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Effect of potting media sterilization on plant growth of Carrizo (*Citrus sinensis* Osb. X *Poncirus trifoliata* L. Raf.) and rough lemon (*Citrus jambhiri* Lush.) nursery stock

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Abstract

Soil steam sterilization or autoclaving is frequently used to eliminate or reduce microbial activity in the soil. An investigation to study the effect of soil sterilization on two rootstocks of citrus i.e. Carrizo and Rough lemon was carried out during December – April at polyhouse, Department of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, Jammu and Kashmir. Among all the treatment, M₁ (Sterilized potting media) was found to be the best for promoting seed germination percentage (86.48%), survival percentage germination (88.04%), plant height after 60 days (6.48 cm) and 120 days (21.50 cm) of germination, number of leaves per plant (10.86), shoot girth (2.04 mm) and root length (6.50). On the basis of overall performance the study clearly revealed that M₁R₁ (sterilized potting media + Carrizo rootstock) was the best treatment for raising nursery stocks of citrus under Jammu condition.

Keywords: Soil sterilization, Carrizo, rough lemon

Introduction

Citrus is one of the most popular fruit crops of the world and is cultivated in around 140 countries and commercially important fruit crop of India (Kumar *et al.*, 2011)^[6]. Citrus crop is generally grown as composite trees with scion grafted onto a rootstock; one of the main reason for shifting citriculture from seedling to grafted plants was major losses caused by foot rot (Castle, 2010)^[3]. Rootstocks are known to affect the performance of many traits of different citrus varieties, including tolerance to biotic and abiotic stresses, fruit quality and size, productivity, ripening period and yield precocity (Castle, 2010; Bowman and Joubert, 2022)^[3]. Carrizo citrange (*Citrus sinensis* L. Osb. x *Poncirus trifoliata* L. Raf.) is the most popular rootstock worldwide, because of its tolerance to diseases and flooding, moderate cold tolerance, good fruit quality, high yield, and good compatibility with varieties (Perez Clemente *et al.*, 2012)^[8]. During 1970s in Florida, Carrizo citrange became the first commercial where it essentially replaced rough lemon and eventually was the rootstock for more than 40% to 50% of annual nursery propagations (Castle, 1987; Wutscher, 1979)^[4, 15]. Rough lemon has largely been used as a rootstock for commercial plantations of citrus in India. It is one of the major rootstock for mandarin, oranges, kinnow as trees grows on these rootstocks are vigorous and high-yielding (Sonkar *et al.*, 2002)^[12]. It provides deep root system with significant drought resistance and high vulnerability to *Phytophthora* and *Fusarium* (Cao *et al.*, 2013)^[2]. These pathogens are known to cause citrus decline and 38% of these pathogens were found in orchard soil (Rehman *et al.*, 2012)^[9].

A number of factors, such as the trend towards increasing planting densities in field-grown trees and the transition to intensive farming systems, have contributed to the need to modernise planting material production technologies of fruit crops, thus leading to an increased demand for high-quality planting material (Rehman and Gill, 2015)^[10]. Soil sterilization is frequently used to eliminate or reduce microbial activity in studies pertaining to microbial inoculations, soil enzymes, and degradation/sorption/mobility of pesticides and other xenobiotics (Liebich *et al.*, 2006)^[7]. Steam penetrates more efficiently into the media and is more effective and safe in controlling soil pests compared with dry heating and using soil fumigants (Hansen *et al.*, 2011)^[5]. It ensures supply of clean and healthy nursery plants to the growers leading to orchards with long productive life, higher yields and quality fruits.

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Therefore, the study was aimed to investigate effect of sterile and unsterile potting media on growth of Carrizo and Rough lemon rootstock.

Materials and Methods

The study was conducted in the polyhouse of Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences & Technology, Jammu. The experiment comprising 4 treatment combinations was laid out in Factorial Completely Block Design having five replications.

Factor -1 (potting media)

M1 = Sterilized potting media

M2 = Unsterilized potting media

Factor – 2 (rootstock)

R1 = Carrizo

R2 = Rough lemon

Treatment combination

T₁= M₁R₁= Sterilized potting media + Carrizo rootstock.

T₂= M₁R₂= Sterilized potting media + Rough lemon rootstock.

T₃= M₂R₁= Unsterilized potting media + Carrizo rootstock.

T₄= M₂R₂ = Unsterilized potting media + Rough lemon rootstock.

