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COMPOST AS PEAT SUBSTITUTE IN OLIVE CUTTING MEDIA

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ABSTRACT

The possibility of replacement compost as peat moss in olive propagation media (PM) and it's impact on growth was investigated during both 2013 and 2014 seasons. Semi- hardwood stems cuttings of Coratina olive cultivar prepared in April and August of both seasons. The basal portion of each cutting was immersed 4000 ppm indole butyric acid before planting. Propagation media (Treatments) consist of: sphagnum peat-moss: sand in one ratio (1:3) as a control and plant composting: sand in five ratio (1: 3, 1: 4, 1: 5, 1: 6 and 1: 7) by volume.

The obtained results clearly showed the enhancements in cuttings rooting percentage and root characteristics were associated with the highest sand compost ratio (1: 6 or 1:7) as well as peat: sand media (1:3) which correlated with decreasing bulk density and penetration of propagating media and raising its aeration. The percentages of rooting were significantly decreased linearly by decreasing compost: sand ratios (1: 2 or 1: 3). The usage of compost: sand at 1: 7 in both seasons and at 1:6 in the second season only resulted in significantly the highest rooting percentage. Statistically equal results were attributed to the contextually used medium (peat: sand at 1:3). The similar trend occurred with the other root characteristics i.e. average root dry weight and number of roots / transplant. Moreover, using compost: sand at 1:4 or 1:5 achieved similar or better growth of shoot than using peat: sand at 1: 3 as PM.

Keywords: *olive, propagation media, rooting percentage, root characteristics, shoot characteristics.*

INTRODUCTION

Olive (*Olea europaea* L.) is commercially propagated by semi hard wood leafy cuttings using a mist irrigation system (Hartmann *et al.,* 2007; Fabbri *et al.,* 2004). Rooting is generally affected by internal and external factors, i.e., cultivars, rooting media and time (Gerakakis *et al.,* 2005). Rooting media is considered to be of the most crucial inputs for successful rooting with supreme root quality of cuttings is a reliable (Loach, 1988, Dolor *et al.,* 2009). Criteria to be considered when selecting a rooting medium are cost and availability of the medium components (Macdonald, 1986; Hartmann *et al.,* 2007), quality (particle size, freedom from silt, salt, weed, seeds, diseases, pH 5.5-6.5), physical structure (ability to support the cutting, easy sticking of the cuttings), adequate aeration, mixing - the ability to be easily mixed and standardization (FAO TECA, 2011).

Egyptian olive propagation industry depends chiefly on peat moss as a main organic component in the propagation media (PM) due to its relative homogeneity and excellent qualities it adds to the medium. Peat moss is imported and is rather expensive. There is a rising trend of replacing the use of peat in PM, driven by the need to recycle organic wastes in an environmentally-sensitive manner, by the lower cost of peat alternatives and due to the understanding of the role of peat bogs in the global carbon cycle (Kala *et al.,* 2012 and Raviv, 2014). Many studies have reported that organic wastes composts can be used with very good results as growth media instead of peat (Perez-Murcia *et al.,* 2006; Grigatti *et al.,* 2007; Ribeiro *et al.,* 2007; Ostos *et al.,* 2008). Many feed stocks can be composted, to be used later in PM. This includes coir, bark, sawdust and other plant wastes, animal manures and others. Limitations to the use of most of the composts as ingredients of PM are related to their physical properties (high bulk density and low amount of easily available water). In some cases also salinity, residual phytotoxicity, high pH, and high biological oxygen demand resulting in potential N immobilization and substrate shrinkage with time may be problematic (Kala *et al.,* 2012).

Coratina is an Italian olive cultivar; it begins to bear fruit early, and has a relatively constant and high productivity. Coratina has a stable and high oil content and excellent organoleptic characteristic. Its' oil is bitter and pungent (Wiesman, 2009).

The aim of this investigation is to assess the possibility of replacing peat moss by plant compost in olive propagation media and it's impact on growth.

MATERIALS AND METHODS

The present investigation was carried out in the nursery of the Faculty of Agric. Cairo Univ. under black siran shade house equipped with a mist irrigation system during April and August in both 2013 and 2014 seasons.

Plant material

1050 semi- hardwood stems cuttings of Coratina olive cultivar prepared from middle portion of vigorous 1-year-old shoots. Cuttings had a 0.8 to 1cm diameter, 15-20 cm length with six leaves. Cuttings were prepared in April and August of both seasons.

Rooting Treatment

The basal portion of each cutting was immersed for 5 seconds in an aqueous solution containing 4000 ppm indole butyric acid (Fouad *et al.,* 1990; Mura et al. 1995; Mancuso et al. 1997).

