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Effect of Various Potting Media on Percent Survival and Growth of Jojoba (*Simmondsia chinensis*) Rooted Cuttings

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A B S T R A C T

Jojoba (*Simmondsia chinensis*) is a dioecious evergreen woody perennial shrub. The economic value of the plant lies in the seed that has a high liquid wax content constituting about 50% of the dry weight. The present study aimed to find out the effect of different potting media on percent survival and growth of rooted cuttings of jojoba plant under greenhouse and shade house conditions. The experiments were laid out in a randomized completely block design (RCBD). Different parameters studied were evaluated after one month followed by six months and then a month before transplanting to the field. The results revealed that the highest value of survival percentage, height of plant (cm) and number of shoots and leaves per plant were obtained by the use of medium containing peat moss+ vermiculite+ perlite (1:1:1) compared to the other media used either individually or in combinations. However, the medium comprising of local available media (sand and soil) additional to imported medium (peat moss) had a comparative value of studied parameters opposite the previous mentioned medium. This makes an importance of use this medium for decreasing input cost synchronizing with achieving higher value of jojoba growth parameters.

Introduction

Jojoba (*Simmondsia chinensis* (Link) Schneider) is a dioecious, long-lived perennial evergreen shrub that grows wild in the semi-arid region of the Sonoran desert in Northern Mexico and Southwestern USA (National Research Council, 1985). The plants have exceptionally deep tap root system that help to survive in drought conditions. Hence, it can be successfully grown in arid and semi-arid areas of Yemen. Its natural life span appears to be between 100 and 150 years (National Oilseed and Vegetable Oils Development Board, 2008). The product, which is traded, is called jojoba oil (known as liquid wax) potential world production of this product is currently around 3,500 metric tonnes per year (Bashir *et al*., 2007). The cosmetic industry appears to be the principal market for jojoba oil products, around 2,000 tonnes per year are thought to be utilized by this industry, this equates to almost 80% of the total market share. The other major industry using jojoba oil is the pharmaceutical sector. Lubricant

applications provide a market for around 100 tonnes of jojoba oil annually. Jojoba oil is a high quality substitute for sperm oil (from the sperm whale); availability of this product is limited now due to the restrictions placed on whaling (Bagby, 1988). Plantations are established by using seeds, seedlings, rooted cuttings, or plantlets produced from tissue culture. Plant vigor, more number of shoots and leaves are important features for good survival and growth of the plant. The growth of aerial plant parts exclusively depends upon the subterranean plant parts. So for normal growth and development of aerial plant parts, proper and suitable environment must be provided to the root system (Wazir *et al*., 2004). John (1981) observed that incorporation of organic wastes improved the root zone environment. Vermiculite was used as a medium for jojoba cuttings by Thomson (1982). Feldman *et al*., (1983) reported that incorporating Osmocote (macronutrient fertilizers containing NPK @ 19-6-12 respectively) into the potting media consisting of a mixture of perlite and vermiculite (1:1) had an advantage for jojoba cuttings. Lee and Palzkill (1984) found that jojoba cuttings rooted and grown significantly more in a mixture of perlite+ vermiculite (1:1) than in Oasis Root Cubes. They also transplanted rooted cuttings into a commercial peat+ vermiculite potting mix and grown for three months in a shade house (50% shade) during summer months. The cuttings grew into normal appearing plants. Howard *et al*., (1984) raised jojoba cuttings in peat+ perlite medium. Mixture of perlite and vermiculite as potting medium for jojoba cuttings is also reported by National Research Council of USA (1985). Harsh and Muthana (1985) used coarse river sand, sandy soil, or a mixture of the two for stem cuttings of jojoba. Palzkill (1988) after trying many different media settled on a mixture of perlite and vermiculite (1:1) for sticking the jojoba cuttings in flats and a mixture of peat, perlite and vermiculite (1:1:1) for sticking the cuttings in individual containers. Eed and Burgoyne (2014) rooted and grew jojoba hard-wood stem cuttings well in a medium contained peat moss and soil (1:1) under plastic tunnel conditions. Ahmad and Qasim (2003) studied the effect of various potting media to determine growth response and nutrient uptake efficiency of *Scindapsus aureus* using FYM, (farmyard manure) leaf mold, poultry manure as main source by making different combinations with sand, silt and saw dust. Potting media in different combinations were better than sole factor of soil itself as different combinations of potting media presented more growth and vigor of the plants along with improving total available nitrogen and phosphorus. Wazir *et al*., (2003) studied the effect of different soil media on the growth of *Dracaena dermensis* var. Janet Craige cuttings. Direct cuttings of Dracaena were planted in 15 cm clay pots containing different soil mixture such as silt, saw dust, leaf mold and garden soil. They found that soil media of silt+ garden soil+ leaf mold+ saw dust gave maximum number of leaves and silt+ garden soil gave maximum stem length.

