS

A factorial experiment based on randomized completely blocks design was conducted to investigate the impact of peanut shelles compost as the growth medium of Camellia in different concentrations of potassium. The peanut shelles were supplied by peeling peanut factory which is located in Astane Ashrafie Township, Guilan, Iran, and then was transferred to research station. Peanut shelles were poured in the wooden boxes by 1 M^3 that had pores to supply aerobic conditions and activity of micro-organisms. Thus, recording temperature and aerating were done during four months and the prepared compost was used as the growth medium. Some physical and chemical characteristics (total nitrogen, phosphorus, potassium, organic carbon, C/N ratio, EC and pH in 1:5 extract peanut shelles to water) before and after being composted were measured (tab. 1). Table 1 shows some characteristics of the used compost. First factor was different ratio of peanut shelles compost include:

1. 50% perlite + 50% sand (v/v)
2. 20% peanut shelles compost + 40% perlite + 40% sand (v/v)
3. 40% peanut shelles compost + 30% perlite + 30% sand (v/v)
4. 60% peanut shelles compost + 20% perlite + 20% sand (v/v)
5. 100% peanut shelles compost

Table 1. Some properties of Composted peanut shelles and peat used in experiment

Property	Peanut shelles before composting	Composted peanut shelles
Total mitrogen (%)	0.87	2.76
Total phosphorus (%)	1.87	0.67
Total potassium (%)	1.19	1.48
Organic carbon (%)	30.0	27.1
C/N ratio	34.5	9.8
pH (1:5)	5.89	5.06
EC (dS/m)	1.38	4.30

Some properties of the growth media are observed in table 2. The different concentration of potassium in nutrient solution was second factor include:

1. Nutrient solution without potassium
2. Nutrient solution with 3 mM potassium
3. Nutrient solution with 6 mM potassium

Fifteen treatments (tab. 3), every treatment at three replicates and 45 plots were used for experiment. The rooted cuttings of Camellia with the same size and height of 20 cm and the leaves number of 5–7, were prepared. The experiment duration was five months to appear the buds. Perlite with a diameter 1–2 mm (fine) was used and sands of the river have been washed to be free from any mud. Peanut shelles compost was prepared from Lahijan's Ornamental Flowers and Plants Research Station. In the beginning, FC (field capacity) of pots was measured to determine irrigation water requirement per pot in each time period, that this rate was 250 ml. Periodic watering with Hoagland solution was performed two times per week.

Table 2. The effect of treatments on some properties of the growth media

Treatments	Bulk density (g·cm^{-3})	Porosity (%)	Total nitrogen (%)	Available phosphorus (mg·kg)	Available potassium (mg·kg)	pH (1:5)	EC (dS·m)
Control[1]	0.62	77.0	0.05	2.3	10.0	5.42	0.21
20% PSC[2]	0.53	82.0	0.6	7.3	212.3	5.54	0.94
40% PSC[3]	0.51	84.0	1.6	14.7	635.6	5.57	1.16
60% PSC[4]	0.36	87.0	2.2	18.3	1042.0	5.97	2.26
100% PSC[5]	0.22	92.0	2.84	20.3	1874.2	6.18	2.47

[1] 50% perlite + 50% sand
[2] 20% peanut shelles compost + 40% perlite + 40% sand
[3] 40% peanut shelles compost + 30% perlite + 30% sand
[4] 60% peanut shelles compost + 20% perlite + 20% sand
[5] 100% peanut shelles compost

Table 3. The characteristics of applied treatments

Symbol	Treatment
Control × K_0	50% perlite + 50% sand without K in nutrient solution
Control × K_3	50% perlite + 50% sand with 3 mM K in nutrient solution
Control × K_6	50% perlite + 50% sand with 6 mM K in nutrient solution
20% PSC × K_0	20% PSC* + 40% perlite + 40% sand without K in nutrient solution
20% PSC × K_3	20% PSC + 40% perlite + 40% sand with 3 mM K in nutrient solution
20% PSC × K_6	20% PSC + 40% perlite + 40% sand with 6 mM K in nutrient solution
40% PSC × K_0	40% PSC + 30% perlite + 30% sand without K in nutrient solution
40% PSC × K_3	40% PSC + 30% perlite + 30% sand with 3 mM K in nutrient solution
40% PSC × K_6	40% PSC + 30% perlite + 30% sand with 6 mM K in nutrient solution
60% PSC × K_0	60% PSC + 20% perlite + 20% sand without K in nutrient solution
60% PSC × K_3	60% PSC + 20% perlite + 20% sand with 3 mM K in nutrient solution
60% PSC × K_6	60% PSC + 20% perlite + 20% sand with 6 mM K in nutrient solution
100% PSC × K_0	100% PSC without K in nutrient solution
100% PSC × K_3	100% PSC with 3 mM K in nutrient solution
100% PSC × K_6	100% PSC with 6 mM K in nutrient solution