Seeds of carrizo (*Citrus sinensis* Osb. x *Poncirus trifoliata* L. Raf.) and rough lemon (*Citrus jambhiri* Lush.) were extracted from healthy fruits, collected from the orchard of Punjab Agricultural University, Ludhiana. Before sowing seeds were treated with fungicide i.e. Bavistin, then they were sown in seed trays filled with sterilized potting media farm soil, sand and FYM (1:1:1) and some of seeds were sown in seed trays with unsterilized potting media during second fortnight of November. The media were sterilized using autoclave steam sterilization at 121 °C for 25 minutes at 15 psi following with certain modifications. The temperature and pressure conditions were optimized since most of the fungi, bacteria, insects, nematodes and weed seeds are killed up to 70-80 °C (Usman and Fatima, 2013) [13]. The media were immediately cooled down and filled in seed trays and polybags. After seed sowing, seed trays were placed in polyhouse. After 45 days of seed germination, seedlings were transplanted in polybags filled with sterilized and unsterilized potting media. Observations were recorded on seed germination in the first fortnight of January. Data on seed germination was recorded from 30 days after sowing and survival rate was recorded after 60 days of seed germination. After 75 days of transplanting, data were collected for plant height (cm), shoot girth (mm), root length (cm), fresh weight of roots (gm) and dry weight of roots (gm). Total number of leaves was counted in seedlings starting from the base of the stem. Height of the seedlings was measured from soil surface to the plant tip in centimeters with a meter scale after 60 days and 120 days of germination and shoot girth was measured with Vernier calipers at 5 cm above ground. The means of all the treatments of the observations were analyzed statistically by ANOVA using OPSTAT software and the significance of the results are verified.

Results and Discussions

Seed Germination (%)

The effect of potting media sterilization and rootstock type

had a significant influence on the increase in seed germination. The maximum seed germination (86.48%) was recorded in M₁ (sterilized potting media) while the minimum (69.46%) was recorded in M₂ (unsterilized potting media). With respect to the rootstock, the maximum increase in seed germination (81.60%) was recorded in R₁ (carrizo rootstock) and minimum (74.34%) in R₂ (rough lemon rootstock). As regards to interactions, the maximum increase in seed germination (92.10%) was recorded in the treatment M₁R₁ (sterilized potting media + carrizo rootstock) and the minimum seed germination (67.83%) was recorded in M₂R₂ (unsterilized potting media + rough lemon rootstock).

Survival rate (%)

The data presented in table 1 indicate that the survival rate was influenced by the effect of different level of potting media and rootstock type. The maximum survival rate (88.04%) was recorded in M₁ (sterilized potting media) which was significantly higher than M₂ (unsterilized potting media). With respect to the rootstock, the maximum survival rate (82.14%) was recorded in R₁ (carrizo rootstock) and minimum (75.74%) in R₂ (rough lemon rootstock). As regards to interactions, there was statistically no significant difference in survival rate.

Plant height (cm)

Data revealed that the effect of potting media sterilization had a significant influence on the increase in plant height after 60 and 120 days of germination. After 60 days of germination, the maximum plant height (6.48 cm) was recorded in M₁ (sterilized potting media) while the minimum (5.45 cm) was recorded in M₂ (unsterilized potting media). Rootstock type also had a significant effect on increase in plant height, the maximum increase in height (6.10 cm) of the plant was recorded in R₁ (carrizo rootstock) and minimum (5.83 cm) in R₂ (rough lemon rootstock). Interaction between potting media sterilization and rootstock had a significant effect on increase in plant height, the maximum height of the plant (6.58 cm) was recorded in the treatment M₁R₁ (sterilized potting media + carrizo rootstock) which was at par (6.38 cm) with M₁R₂ (sterilized potting media + rough lemon rootstock) and the minimum (5.27 cm) was in M₂R₂ (unsterilized potting media + rough lemon rootstock). While after 120 days of germination, the maximum plant height (21.50 cm) was recorded in M₁ (sterilized potting media) while the minimum (15.02 cm) was recorded in M₂ (unsterilized potting media). With respect to the rootstock type, the maximum increase in height (18.82 cm) of the plant was recorded in R₁ (carrizo rootstock) and minimum (17.71 cm) in R₂ (rough lemon rootstock). Interaction between level of potting media and rootstock had a significant effect on increase in plant height, the maximum height of the plant (22.30 cm) was recorded in the treatment M₁R₁ (sterilized potting media + carrizo rootstock) and the minimum (14.70 cm) was in M₂R₂ (unsterilized potting media + rough lemon rootstock).