A comprehensive literature is available on the use of rooting media for direct planting of jojoba cuttings into these media, but very little literature is available on the use of soil media for the planting of rooted cuttings during transitional period before planting of these cuttings into field conditions. Direct planting of rooted cuttings into the field conditions may cause death of cuttings, because of stress due to high temperature and low humidity during hot summer months or frost injury during winter months in arid and semi-arid regions (Harsh *et al*., 1987). Jojoba is a slow growing plant. In the hardening process of rooted cuttings, the

cuttings should be shifted to such a soil or a mixture of soil and mineral components medium that may enhance its growth and vigor before going to the field plantation. Therefore, the present investigations were conducted with aim of studying the effect of different potting media on survival percentage and growth parameters of rooted cuttings of jojoba plant before transplanting to the field.

Materials and Methods

Plant material

The investigations were carried out at the Jojoba Naturals Company greenhouse and shade house, Sana'a, Yemen during 2012-2013. The plant material for these two experiments was the rooted cuttings, which had been rooted previously by the application of suitable plant hormone and transferred to pots (polythene bags) filled with different potting media as a two experiments.

Experiment 1

In this experiment, the rooted cuttings were transferred to different potting media and kept in the greenhouse for growing for a period of six months. Watering time was when the medium surface looks like dry. The temperature mean inside green house was less than 35º C^0 and the humidity mean was not more than 60%. Both of them were measured with Hygro-Thermometer device (Jumbo Display Hygro-Thermometer, USA). Evaluation of different parameters such as survival percentage and various growth parameters such as height of plant (cm) and number of branches and leaves per plant were done after one month (Table 1) and six months (Table 2). An extra medium containing peat moss+sand (1:1) was added to the experiment to assess its effect on the survival percentage and growth parameters on rooted cuttings (Table 2). Because this medium components are available locally and getting them are easy. Further, high success was observed in some pre-experiments when these media were used.

Experiment 2

In this experiment, the rooted cuttings which appeared poor growth within the previous six months in the first experiment were transferred to another different promising potting media in order to improve their growth (Table 3) under shade house conditions (55% shade). This transfer came due to getting good results from the medium consisting of peat moss+sand (1:1) in the first experiment which its components are available locally and gave comparative results. Therefore, the composition of all media almost contained peat moos or sand individually or in combination. Watering was as in experiment 1. The temperature mean was 22.5 C^0 and the humidity mean was 49%. Evaluated parameters were as in experiment 1 except the character of survival of percentage.

Experimental design and data analysis

Experiments were conducted in a randomized completely block design (RCBD) with three replicates, each with 10 rooted cuttings per replicate. Obtained data of survival percentage were transformed by square root before analyzing the data. Different parameters studied of rooted jojoba cuttings were subjected to statistical analysis according to Gomez and Gomez (1983) and Sastry (2007). ANOVA values were obtained with Opstat1 software (O.P Sheron, Programmer, Computer Section, CCS HAU, Hisar, India) and means were separated with least significant difference (LSD) at $P = 0.05$.

Results and Discussion

Influence of different potting media on survival percentage and various growth parameters of jojoba rooted cuttings under greenhouse conditions after a month of transplanting were studied (Table 1). Survival percentage of jojoba rooted cuttings was more than 98% in all potting media used but with no significant effect after a month of transplanting to the pots. Significantly, the number of shoots per plant was the highest (2.33) with medium contained peat moss+ vermiculite+ perlite (1:1:1) compared to the other media in which they did not differ significantly.