*Peanut Shelles Compost

The pots were treated with the nutrient solution based on Hogland formula [Hogland 1950]. It is produced in two stages with a stock solution of each element maintained separately (tab. 4). The salts present in the Hogland formula include potassium phosphate, potassium nitrate, calcium nitrate and magnesium sulphate, which contain six microelements of phosphorus, potassium, nitrogen, calcium, sulphur and magnesium.

However, for the control or change in the concentration of one or multiple nutritional elements, the concentration of other elements within this formula would be also changed. Hence, trying to change the salt despite the controlled element concentrations of potassium would not make a difference in the concentrations of other elements. This is why the salts compounds differentiate in different concentrations of potassium [K_0, K_3 (3 mM) and K_6 (6 mM)]. After studying the salt types, first of all one molar of their solution will be produced and stored as a stock solution, based on their chemical formulae and the molecular mass. Then an appropriate amount of each key solution will be mixed together to produce one litter of complete nutrition soluble solution.

Table 4. The salts containing the macro nutrition elements in Hogland nutrition solution

Macronutrients			Micronutrients
K_1 (6 mM)	$K_{0.5}$ (3 mM)	K_0 (without K)	
KH_2PO_4	KH_2PO_4	$Ca(NO_3)_2·4H_2O$	H_3BO_3
KNO_3	KNO_3	$MgSO_4·7H_2O$	$MnCl_2·4H_2O$
$Ca(NO_3)_2·4H_2O$	$Ca(NO_3)_2·4H_2O$	NH_4NO_3	$ZnSO_4·7H_2O$
$MgSO_4·7H_2O$	$MgSO_4·7H_2O$	H_3PO_4	$CuSO_4·5H_2O$
	H_3PO_4		$H_2MoO_4·H_2O$
	NH_4NO_3		$Fe_2(C_4H_4O_6)_3$

The second stage of producing nutrition soluble solution is to supply one litter of stock solution, which is made up of salt micro elements (tab. 4). But the best way is to avoid mixing the stock solution with any salt. In the end, one cubic centimeter of each of the micro element solutions was added to each one litter of macro element solutions. The end product with a mass of one litter is a complete nutrition solution.

After five months, the plants were harvested and the plant height, stem diameter, flower bud number, fresh and dry shoot and root weight were measured at every treatment. The sub samples of dry leaves (at 70°C for 48 h) were ground and then dry-ashed in a furnace at 550°C and then extracted with 2 M HCl. The concentrations of Ca, Mg, Fe, Mn and Zn were measured in the extracts by atomic absorption spectrophotometry, K by flame photometry, and P by spectrophotometry. Total kjeldahl nitrogen (TKN) of leaves and media and the total organic carbon (TOC) of the media were estimated by using a microkjeldahl method [Singh and Pradhan 1981] and Walkey and Blacks Rapid titration method [1934], respectively. The pH and EC of growth media were determined on a water extract from compost using compost to water ratio of 1:5 by weight. Thus, the phosphorus and potassium of media were determined by spectrophotometric and flame photometric methods, respectively.

The experiment was a completely randomized design in three replications and MSTATC software was used for variance analysis of data by Least Significant Difference (LSD) test.

RESULTS AND DISCUSSION

The effects of medium on the growth indices. The effect of planting substrates on the growth indices is observed in table 5. The growth of Camellia in the treatments of 40 and 60% peanut shelles compost was more than control and 100% peanut shelles. The achieved results are accordance to Alidoust et al. [2012], Pool and Conover [1991] in dracaena, Abad et al. [2001], Mahboub Khomami and Padasht Dehkaei [2010] in *Ficus Benjamin*, Basantia et al. [2011] in marigold. Padasht Dehkaei [2004] survey the different effects of bark, tea wastes, municipal waste compost and rice hull on the growth of *Beaucarnea recurbata* and *Draceana marginanta* and concluded that these compounds significantly increased the number of leaves, plant height and other growth parameters. Chen et al. [1989] found that the preference of compost substrates is due to the high level of nutrients and microbial population in the root rhizosphere lead to more growth. The growth of plant decreased significantly in 100% peanut shelles than in the control and other treatments of peanut shelles compost. It seems that the growth decreased due to the high percentage of pores, reducing of water retention capacity and increasing of salinity. A desirable bed must have a proper water holding capacity [Ronald and Dianne 2006]. Alidoust et al. [2012] attributed the decrease in growth of 100% peanut shelles than in other beds base on Atiyeh [2001] due to the severe decrease in bulk density to reduce the air conditioning and available water.