Treatments (propagation media)

Propagation media (Treatments) consist of: sphagnum peat-moss: sand in one ratio (1:3) as a control and plant composting: sand in five ratio (1: 3, 1: 4, 1: 5, 1: 6 and 1: 7) by volume. Each of the considered propagation medium was placed in 3 cutting propagation boxes (each representing a replicate) in which 50 cuttings were planted.

Chemical composition of the used compost is shown in Table (1). Further, propagation media physical properties determined according to Klute (1986) and the results are summarizing in Table (2).

Table 1: Chemical analysis of the compost used in the study.

Parameter	Value	Parameter	Value
Cubic meter weight	450 kg	Total P%	1.5
Moisture%	24	Total K%	1.26
Organic matter%	52.6	Total Ca%	2.1
pH(1:10)	8.1	Total Mg%	0.96
EC (ds/m)	3.8	Total Fe (ppm)	990
C/N ratio	1: 18	Total Mn (ppm)	280
Total N%	1.9	Total Zn (ppm)	180

Table 2: Physical properties of propagation media.

Treatments		Bulk density gm/cm^3	Media penetration kg/sq cm	Aeration %
Compost: sand	1: 2	1.45	0.43	30.4
	1: 3	1.43	0.42	31.2
	1: 4	1.53	0.40	33.6
	1: 5	1.58	0.35	34.8
	1: 6	1.64	0.33	35.0
	1: 7	1.71	0.31	35.1
Peat: sand	1: 3	1.54	0.32	34.3

Assessments

After 60 days, transplants were removed from the PM and rooting percentage was calculated from the number of cuttings with at least one root. 10 transplants per replicate were taken to determine the average root and shoot dry weight, average root and shoot length and average number of roots and leave per transplant.

Experimental design and Statistical analysis

The experiment design was a randomized complete block design with three replicates in each treatment. The obtained data over the 2 propagation times of year were pooled for analysis. The two times were statistically homogenized. Tabulated and subjected to analysis of variance (ANOVA) according to Snedecor and Cochran (1989), using the general linear models ‘‘GLM’’ procedure of the SAS software (SAS Institute, 2002). Significant differences between treatments were assessed by Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSIONS

Effect of propagation media on roots characteristics:

The percentages of rooting were significantly decreased linearly by decreasing compost: sand ratios, whereas the ratio at 1: 2 caused significantly the lowest percentage in both seasons. The usage of compost: sand at 1: 7 in both seasons and at 1:6 in the second season only resulted in significantly the highest rooting percentage (Tables 3& 4). Statistically equal results were attributed to the contextually used medium (peat: sand at 1:3).

Data in Tables (3& 4) clearly indicate that compost: sand at 1: 6 or 1: 7 in addition to peat: sand at 1: 3 produced significantly the highest average root dry weight of transplant during both seasons. Whereas, compost: sand at 1: 2 or 1: 3 produced significantly lowest weights.

The number of roots / transplant seemed to be significantly higher by using media with highest sand content i.e. compost: sand (1: 6 and 1: 7). The attained numbers were also statistically higher than number of roots /transplant planted in the conventional peat sand medium at 1:3. It is worth mentioning that the number of roots / transplant decreased linearly with decreasing sand in the media whereas at 1: 2 or 1:3 the lowest root number were attained (Tables 3& 4).

Aaverage root length increased by increased compost: sand ratio (Tables 3& 4). In first season, compost: sand at 1:6 or 1:7 ratio achieved significantly the longest roots. While the shortest ones were due to planting in compost: sand at the lowest ratio 1: 2.

Table 3: Effect of PM on rooting percentage and root growth parameters of Coratina olive variety (combined data of April and August 2013 season).

Treatments (Propagation media)		Rooting percentage (%)	Root Dry weight (g)	N. of root/ trans.	Root length/ trans. (cm)
Compost: Sand	1:2	28.33f	0.40e	8.36e	7.80b
	1:3	35.83ef	0.67de	9.48de	8.17b
	1:4	40.00de	0.78cd	10.27dc	8.90b
	1:5	47.50cd	0.98bc	11.27c	8.60b
	1:6	51.67bc	1.38a	13.30b	11.33a
	1:7	60.0a	1.40a	15.10a	9.57ab
Peat: Sand	1:3	57.50ab	1.15ab	13.43b	8.70b

*** Values shown are average and standard deviation, within each column, different letters indicate significant differences according to means of multiple Duncan range tests ($P < 0.05$).**

Table 4: Effect of PM on rooting percentage and root growth parameters of Coratina olive variety (combined data of April and August 2014 season).

