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EVALUATION OF POTTING MEDIA FOR THE PRODUCTION OF ROUGH LEMON NURSERY STOCK

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Abstract

Effect of different potting media on growth of rough lemon (*Citrus jambhiri* L.) rootstock was studied. Freshly harvested seeds of rough lemon were germinated in flat trays of sterilized sand under greenhouse conditions. Six week old seedlings, uniform in size were transplanted from trays to pots (15x15 cm). Leaf manure, peat, spent compost of oyster and button mushroom were added in different compositions with soil, sand, leaf manure and farmyard manure (FYM). Physical and chemical characteristics of different media combination were studied. Data was collected on monthly basis for plant growth parameters. Sand +peat (1:1) proved to be a superior potting medium followed by sand + peat + spent compost of Button mushroom (1:1:1) for growth of rough lemon (*C. jambhiri*) nursery stock.

Introduction

Citrus is one of the largest and most important groups of fruits of tropical and subtropical regions. It is a slow growing plant and is commercially propagated through budding/grafting on seedling rootstocks. The rootstocks have a great impact on scion vigour and fruit size, fruit yield and juice quality as well as tolerance to salt, cold and drought. Citrus rootstocks also have a considerable effect on leaf mineral content in the scion (Wutscher, 1989). Rough lemon (*Citrus jambhiri* L.) is major and widely used rootstock in Punjab province. Rootstocks are propagated through seeds in open field nurseries and the nursery site is often infected with citrus nematodes, foot rot and deleterious weeds. These problems are major difficulties for nurserymen to grow healthy citrus nursery stock.

Production of containerized citrus nursery plants has increased greatly in recent years and found to be a possible solution against the soil related problems. In Pakistan, however, little work has been done on production of containerized citrus nursery plants. Container grown citrus nursery has some advantages over field-grown nursery (Maxwell & Lyons, 1979). The advantages are: (i) the same site can be used each year for a container nursery using soilless or fumigated/sterilized potting mixtures, (ii) nematodes, noxious weeds and soil borne diseases are not transferred into new grove sites, (iii) less equipment is needed in container nursery than in field nursery, (iv) the operation is concentrated in screenhouse/greenhouse complex where partial control of microclimate is possible and freeze/heat protection is feasible and (v) container grown citrus plants starts growth faster after being transplanted into field because of having an undisturbed root system.

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Table 1. Potting media composition.

Media composition	Ratio (v/v)
Silt	Control
Sand + Peat	1:1
Sand + Peat + Silt	1:1:1
Sand + Soil + F.Y.M	1:1:1
Sand + Spent compost (Button)	1:1
Sand + Peat + Spent compost (Button)	1:1:1
Sand + Silt + Leaf Manure	1:1:1
Sand + Silt + Leaf Manure + Spent Compost (Button)	1:1:1:1
Sand + Peat + Spent Compost (Oyster)	1:1:1
Sand + Silt + Leaf manure + Spent Compost (Oyster)	1:1:1:1
Sand + Silt + Spent compost (Button) + Spent Compost (oyster)	1:1:1:1
Silt + Spent Compost (Button) + Spent Compost (Oyster)	1:1:1

Good container-media management is basic to the production of quality container-grown citrus nursery plants. Farmyard manure has been the main source of organic matter for the supply of essential minerals needed by the plants. Heavy applications of organic matter are required for successful production of fruits and vegetables (Chaudhary, 1996). The potting media containing sand, manure, clay loam and sawdust were found effective for the healthy growth and development of Troyer citrange grown in pots (Anvari *et al*., 1994). Similarly, maximum growth was observed in *Citrus limonia* Osbeck container-grown nursery plants in mixture of cattle manure, lignite and two commercial products Agrohumus 51 and 61 (Grossi *et al*., 2001). A growing media containing different mixture of loam, sand and cattle manure (2:1:1) had a significant effect on growth of Sour orange and Troyer citrange container-grown seedlings (Nisar *et al*., 1990). Potting media is a very important complex system, which is made up of solid, liquid and gaseous materials. The chemical and physical relationships among the solid, liquid and gaseous phases are affected not only by their own respective properties but also by some environmental factors. The physical and chemical properties as well as nitrogen, phosphorus and potassium concentration of potting media are dominant factors affecting the use of media, availability of nutrients to plant, mobility of water into or through media and penetration of roots in the potting media (Sabah, 1994). Citrus thrives best in a soil with a pH slightly below the neutral point. Vigorous growth is needed to face the seasonal hazards and this is entirely based on the chemical and physical characteristics of the potting media. Optimum water holding capacity, electrical conductivity, pH, better aeration and organic matter of media may help in better seedling stand and plant growth of container grown citrus nursery plants.