The more growth of roots in the 40 and 60% peanut shelles compost can have a major role on the effectively uptake of water and nutrients in the future. The parts of compost impacts can be due to humic materials. Chen et al [1989] also stated that the part of the effects of compost on growth of *Ficus Benjamin* could be due to a similar role in plant growth regulators. Accordingly, the root growth of the plant has increased in the presence of compost in the growth medium and improvement of bed physical conditions.

The effects of potassium on the growth indices. Based on table 6, the use of 3 mM potassium had the greatest effect on leaves number, fresh and dry weight of shoot and root of Camellia. Although K is not a constituent of any organic molecule or plant structure, it is involved in numerous biochemical and physiological processes and pivotal role to plant growth, yield, quality and stress [Cakmak 2005]. Potassium due to the rapid increase in leaf surface and transmission of combinations made from the leaves to the root is led to root growth [Salardini 2009]. Potassium is necessary for the synthesis and transport of nutrients and it is effective in elimination of some nutrients imbalance of soil and regulation of water uptake [Wang 2007].

Plant growth without potassium treatment indicated that peanut shelles compost plays a role in the providing of the needed potassium but it is not sufficient and the growth was increased with the addition of potassium to nutrient solution. Increasing of growth can be attributed to the potassium role in the cell growth and development and increase in photosynthesis. It is well known that potassium plays a key role in carbohydrate metabolism and photosynthesis [Marschner 1995]. Potassium is important for cell expansion and growth of the plants is the resulting concentrated potassium in cells and vacuoles [Marschner 1986]. Potassium specifically activates enzymes to produce large molecules such as protein and starch [Sulter 1985, Faquin 1994, Shabala 2003]. Egilla et al. [2005] stated that the sufficient consumption of potash fertilizer in Hibiscus when

Table 5. The Effect of growth media, K concentration in nutrient solution and interaction effect (K concentration × growth medium) on the growth indices of Camellia

	Treatments	Leaves number	Plant height (cm)	Bud number	Stem diameter (cm)	Fresh weight of root (g)	Dry weight of root (g)	Fresh weight of shoot (g)	Dry weight of shoot (g)
	control	10.2b	18.3ab	2.2b	4.2b	21.9c	5.3b	21.3c	6.0b
	20% PSC	11.0ab	17.8ab	2.3b	4.4b	25.3ab	4.5b	21.6bc	6.4b
	40% PSC	13.1ab	20.4a	3.1a	5.3a	45.9a	7.3a	27.1a	7.9a
	60% PSC	14.2a	21.4a	2.4b	4.4b	28.6b	6.6a	24.8ab	7.4a
	100% PSC	6.0c	12.9b	1.6c	2.7c	8.6d	4.7b	13.4d	3.2c
K concentration in nutrient solution	K_0	8.6b	16.5b	2.3a	4.0a	22.7b	3.7b	18.9b	5.1b
	K_3	13.8a	18.8a	2.2a	4.4a	33.0a	5.2a	24.3a	7.1a
	K_6	10.3b	19.2a	2.3a	4.2a	22.6b	4.6ab	21.8a	6.6a
K concentration × growth medium	Control × K_0	9.3de	17.3bcd	2.2b-f	4.7b	32.0cde	4.1cd	22.1b	6.2cd
	Control × K_3	11.3cd	19.3ab	2.6b-e	4.0bc	22.3ef	5.5bc	22.2b	6.3cd
	Control × K_6	10.0d	18.3ab	1.6ef	3.8bc	11.5fgh	1.3e	19.6bc	5.4de
	20% PSC × K_0	9.4de	15.4cd	1.9c-f	4.6b	17.3fgh	3.8cd	21.7bc	5.9cde
	20% PSC × K_3	11.6cd	19.5ab	2.1b-f	4.8b	43.2b	5.6bc	30.9a	9.1b
	20% PSC × K_6	12.0cd	18.4abc	3.0ab	3.9bc	15.4fgh	4.1cd	12.1d	4.3fg
	40% PSC × K_0	10.6d	20.2ab	4.0a	4.6b	37.4bcd	8.6a	20.3bc	5.45def
	40% PSC × K_3	16.6b	21.1ab	2.3b-f	5.8a	57.9a	6.5b	30.3a	9.1b
	40% PSC × K_6	12.0cd	20.1ab	2.8bcd	5.6ab	42.5bc	6.6b	30.9a	9.3b
	60% PSC × K_0	9.0de	19.5ab	2.0b-f	3.6c	18.6fg	4.3cd	19.5bc	4.9ef
	60% PSC × K_3	21.3a	19.7ab	2.4b-f	4.4bc	31.3de	6.4b	22.1b	6.8c
	60% PSC × K_6	12.4cd	25.1a	2.9bc	5.3ab	36.0bcd	9.1a	32.8a	10.4a
	100% PSC × K_0	4.6e	10.2e	1.7def	2.6cd	8.2bcd	2.1e	10.7d	2.6h
	100% PSC × K_3	8.0de	14.5cd	1.5f	3.1cd	10.3gh	1.8e	16.1cd	3.8g
	100% PSC × K_6	5.3e	14.1cd	1.4f	2.3e	7.4h	1.7e	13.4d	3.3gh