Treatments (Propagation media)		Rooting percentage (%)	Root dry weight (g)	N. of root/ trans.	Root length/ trans. (cm)
Compost: Sand	1:2	34.17d	0.60d	8.40c	9.70a
	1:3	50.83c	0.68cd	9.33c	9.10a
	1:4	56.67bc	0.92bc	10.90b	10.57a
	1:5	55.83bc	1.08ab	10.83b	10.03a
	1:6	63.00a	1.40a	12.40a	9.70a
	1:7	61.67ab	1.30a	12.30a	9.16a
Peat: Sand	1:3	62.50a	1.15ab	11.00b	9.70a

*** Values shown are average and standard deviation, within each column, different letters indicate significant differences according to means of multiple Duncan range tests ($P < 0.05$).**

Effect of growing media on vegetative growth characteristics:

As for the average shoots dry weight, significantly heaviest weights were obtained by using 1: 3 peat: sand or 1: 5 compost: sand ratio in both seasons. While, the lowest weights were associated with low sand containing media i.e. compost: sand at 1: 2 or 1: 3 (Tables 5& 6).

As for average shoot number per transplant, insignificant differences were attributed to the used media. Yet it is worth mentioning that1: 5 compost: sand followed by 1: 3 pet: sand ratios produced the highest number of shoots in both season (Tables 5& 6).

Shoot length was significantly affected by different media used (Tables 5& 6). Since, the longest values were due to used culture in 1: 5 and 1: 4 compost: sand ratio in first and second seasons respectively. However attained lengths were significantly longer than those due to culture in peat: sand (1: 3).

Average leave number per transplant seemed to be higher with using the moderate compost: sand ratios (1: 3up to1: 5) in first season. In second one peat: sand as all compost: sand ratios except 1: 3 resulted in statistically equal numbers (Tables 5& 6).

Table 5:Effect of PM on shoot growth parameters of Coratina olive variety (combined data of April and August 2013 season).

Treatments (Propagation media)		Shoot dry weight (g)	N. of shoot/ trans.	Shoot length/ trans. (cm)	Leave n./ trans.
	1:2	0.52de	1.63a	2.40bc	3.77b
	1:3	0.35e	1.66a	2.50ac	4.45ab
Compost:	1:4	0.72cd	1.77a	2.85ab	5.42a
Sand	1:5	1.05ab	2.15a	3.30a	5.33a
	1:6	0.70cd	2.03a	1.88c	3.77b
	1:7	0.83bc	1.93a	1.72c	3.45b
Peat: Sand	1:3	1.10a	2.12a	2.40bc	4.23b

*** Values shown are average and standard deviation, within each column, different letters indicate significant differences according to means of multiple Duncan range tests (P < 0.05).**

Table 6: Effect of PM on shoot growth parameters of Coratina olive variety (combined data of April and August 2014 season)

Treatments (Propagation media)		Shoot dry weight (g)	N. of shoot/ trans.	Shoot length/ trans. (cm)	Leave n./ trans.
	1:2	0.47d	1.33a	1.83c	2.97b
	1:3	0.83dc	1.60a	1.97c	3.98a
Compost:	1:4	1.25b	1.53a	3.00a	4.62a
Sand	1:5	1.47ab	1.57a	2.73ab	4.23a
	1:6	1.27b	1.73a	2.18bc	3.67ab
	1:7	1.10bc	1.80a	1.70c	3.75ab
Peat: Sand	1:3	1.72a	1.87a	1.90c	3.82ab

*** Values shown are average and standard deviation, within each column, different letters indicate significant differences according to means of multiple Duncan range tests (P < 0.05).**

Successful rooting is determined not only by rooting percentage but also by the number and length of roots formed (Hartman *et al.,* 2007). Rooting medium not only affects the percentage of rooted cuttings but also the quality and quantity of roots produced (Dolor *et al.,* 2009). This is due to a function of available moisture and air in the rooting medium (Sadhu, 1989).

However, in this investigation the enhancements in cuttings rooting and root characteristics were associated with the highest sand compost ratio as well as peat:sand media(control)which correlated with decreasing bulk density and penetration of propagating media and raising its aeration(Table 2).