Number of leaves/plant

The highest number of leaves per plant (10.86) was recorded in M₁ (sterilized potting media). Under the influence of rootstock type, the maximum number of leaves per plant (10.16) was recorded in R₁ (carrizo rootstock) and least number of leaves (9.36) was recorded in R₂ (rough lemon rootstock). The interaction between the two factors also

showed significant influence over the number of leaves. The maximum number of leaves (11.12) was obtained in M₁R₁ (sterilized potting media + carrizo rootstock) and least (8.12) in M₂R₂ (unsterilized potting media + rough lemon rootstock).

Shoot girth (mm)

Shoot girth recorded a significant increase under the influence of potting media sterilization and rootstock type. The maximum increase (2.04 mm) in shoot girth was recorded M₁ (sterilized potting media) and lowest (1.21 mm) in M₂ (unsterilized potting media). With respect to rootstock type, the maximum increase in the shoot girth (1.63 mm) was recorded in R₁ (carrizo rootstock), which was at par (1.60 mm) with R₂ (rough lemon rootstock). The interaction effect between potting media sterilization and rootstock had a significant influence on the shoot girth. The maximum shoot

girth (2.21 mm) was recorded in M₁R₁ (sterilized potting media + carrizo rootstock).

Root parameters

The effect of potting media sterilization on all the root parameters was found to be significant. The maximum root length (6.50 cm), fresh weight of roots (0.90 g) and dry weight of roots (0.16 g) was recorded in M₁ (sterilized potting media), whereas minimum values for all the root parameters were recorded in M₂ (unsterilized potting media). With regards to rootstock type, maximum root length (5.91 cm), fresh weight of roots (0.78 g) and dry weight of roots (0.10 g) root was recorded in R₁ (carrizo rootstock). The interaction between the two factors had non-significant influence over the root parameters.

Table 1: Effect of potting media and rootstocks on plant growth parameters

Treatment	Seed Germination (%)	Survival rate after 60 days (%)	Plant height (cm)		No. of leaves/plant	Shoot girth (mm)	Root length (cm)	Fresh weight of roots (gm)	Dry weight of roots (gm)
			60 DAG	120 DAG					
Potting media									
M ₁	86.48	88.04	6.48	21.50	10.86	2.04	6.50	0.90	0.16
M ₂	69.46	69.85	5.45	15.02	8.66	1.21	5.04	0.35	0.02
CD(0.05)	2.66	3.68	0.07	0.08	0.18	0.25	0.02	0.14	0.03
Rootstocks									
R ₁	81.60	82.14	6.10	18.82	10.16	1.63	5.91	0.78	0.10
R ₂	74.34	75.74	5.83	17.71	9.36	1.60	5.62	0.47	0.09
CD(0.05)	2.66	3.68	0.07	0.08	0.18	0.25	0.02	0.14	0.03
Interaction (M x P)									
M ₁ R ₁	92.10	92.15	6.58	22.30	11.12	2.21	6.69	1.03	0.17
M ₁ R ₂	80.85	83.93	6.38	20.71	10.60	1.88	6.31	0.77	0.16
M ₂ R ₁	71.10	72.14	5.63	15.34	9.20	1.05	5.14	0.53	0.03
M ₂ R ₂	67.83	67.56	5.27	14.70	8.12	1.38	4.93	0.17	0.02
CD(0.05)	3.76	NS	0.09	0.11	0.25	0.36	0.03	NS	NS

Note: T₁= M₁R₁= Sterilized potting media + Carrizo rootstock, T₂= M₁R₂= Sterilized potting media + Rough lemon rootstock, T₃= M₂R₁= Unsterilized potting media + Carrizo rootstock, T₄= M₂R₂= Unsterilized potting media + Rough lemon rootstock



Fig 1: Seed germination and seedling growth responses in sterilized potting media

Conclusion

From the present investigation, it is concluded that, carrizo and rough lemon plants showed better growth and development in the sterilized potting media. To raise healthy nursery stock with effective pest and weed control, satisfactory plant growth, development and ultimately plant quality sterilized potting media was found to be the best as compared with unsterilized potting media.

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