Table 6. The Effect of growth media, K concentration in nutrient solution and interaction effect (K concentration × growth medium) on the nutrient concentration of leaves

	Treatments	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Iron (mg·kg)	Zinc (mg·kg)	Manganese (mg·kg)
	control	2.65ab	0.43b	2.41c	81.8a	7.16 b	16.1ab
	20% PSC	2.95a	0.43b	2.81bc	100.6a	10.4b	11.2b
	40% PSC	2.66ab	0.54a	3.75a	81.4a	7.70ab	14.0b
	60% PSC	2.84ab	0.41b	3.30ab	98.2a	9.42ab	11.5b
	100% PSC	2.38b	0.55a	2.29c	102.4a	9.61ab	19.8a
K concentration in nutrient solution	K_0	2.53b	0.48ab	2.23b	89.3a	8.33a	13.25a
	K_3	3.1a	0.43b	3.19a	90.9a	8.76a	14.34a
	K_6	2.51b	0.51a	3.33a	92.5a	9.40a	16.05a
K concentration × growth medium	Control × K_0	2.70abc	0.54bcd	1.73fg	49.30e	7.36a	15.27cde
	Control × K_3	2.94ab	0.34i	1.65fg	73.86cde	7.76a	10.61e
	Control × K_6	2.32abc	0.41fghi	3.85ab	92.26bcde	6.36a	22.43ab
	20% PSC × K_0	2.80abc	0.42efgh	2.51cde	98.30bcd	9.16a	8.36e
	20% PSC × K_3	3.27a	0.36hi	2.87cde	144.86a	11.43a	13.6de
	20% PSC × K_6	2.80abc	0.50bcde	3.06cd	57.73de	10.53a	11.5e
	40% PSC × K_0	2.48abc	0.49cdef	2.33def	88.30bcde	8.60a	10.16e
	40% PSC × K_3	3.01ab	0.45efg	4.38a	79.66cde	6.23a	20.84abc
	40% PSC × K_6	2.48abc	0.67a	4.56a	76.30cde	8.20a	11.03e
	60% PSC × K_0	2.80abc	0.37hi	3.15bc	102.13bcd	10.13a	13.18de
	60% PSC × K_3	2.94ab	0.38ghi	3.83ab	83.80bcde	10.46a	8.66e
	60% PSC × K_6	2.80abc	0.47def	2.92cde	108.60abc	7.50a	12.80de
	100% PSC × K_0	1.86c	0.57bc	1.42g	108.13abc	6.40a	19.30bcd
	100% PSC × K_3	3.11ab	0.58b	3.21bc	72.36cde	11.13a	26.48a
	100% PSC × K_6	2.17bc	0.49cdef	2.24ef	126.43ab	11.20a	13.88de

Table 7. The Effect of growth media, K concentration in nutrient solution and interaction effect (K concentration × growth medium) on the uptake of nutrients (mg·pot)