Experiments were carried out to study the physical and chemical characteristics of different potting media combinations and their influence on the growth and development of container grown rough lemon nursery plants.

Materials and Methods

Media: Peat, spent compost of mushroom (Button and Oyster), leaf manure and farmyard manure in different ratios (v/v basis) were used as amendment sources for preparation of media with silt and coarse sand (Table 1).

Plant growing conditions: Freshly harvested seeds of rough lemon (*C. jambhiri* L.) rootstock were collected and germinated in flat trays filled with sterilized sand. The germinated seedlings were kept and maintained under controlled conditions in growth room. Six months old vigorously growing seedlings having good root system and uniform size were transplanted in clay pots (15x15). Watering was done at one day interval. The experiment was carried out in completely randomized design (CRD). Each treatment consisting of 10 plants were replicated five times. The data collected for plant growth parameters were subjected to Duncan's multiple range (DMR) test where as for chemical and physical characteristics of potting media, means were compared.

Potting media analysis

Physical characteristics: Analytical methods of U.S. Salinity Laboratory Staff (Richards, 1954) were followed to determine the physical characteristics of different media compositions. The core method was used for the determination of bulk density. Bulk density was calculated by the formula derived by the American Society of Agronomy (Anon., 1965) as follows: Bulk density (d) = Weight of oven dry core soil / volume of the sample (g cm^{-3}).

This is numerically equal to apparent specific gravity or volume weight. Porosity was calculated from bulk density and particle density (Method 40) by the formula: Total porosity = bulk density / particle density. Moisture percentage (Method 2) was calculated by the formula: Moisture Percentage = loss in weight on oven drying / weight of oven dry soil X 100.

Chemical characteristics: About 250 g of soil was saturated with distilled water, paste was allowed to stand for an hour and pH was recorded by Beckman Zero-matic pH meter with glass electrode using buffers of pH 4.0 and 9.0 for standardizing the instrument (Method 21a). Electrical conductivity (EC) of the saturation extract was measured by using conductivity meter Model CM-1 Mark v (Kent). Electric Instrument Ltd. England (Method 3a and 4b). Total nitrogen was determined by using Gunning & Hibbards method of sulphuric acid digestion and distillation with marco Kjeldahl apparatus (Jackson, 1962). Available phosphorus was calculated as previously described by Watanabe and Olsen (1965) and available potassium was determined by Gallenkamp Flame Analyzer (Method 18).

Plant growth analysis: The data for plant growth characteristics were recorded after every month up to six months of transplanting of seedling. Stem height was measured from surface of potting media to the top of rootstock seedling. Stem diameter was measured by screw gauge in millimeters from the centre of seedling. Number of mature leaves was counted on each seedling. Five leaves were picked from each replication of the treatment, cleaned with tissue paper and leaf area index was measured through leaf area meter. Mortality in each media composition was also recorded.

Results and Discussion

Potting media analysis:

Physical characteristics: The silt alone has high value (1.25 g cm^{-3}) of bulk density compared to all other combinations and sand + peat + spent compost (button mushroom)

had the lowest value (0.80 g cm^{-3}) of bulk density (Table 2). The addition of organic matter in the form of peat and spent compost of mushroom can improve the physical status of soil for better root development because of increased aeration in the media. De-Boodt (1971) and Paul & Lee (1976) concluded that aeration was enough in loam and sand with the addition of organic amendments. Wilson *et al*., (2001) reported similar results with biosolid yard waste compost in a peat medium.

The highest moisture percentage (58.14 %) was found in silt media amended with equal proportion of spent compost (button and oyster mushroom), whereas moisture percentage was minimum (10.33%) in silt alone (Table 2). These results are in accordance with the finding of Goh & Haynes (1977) who reported that three New Zealand commercial potting media, (i.e. peat and sand; peat, sand and sawdust and peat, sand and soil in equal proportions by volume) hold more water as compared with control. Organic mud and spent mushroom compost (SMC) increases the porosity of soil and then improves the physical structure of soil.