Number of leaves per plant had a trend to give the same result as in number of shoots per plant, where the highest value of this character (2.33) was recorded by the medium comprised of peat moss+ vermiculite+ perlite (1:1:1) and the significant difference was seen among the rest media. The highest value of the height of plant (24.66cm) was recorded by medium consisted of peat moss+ vermiculite+ perlite (1:1:1) whereas the lowest value (10 cm) of this character was recorded with medium composed of cocopeat+ sand (1:1). This high survival of rooted cuttings in these media (peat moss+ vermiculite+ perlite (1:1:1) reflected the fact that these combinations might have provided favorable physical conditions and sufficient nutrients to the cuttings needed for activating enzymatic and biochemical processes (Wazir *et al*., 2003).

Similarly, which was said for survival percentage character, also it might be said for the other parameters studied in the same superior medium (peat moss+ vermiculite+ perlite (1:1:1). Similarly, the second evaluation of jojoba rooted cuttings was done after six months of growth in the same pots. Additional to different parameters such as survival percentage, height of plant (cm) and number of shoots, nodes and leaves per plant were evaluated (Table 2). Values of survival percentage differed significantly; the highest value (95%) was recorded with medium contained peat moss+ vermiculite+ perlite (1:1:1) and the lowest value (84%) was noticed with medium consisted of cocopeat+ sand (1:1). On the same trend, the number of branches per plant was the highest (3.66) in the same pervious medium whereas the least value of this character (1.0) was recorded in another media used (cocopeat alone, cocopeat+ perlite and cocopeat+ sand). The medium comprised of peat moss+ vermiculite+ perlite (1:1:1) also gave the highest value (40.333) of number of leaves per plant whereas the lowest number of this character (5.66) was recorded with medium contained cocopeat+ sand (1:1).

Height and number of nodes per plant were also similar to the previous character in which the highest values of both (31 cm and 12.33 nodes, respectively) were recorded in the medium composed of peat moss+ vermiculite+ perlite (1:1:1) compared to the rest media. The lowest value of height of plant (11.33 cm) was recorded in the medium consisted of cocopeat+ perlite (1:1) and cocopeat+ sand (1:1). On the other hand, almost the medium contained peat moss+ vermiculite+ perlite (1:1:1) gained the highest values of all parameters studied (Table 2).

This also might be due to the rich nutritional status and better physical conditions of this mixture in which the mixture contains organic matter in form of peat moss, and mineral substances in form of vermiculite and perlite, all are good for better survival and growth of rooted cuttings than the media consisted of organic matter or mineral substance alone.

Table.1 Effect of different potting media on the growth of rooted jojoba cuttings under greenhouse conditions

Substrates	% Survival (Mean)	No. of shoots/plant (Mean±SE)[1]	No. of leaves/ plant (Mean±SE)[1]	Height of plant (cm) (Mean±SE)[1]
Peat moss+vermiculite + perlite (1:1:1)	99.70 a[3] (10.03)[2]	2.33±0.33 a	24.33±0.88 a	24.66±0.88 a
Cocopeat	98.66 a (9.98)	1.00±0.28 b	11.66±0.33 b	13.66±0.88 b
Cocopeat+perlite (1:1)	98.66 a (9.98)	0.66±0.16 b	9.33±0.88 b	10.16±0.92 c
Cocopeat+sand (1:1)	99.00 a (10.00)	0.50±0.28 b	10.00±0.57 b	10.00±0.82 c

[1] Values represent means ± SE (Standard Error), means followed by the same letter within columns are not significantly different by the LSD test at 5 % probability level.
[2]Data in brackets are square root transformed values.
Data were recorded a month after transplanting to pots.

Table 2 Effect of different potting media on the growth of rooted jojoba cuttings under greenhouse conditions

Substrates	% Survival	No. of shoots/ Plant (Mean±SE)[1]	No. of leaves/ plant (Mean±SE)[1]	Height of plant (cm) (Mean±SE)[1]	No. of nodes/ plant (Mean±SE)[1]
Peat moss + Vermiculite + Perlite (1:1:1)	95.00 a[2] (9.79)	3.66±1.20 a	40.33±2.02 a	31.00±0.57 a	12.33±1.20 a
Cocopeat	87.00 bc (9.38)	1.00±00 b	11.33±1.76 bc	16.33±2.18 b	6.66±0.33 b
Cocopeat + Perlite (1:1)	85.00 cd (9.30)	1.00±00 b	6.66±2.40 c	11.33±1.66 c	3.66±0.88 c
Cocopeat + sand (1:1)	84.00 d (9.21)	1.00±00 b	5.66±2.33 c	11.33±1.45 c	3.33±1.20 c
Peat moss + Sand (1:1)	89.00 b (9.52)	2.33±0.33 ab	18.33±3.48 b	16.66±1.45 b	5.66±0.88 bc