	Treatments	Nitrogen	Phosphorus	Potassium	Iron	Zinc	Manganese
	control	159.4a	25.9bc	139.8cd	0.42bc	0.037bc	0.088ab
	20% PSC	194.4a	26.8bc	180.9bc	0.71a	0.058a	0.068ab
	40% PSC	213.2a	43.7a	319.5a	0.63ab	0.054ab	0.11a
	60% PSC	209.6a	31.0b	239.6b	0.73a	0.062a	0.082ab
	100% PSC	79.4b	17.8c	77.7d	0.32c	0.026c	0.061b
K concentration in nutrient solution	K_0	163.8b	23.7b	114.5b	0.42b	0.05b	0.03b
	K_3	184.0a	28.9ab	229.4a	0.66a	0.10a	0.05a
	K_6	165.7b	34.5a	230.4a	0.59ab	0.08ab	0.04ab
K concentration × growth medium	Control × K_0	167.3bcd	33.68d	107.2de	0.30e	0.04bcdef	0.09bcd
	Control × K_3	185.6bcd	21.56fg	103.9de	0.46cde	0.04bcde	0.06cde
	Control × K_6	125.2cde	22.50efg	208.2c	0.49bcde	0.03ef	0.11b
	20% PSC × K_0	165.2bcd	25.17ef	148.4d	0.57bcd	0.05bcde	0.04e
	20% PSC × K_3	297.5a	33.36d	261.7bc	1.31a	0.08a	0.12b
	20% PSC × K_6	120.3def	21.78efg	132.4de	0.24e	0.04bcdef	0.04e
	40% PSC × K_0	134.2cde	26.64e	125.8de	0.47bcde	0.04bcdef	0.05e
	40% PSC × K_3	274.2a	41.55c	398.8a	0.72b	0.05bcde	0.18a
	40% PSC × K_6	231.2ab	62.93a	433.6a	0.70bc	0.07abc	0.09bc
	60% PSC × K_0	137.2cde	18.13gh	154.3d	0.49bcde	0.04bcde	0.06cde
	60% PSC × K_3	200.3bc	26.06ef	260.6bc	0.56bcd	0.06abcd	0.05de
	60% PSC × K_6	291.2a	48.88b	303.6b	1.12a	0.07ab	0.13b
	100% PSC × K_0	48.36f	14.82h	37.00f	0.27e	0.01f	0.04e
	100% PSC K_3	118.3def	22.16efg	121.98de	0.27e	0.03cdef	0.09bc
	100% PSC K_6	71.72ef	16.39h	74.14ef	0.41de	0.03def	0.04e

the water potential is low, lead to maintaining of pure photosynthesis and increase in net photosynthesis to transpiration ratio and finally lead to increase in dry weight.

Significant difference between the control treatment (without K) and 6 mM potassium treatment were not seen. It seems that in without potassium conditions, the bed containing peanut shelles compost plays a role in providing the required potassium and the growth had not been stopped, but the addition of 3 mM potassium and the better supply of potassium was led to increasing of plant growth. Using of full concentration of potassium in Hoagland solution (6 mM) lead to decrease in the growth. It seem that providing the potassium from both peanut shelles compost and nutrient solution caused to severe increase in K concentration around root environment and ionic competence was led to failure in uptake of other nutritional cations. Xu [2011] evaluated the impact of potassium in nutrient solution on *Houttuynia cordata* Thunb. Their results showed that 1.28 mM potassium was the optimum for *H. cordata* as highest values of dry weight, shoot height; root length and number were obtained at this concentration. The optimum potassium concentration resulted in the maximum net photosynthetic rate which could be associated with the highest chlorophyll content rather than limited stomatal conductance. The supply of surplus potassium negatively correlated with the biomass.

Leaf nutrients concentration and nutrients uptake. Table 6 shows the effects of different treatments on nutrients concentration in the leaf of Camellia. As regards, the nutrient concentration in the plants organ influenced by different factors like plant growth, ionic competence and deposition, sometimes it cannot use from elements concentration in plant as a reliable parameter for evaluation of plant growth. In this regard, the use of nutrient uptake by plants from the soil is a more reliable parameter. Since the uptake rate obtained from multiplying of nutrient concentration of plants and dry weight of plant, therefore, nutrient dilution effect disappears.