An ideal propagation media according to Hartmann *et al.,* (2007) should provide porosity to allow good aeration. They stated further that rooting is reduced when cuttings are stuck in highly water saturated propagation media with small air pore space. The water blocks the pathways by which gases could exchange with the atmosphere (Brady and Weil, 1999). The air/water balance of some media may have changed to favor or disfavor rooting (Loach,1988). Whereas, better results were achieved when media with good aeration and a reduced water retention capacity were used for instance; root regeneration was strongly suppressed in pure peat, but the values for all rooting variables were significantly increased by mixing this with polystyrene and vermiculite in both years. The negative effects of peat are likely related to its high water retaining capacity (Isfendiyaroglu *et al.,* 2009). In addition, organic by-products and composts tend to have porosity and aeration properties comparable to those bark and peat and as such are ideal substitutes in propagating media (Chong, 2005). The usage of compost improves the fertilizing capacity of a substrate (Ostos *et al.,* 2008).

Moreover, using compost: sand at 1:4 or 1:5 achieved similar or better growth of shoot than using peat: sand at 1: 3 as PM. In this respect, Ribeiro *et al.* (2007) suggest that the compost is a good alternative to peat-based substrates for the production of vegetable seedlings. Furthermore plants of the compost-based substrates reached better growth and nutrition than plants growing in peat-based substrate (Ostos *et al.,* 2008).These enhancements achieved with the moderate compost ratio may be due to the better rooting occurred under this media in comparison with the (1: 2 or 1:3) which is reflect on better absorption of nutrients or water leading to better growth. In addition these moderate ratios are of higher contents of nutrients than the 1:6 or 1:7 ratios. Root functions and also the shoot and root dry weight mainly depend on the concentration of nutrients in the soil (or substrate), and the physical, chemical and microbiological conditions for root activity. In natural vegetation the shoot/root decreases as soil fertility decreases and vice versa (Marschner, 1995). In general, significant increases in the dry weight of shoot under compost media compared to peat have been referred to by other researchers (Perez-Murcia *et al.,* 2006; Grigatti *et al.,* 2007; Jayasinghe *et al.,* 2010), which were mainly due to the great contribution of nutrients, especially N and P in composts.

In conclusion, the present results show the possibility of the replacement of peat moss by compost in olive propagation media. Since, using plant composting in olive PM in ratio 1: 6 or 1:7 to sand induced lower bulk density, lower penetration force and good aeration leading to equal or even better rooting percentage and quality and quantity as the conventional peat moss sand medium.

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استعمال الكومبوست فى بيئة اكثار الزيتون بالعقل بدلا من البيت

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تم دراسة إمكانية استبدال البيت موس بالكمبوست في بيئة اكثار الزيتون وتأثير ذلك على نمو الشتلات الزيتون خلال عامي ٢٠١٣ و ٢٠١٤. حيث اعدت العقل النصف خشبية لصنف زيتون الـ كوراتينا في أبريل وأغسطس من كلا الموسمين. تم غمر الجزء القاعدي من كل العقل فى ٤٠٠٠ جزء في المليون إندول حامض البيتوريك قبل الزراعة. وتضمنت اوساط الزراعة المستخدمة (المعاملات) كلا من: البيت موس: الرمل بنسبة (١: ٣) كنترول، الكمبوست: الرمل في خمس نسبة (١: ٣، ١: ٤، ١: ٥، ١: ٦ و ١: ٧) على اساس الحجم.

أظهرت النتائج التي تم الحصول عليها بشكل واضح ارتباط التحسن في نسبة التجذير للعقل المنزرعة وخصائص الجذور مع استخدام الكمبوست: الرمل بالنسب (١: ٦ أو ١: ٧)، والتى تحققت ايضا مع استخدام البيت: الرمل (١: ٣). وقد ارتبط ذلك مع تناقص الكثافة الظاهرية و وقوة الاختراق وزيادة نسبة التهوية لوسط الزراعة العقل المستخدم. فى حين نسبة التجذير بشكل ملحوظ مع النسب المنخفضة للكمبوست : الرمل (١: ٢ ، ١: ٣). كما ان استخدام الكمبوست: الرمل بنسبة ١: ٧ في كلا الموسمين وحتى ١: ٦ في الموسم الثاني فقط اعطت أعلى نسبة للتجذير. نفس النتائج تم تحقيقها مع استخدام البيت: الرمل بنسبة ١: ٣. الاتجاه نفسه حدث مع الخصائص الجذرية الأخرى مثل متوسط الجذر والوزن الجاف وعدد الجذور / شتلة. وعلاوة على ذلك استخدام الكمبوست: الرمل بنسبة ١: ٤ أو ١: ٥ حققت نمو مماثل أو أفضل للأفرع من استخدام البيت: الرمل بنسبة ١: ٣ كوسط زراعة.

الكلمات الدالة: الزيتون، وسط الإكثار، نسبة التجذير، الخصائص الجذرية، الخصائص الخضرية