Total porosity was high (0.90) for sand + silt + leaf manure and silt + spent compost (button and oyster) where as silt alone (control) depicted the lowest total porosity (0.63). The higher values of total porosity mean the less compactness and increased aeration, which results in better root growth and penetration of citrus plants into the soil. These findings were supported by the results of De-Boodt (1971) and Paul & Lee (1976) who reported that aeration was improved in aggregated loam and sand with the addition of organic amendments.

Chemical characteristics: Sand + peat showed the lowest pH value (6.5) while the highest pH value (8.02) was observed in spent compost of button mushroom with sand (Table 2). Other combinations of media had pH value within the range of 7.4 to 7.5. High values of pH were noted in all treatments except sand +peat because in these treatments spent mushroom compost (SMC) and farmyard manure (FYM) was mixed in different proportions. Mushroom and farmyard base media is basic in nature, which increased the pH because organic compound was present but not in decomposed form. The results were supported by Joiner (1981) and Fitzpatrick *et al*., (1998) who suggested that the media pH value for container grown plants should range from 5.5 to 6.5.

Electrical conductivity (EC) of the saturation extract is an important criterion, which indicates the presence of electrolytes in a unit area. It is directly related to the concentration of total soluble salts in a soil. The results indicates that minimum EC value (1.65 dSm^{-2}) was in sand + peat and the maximum (6.29 dSm^{-2}) in sand + spent compost of button mushroom (Table 2). It was observed that media combinations having low value of electrical conductivity (EC) gave good results for plant growth and development (Table 3). High levels of electric conductivity showed poor plant growth (Poole *et al*., 1981; Bernstein, 1975). They recommended that EC values should range between 0.63 to 1.56 dSm^{-2} for media used for container grown plants and EC values > 3.5 dSm^{-2} can have adverse effects on seedling growth.

Nitrogen is vital plant nutrient and it is apparent from results that media combinations differed from one another with regard to average content of total nitrogen (Table 2). Differences in the nitrogen contents might be due to variation in organic matter contents in the different components of potting media. More or less similar findings were reported by Ouyang *et al*., (1984).

Phosphorus and potassium is also an important nutrient for better growth of citrus plant. It is revealed from the results that potting media differed in phosphorus and potassium contents (Table 2). Anjaneyulu (1984) also reported similar findings.

Plant growth and development: The medium containing only sand and peat significantly performed better for plant growth parameters as compared with other combinations (Table 3). However, for leaf area index; three combinations [sand + peat, sand + peat + spent compost (Oyster) and silt + peat + spent compost (Button)] showed significant results over other combinations but were statistically non-significant with each other. Saleem *et al*., (1995) demonstrated that the growth rate, plant height, vegetative growth and root fresh weight of sour orange were increased in media containing sand + peat (1:4). Similarly Ma *et al*., (2000) reported maximum plant growth and stem diameter of citrus seedlings in media containing peat + Sand (1:4), however, Anvari *et al*., (1994) observed maximum stem diameter of plants in media containing sand and manure. Similarly, Wilson *et al*., (2001) observed that plants grown in different types of medium were slightly reduced in size (number of leaves/plants) compared to plants grown in peat based medium.

Minimum mortality percentage (8 %) was found in plants grown in sand + peat (1:1) and maximum (58%) was in sand + soil + F. Y. M (1:1:1). Maximum mortality and poor plant growth were recorded in potting media, where spent mushroom compost (SMC) and farmyard manure (FYM) were applied without peat (Table 3). These findings are in accordance with Wilson & Stoffella (2003) who observed that the plant growth in compost based medium was different in terms of stem dry weight and leaf dry weight as compared with plant growth recorded in peat based media. Similar results were also reported for other perennials plants such as Mexican heather (Wilson *et al.*, 2001).

It is concluded from the results that rough lemon showed better growth and development in the media containing peat in the different proportions. Sand amended with peat (1:1) was found to be the best for rough lemon nursery stock as compared with other amendment. This could be used as a standard potting media for rough lemon nursery production in containers to maintain satisfactory plant growth, development and ultimately plant quality.

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