Table 7 show the effect of different treatments on nutrients uptake. The maximum uptake of nitrogen, phosphorus and potassium was observed on medium containing 40% compost and then 60% compost. Increasing of compost to 100% was led to significant decrease in uptake elements. Achieved results in agreement with those obtained by Alidoust et al. [2012] on Dracaena and Sharifi et al. [2010] on Marigold. The effect of planting bed on uptake of nutrients in this study shows that the microelements such as iron, manganese and zinc increased with increasing of compost until 40% and reached to the minimum level in the peanut shelles compost bed of 100%. This issue can be justified with improving of physical conditions and bed properties by compost. Castro et al [2009] reported increasing uptake of iron, copper and zinc in lettuce grown in the beds containing compost and they stated this issue is due to the high level of these elements in compost. Uptake of micronutrients in leaf of plant can be due to the relative increase of zinc and manganese in the bed with the higher compost. Zinc and manganese have high mobility to transport from root to the shoots, easily. In the present study, it was observed that 40% compost had the most effect on the amount of potassium uptake. It has been reported that vermicompost increases potassium uptake in the medical plants of Chamomile [Salehi et al. 2011]. The similar results were reported on the confirmation of the effect of vermicompost on the increasing of potassium uptake in the tomatoes that it is effective on the microbial activity improvement, the existence of plant growth regulator and increasing uptake of mineral elements such as potassium [Zaller 2007].

The results show that the usage of 3 mM potassium in the nutrient solution had the best results on the uptake of all nutrients, while the uptake of potassium decreased in the pots with zero concentration of potassium in the nutrient solution (potassium deficiency) and 100% concentration of potassium in the nutrient solution (potassium exorbitance). This issue can be due to better supplying of potassium in the planting bed and its availability for the plants which subsequently leads to better yield. The potassium intake of leaf was increased by increasing of potassium concentration. It can say that potassium uptake in plant is increased by adding of potassium to the growth medium.

The interaction effect of medium and potassium on growth indices. The results of table 5 shows that the greatest amount of plant growth in most indices achieved on the different beds on the concentration of 3 mM K. The results show that the growth in planting bed of 40 and 60% peanut shelles compost without potassium was similar or more than of the growth in control bed with consumption of 6 mM potassium in nutrient solution. This represents the providing of needed potassium of plant on the peanut shelles compost bed than in the control (without peanut shelles compost) even with the use of complete potassium in the nutrient solution that could support the growth of plant. Compost is led to better growth of root due to appropriate porosity to increase root surface in the soil and nutrients uptake for the growth of shoots. Also, peanut shelles compost rich in potassium can partially provide the needed potassium for plants and in other word, it leads to better quality of bed with air conditioning of the culture bed. Accordingly, growth and optimal uptake of nutrients through the roots is predictable.

In the 40 and 60% peanut shelles compost with 3 mM potassium in nutrient solution, the growth is increased. Increasing of concentration to 6 mM caused to slow growth. It seems that the combined effects of potassium in nutrient solution and the potassium of the peanut shelles compost is led to increase in potassium concentration that its competitive effect can be had a negative effect on the uptake of other nutrients. In the treatments of 40 and 60% compost (tab. 7) without potassium, the uptake of nitrogen, phosphorus, iron and zinc have not any difference with the uptake of these elements in the control bed with 6 mM potassium that this is due to increasing yield of plants and providing nutrients by peanut shelles compost.

CONCLUSION

1. In general, the results showed that peanut shelles compost increased the growth indices of Camellia plant.

2. In the most growth indices, replacement 40–60% compost had the better effects on the growth of plant. Increasing of peanut shelles compost to 100% was led to decrease in growth and quality of plant.

3. The best result of plant growth was obtained by using 40–60% peanut shelles compost along with 3 mM potassium. The comparison between control with 6 mM K and 40 and 60% peanut shelles compost without K showed that mostly the growth indices of 40–60% compost either were more than the control or they have not significant difference than in the control.

4. The results are indicator of providing the needed potassium for plant by peanut shelles compost.

5. According to the desirable properties of peanut shelles compost and high porosity; it is suggested that this bed mixed with low pores beds and it can be used as an alternative imported beds.

ACKNOWLEDGEMENTS

Research was conducted at: A greenhouse in Rasht city, Guilan province and Soil Sciences Lab., Department of Horticulture, Rasht Branch, Islamic Azad University, Rasht, Iran

REFERENCES

Abad M., Noguera P., Bures S., 2001. National inventory of organic wastes for use as growing media for ornamental potted plant production: case study in Spain. Biores. Technol., 77, 197–200.

Agriculture Organization of Guilan Province, 2010. Crops data of Guilan province, Rasht, Guilan province, Iran.