[1] Values represent means ± SE (Standard Error), means followed by the same letter within columns are not significantly different by the LSD test at 5 % probability level.
[2]Data in brackets are square root transformed values.
Data were recorded six months after transplanting the plants to the pots

Table.3 Effect of different potting media on the growth of rooted jojoba cuttings under shade house conditions

Substrates	No. of shoots/ Plant (Mean±SE)[1]	No. of leaves/ plant (Mean±SE)[1]	Height of plant (cm) (Mean±SE)[1]	No. of nodes/ plant (Mean±SE)[1]
Peat moss + Vermiculite + Perlite(1:1:1)	3.00±0.57 abc[2]	23.33±2.02 a	27.33±3.93 a	7.66±0.88 a
Peat moss + Sand (1:1)	1.66±0.33 d	15.00±2.64 c	17.66±1.76 b	6.00±0.57 ab
Soil + Sand (1:1)	2.00±.00 bcd	11.00±0.57 bc	15.66±1.45 b	4.66±0.33 b
Soil (1:1)	1.00±00 d	11.00±1.52 bc	14.00±0.57 b	4.00±0.57 b
Soil + Peat moss + Sand (1:1:1)	3.66±0.60 ab	17.00±1.00 b	16.83±1.92 b	4.33±0.88 b
Soil + Peat moss + Sand (1:0.5:1)	4.00±0.57 a	16.66±1.85 b	18.33±1.48 b	4.66±0.66 b

[1] Values represent means ± SE (Standard Error), means followed by the same letter within columns are not significantly different by the LSD test at 5 % probability level.
[2]Data in brackets are square root transformed values.
Data were recorded a month after transplanting to the pots

After a month of transplanting rooted cuttings of jojoba plant which appeared poor growth within consumed time in the experiment 1 to another combinations of growth media and to another conditions (shade house), these media contained combinations of soil, sand, and peat moss because of its superiority for producing comparative growth at almost all parameters studied as in experiment 1 compared to the best medium which contained peat moss+ vermiculite+ perlite (1:1:1) (Table 3). All parameters of growth at different potting media were evaluated. Generally, these parameters differed significantly. The medium consisted of peat moss+ vermiculite+ perlite (1:1:1) yielded the greatest values of number of leaves per plant (23.33), height of plant (27.33 cm) and number of nodes per plant (7.66) except the number of shoots per plant (4.0) which was recorded with medium contained soil+ peat moss+ sand (1:0.5:1). Either, the medium contained soil+ peat moss+ sand (1:1:1) or the similar medium which contained the same contents of soil and sand and half quantity of peat moss (1:0.5:1) recorded comparative values for almost all parameters studied in comparisons to the other media used except with the best medium (peat moss+ vermiculite+ perlite; 1:1:1). These two media were statistically on a par with each other for different parameters applied. Superiority of these media, it may be attributed to nutritionally better mixtures, high water and nutrient holding capacity, good drainage and high porosity, which helped in the development of excellent root system. Such media enhance apical meristematic activities and also trigger cambial division. Decomposed organic matter improves pore spaces, water holding capacity and microbial activity that result in a maximum shoot growth (Wazir *et al*., 2004).

In conclusion, the present study was created a composition of growth media which was superior for survival percentage and growth of jojoba rooted cuttings under green and shade house conditions i.e., soil+ peat moss+ sand (1:1:1) for almost all parameters used. The components of these media almost available locally. Of course, the superiority

rank of this medium almost similar to the ideal composition medium; peat moss+ vermiculite+ perlite (1:1:1) but the components of this ideal medium are imported and need hard currency to be imported to Yemen. Further, there is no much difference between both of them with respect to their effect on the different parameters investigated.

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