Alidoust M., Mohammadi Torkashvand A., Mahboub Khomami A., 2012. The effect of growth medium of peanut shelles compost and nutrient solution on the growth of Dracaena. Ann. Biol. Res., 3(2), 789–794.

Atieyh R.M., Arancon N., Edwars C.A., Metzger J.D., 2000. Influence of earthworm processed pig manure on the growth and yield of greenhouse tomatoes. Biores. Technol., 75, 175–180.

Atiyeh R.M., Subler S., Edwards C.A., Metzger J.D., 2001. Pig manure vermicompost as a component of a horticultural bedding plant medium: Effects on physicochemical properties and plant growth. Biores. Technol., 78(1), 11–20.

Basantia D., Singh L.B., Sirvastava R.C., 2011. Effect of vermicompost on the round year flower production of marigold (*Tagetes erecta* L.). Sevaeola, in Andaman Island. International Conference on Tropical Island Ecosystem Andaman and Nicobar Island, India.

Bugbee J.G., 2002. Growth of ornamental plants in container media amended with biosolids compost. Compos. Sci. Util., 10, 92–98.

Cakmak I., 2005. The role of potassium in alleviating detrimental effects of abiotic stresses in plants. J. Plant Nutr. Soil Sci., 168, 521–530.

Castro E., Manas P. De las Heras J., 2009. A comparison of the application of different waste products to a lettuce crop: Effects on plant and soil properties. Sci. Hortic., 123(2), 148–155.

Chen Y., Inbar Y., Hadar Y., 1989. Composted agricultural wastes as potting media for ornamental plants. Soil Sci., 145, 298–303.

Cull D.C., 1981. Alternatives to peat as container media: Organic resources in UK. Acta Hort., 126, 69–81.

Egilla J.N., Davies F.T., Boutton T.W., 2005. Drought stress influences leaf water content, photosynthesis, and water- use efficiency of *Hibiscus rosa sinensis* at three potassium Concentrations. Photosynthetica, 43, 135–140.

Faquin V., 1994. Mineral nutrition of plants. Lavras: ESAL-FAEPE:227.

Fred D.R., Hariss H.M., Watanabe R., Stanley R.W., 1997. Plant growth in potting media using compost. Horticulture Research Note. University of Hawaii, 4 p.

Gayasinghe G.Y., Liyana Arachchi I.D., Tokashiki Y., 2010. Evaluation of containerized substrates developed from cattle manure compost and synthetic aggregates for ornamental plant production as a peat alternative. Resour. Conserv. Recy., 54, 1412–1418.

Hogland D.R., Arnon D.I., 1950. The water culture method for growing plants without soil. California Agricultural Experiment Station Circular, 347, 2nd edit., 32 pp.

Krumfolz L.A., Wilsonand S.B., Stoffella P.J., 2000. Use of compost as amedia amendment for containerized production of perennial cat whishkers. SNA Res. Conf., 45, 69–72.

Larcher F., Scariot V., 2009. Assessment of partial substitutes for the production of *Camellia japonica.* HortSci., 44(2), 312–316.

Mahboub Khomami A., Padasht Dehkaei M.N., 2010. Effect of composted Azolla in different growth media on growth and nutrient elements compasition in *Ficus benjamina* plant cv. Starlight. Seed Plant Prod. J., 25(4), 417–430.

Maiti R., Ebeling W., 2002. The peanut (*Arachis hypogaea*) crop. Sci. Pub. Inc., 376.

Marschner H., 1986. Mineral nutrition in higher plants. New York, Academic Press.

Marscher H., 1995. Mineral nutrition of higher plants. Academic Press. Limited, London 2nd edit., 861 pp.

Mohammadi Torkashvand A., 2010. Improvement of compost quality by addition of some amendments. Aus. J. Crop Sci., 4(4), 252–257.

Murata M.R., 2003. The impact of soil acidity amelioration on groundnut production on sandy soils of Zimbabwe. Ph.D. Thesis, Univ. of Pretoria, Zimbabwe.

Padasht Dehkaei M.N., 2004. Selection of the best growth medium of *Draceana marginanta* and *Beaucarnea recurbata.* 3th Iranian Horticulture Congress, 1–3 August, Karaj, Iran.

Papafotiou M., Phsyhalou M., Kargas G., Chatzipavlidis I., Chronopoulos J., 2005. Olive-mail waste compost as growth medium component for the production of poinsettia. Hort. Sci., 102, 167–175.

Pool R.T., Conover C.A., 1991. Potential for eucalyptus mulch used as a component of potting mixes for foliage plant production. CFREC-Apopka Res. Rep. RH-15.

Ronald J.B., Dianne A.N., 2006. Floriculture: from greenhouse production to flora design. Forest Indian Reprint.

Salardini A., 2009. Soil fertility. University of Tehran Press, Fourth edition, Tehran, Iran.

Salehi A., Ghalavand A., Sefidkon F., Asgharzade A., 2011. The effect of zeolite, PGPR and vermicompost application on N, P, K concentration, essential oil content and yield in organic cultivation of German Chamomile (*Matricaria chamomilla* L.). Iranian J. Med. Aromat. Plants, 27(2), 188–201.

Scagel C.F., 2003. Growth and nutrient use of cricaceous plants grown in media amended with sphagnum moss peat or coir dust. HortSci., 38, 46–54.

Scharpenseel H.W., Kunth K., 1987. Use and importance of Azolla Anabaena in industrial countries, Azolla utilization (IRRI), 241–245.

Shabala S., 2003. Regulation of potassium transport in leaves: From molecular to tissue level. Ann. Bot., 92, 627–634.

Sharifi M., Afyuni M., Khoshgoftarmanesh A., 2010. Effect of sewage sludge, compost and cow manure on growth and yield and Fe, Zn, Mn and Ni uptake in *Tagetes* flower. J. Sci. Technol. Greenhouse Cult., 1(2), 43–54.

Singh R., Pradhan K., 1981. Determination of nitrogen and protein by Kjeldahl method. In: Forage evaluation science, Heath M.E., Barnes R.F., Metcalfe D.S. (eds). Pvt. Publishers Ltd., New Delhi, 23.

Sulter C.H., 1985. Role of potassium in enzyme catalysts. In: Potassium in agriculture, ASA, CSSA and SSSA, Munson R.D. (ed.). Madison, WI, 337–349.

Verdonck O., Gabriels R., 1992. I. Reference method for the determination of physical properties of plant substrates. II. Reference method for the determination of chemical properties of plant substrates. Acta Hort., 302, 169–179.

Walkey J.A., Black J.A., 1934. Estimation of organic carbon by the chromic acid titration method. Soil Sci., 37, 29–31.

Wang Y.T., 2007. Potassium nutrition affects growth and flowering of *Phalaenopsis* grown in a bark mix or sphagnum moss substrate. Hort. Sci., 42, 1563–1567.

Xu W.Y., Yu T.Z., Husaini A.M., Wei J.Z., Lin L.G., Qian L., Wei W., 2011. Optimization of potassium for proper growth and physiological response of *Houttuynia cordata* Thunb. Environ. Exp. Bot., 71(2), 292–297.

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

WZROST KAMELII W PODŁOŻU Z KOMPOSTU Z ŁUPIN ORZECHÓW ZIEMNYCH O RÓŻNYM STĘŻENIU POTASU

Streszczenie. Zarządzanie odpadami rolniczymi jest krokiem w kierunku zrównoważonego rolnictwa. Łuski orzechów ziemnych jako pozostałość po uprawie orzechów mają znaczną objętość i w formie kompostu mogą być używane jako dostępne źródła podłoża dla roślin ozdobnych. Doświadczenie czynnikowe na podstawie całkowicie rondomizowanych bloków przeprowadzono w celu zbadania wpływu kompostu z łusek orzechów ziemnych jako podłoża dla kamelii przy różnych stężeniach potasu. Doświadczenie objęło piętnaście zabiegów w trzech powtórzeniach oraz 45 poletek. Posadzone ukorzenione sadzonki kamelii podlewano dwa razy w tygodniu roztworem Hoaglanda. Po pięciu miesiącach dokonano pomiaru wskaźników wzrostu roślin, a także stężenia i poboru substancji odżywczych. Na podstawie wyników stwierdzono, że kompost z orzechów ziemnych zwiększa wskaźniki wzrostu w porównaniu z kontrolą. W odniesieniu do większości wskaźników wzrostu, rośliny wykazywały lepszą reakcję w przypadku 40% i ostatecznie 60% dodatku kompostu (% wag.). Wyniki wskazują na skuteczniejsze dostarczanie potasu potrzebnego do wzrostu roślin w przypadku kompostu z łusek orzechów ziemnych w porównaniu z kontrolą.

Słowa kluczowe: odpady rolnicze, roztwór Hoaglanda, rośliny ozdobne, doświadczenie doniczkowe

Accepted for print: 30.06.2014