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Optimization of Growing Media Composition for Peach Rootstock Seedlings

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Abstract
Growing media directly influences a peach's development of a robust root system, which ultimately contributes to a healthy, vigorous rootstock. During the 2019 and 2020 growing seasons, this experiments were conducted to evaluate and optimize the growing media compositions for peach rootstock seedlings. The experiments were carried out in three replications using a CRD design with ten treatments; namely, Topsoil (100%), Compost (100%), FYM (100%), Topsoil (75%) + Compost (25%), Topsoil (75%) + FYM (25%), Topsoil (50%) + FYM (25%) + Compost (25%), Topsoil (25%) + Compost (75%), Topsoil (25%) + FYM (75%), Compost (75%) + FYM (25%), and FYM (75%) + Compost (25%). The results showed that the composition of the media affected the number of peach seedling leaves per plant, seedling height, collar girth, and leaf area of peach seedlings. The medium of Topsoil (25%) + Compost (75%) fill polybags was the best media because seedling growth and development parameters were higher in this medium than in the other media.
Keywords: Peach, planting media, compost, topsoil, girth, leaf area, plant height, leaf number
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1. Introduction

Peach (*Prunus persica* L.) is a vital economic fruit tree all over the world and has recently emerged as one of Ethiopia's most important fruit crops. Successful plant propagation is highly dependent on the production of healthy, vigorous rootstock. Plant growth and development characteristics are significantly affected by the soil media's physical and chemical properties (Shah et al., 2006; Riaz et al., 2008). When the medium was free of pathogens, it provided proper aeration, water retention capacity, and nutrient availability, resulting in lush plant growth (Ahmad et al., 2004; Larsen and Andreasen, 2004).

Seedling quality from nurseries can significantly affect an orchard's re-establishment in the field and its overall productivity (Dayeswari et al., 2017; James and Michael, 2021). This occurs because the media play a vital role in the establishment of an extensive rooting system (Bhardwaj, 2014). Overall, seedling quality in the nursery is primarily determined by the growth medium (Manenoi et al., 2009; Osaigbovo and Orhue, 2012). The best-growing media should have favorable physical and chemical properties that promote seedling growth and development (Abad et al., 2002). In addition to being light, it should also be cost-effective (Fadilah et al., 2019), easy to source, process, and be a cheap source (Renuka et al., 2015; Bhagat et al., 2013), well-drained, and capable of retaining enough water to reduce the watering frequency (Unal, 2013), able to serve as a reservoir for nutrient and water, and able to allow oxygen diffusion (Abad et al., 2002). Due to the influence that organic matter has on the biological, physical, and chemical characteristics of a potting medium (Gülcü et al., 2010; Khan et al., 2012; Osaigboo and Orhue, 2012), it is crucial to be able to add organic materials to potting media.

A well-balanced growth medium with a sufficient supply of nutrients is, therefore, essential for seedlings raised in a nursery to develop and grow to their full potential. Suitable planting media for raising healthy and quality seedlings is available on the international market, but it is unavailable on the local premises, making it difficult for growers, particularly those from developing countries such as Ethiopia, to bear the high costs. As a result, it is critical to select the proper potting medium, which is a fundamental step toward the successful nursery of any fruit crop. For this problem, the best solution is to use cheap and easily available local resources to get good materials for potting mix by optimizing the protocol for potting mix by using materials that are easily available from local premises for growing healthy and quality peach seedlings. In this context, the current study was designed to evaluate and optimize the growing media compositions for peach rootstock seedlings.

2. Materials And Methods

2.1. Experimental site

Trials were conducted at the Holetta Agricultural Research Center during the 2019 and 2020 crop seasons. The site is situated at 10^{O}02' N and 34^{O}34' E in central Ethiopia. Its elevation is 2420 m a.s.l and its annual rainfall averages 1275 mm. The rainy season spans from April to October, with the most rain falling between June and August. In the center, the average maximum and minimum temperatures are 32 °C and 17 °C, respectively. The soil is a distinctive reddish-brown *Nitosol* with a pH of 5.5 (EIAR, 2017).

2.2. Treatments and management

The experiment was carried out using a CRD design with three replications. Ten treatments; namely, Topsoil (100%), Compost (100%), FYM (100%), Topsoil (75%) + Compost (25%), Topsoil (75%) + FYM (25%), Topsoil (50%) + FYM (25%) + Compost (25%), Topsoil (25%) + Compost (75%), Topsoil (25%) + FYM (75%), Compost (75%) + FYM (25%), and FYM (75%) + Compost (25%) were used. Before planting, samples of the media were analyzed for nutrient content. Sand (12.5% of the treatment amount) was added to each treatment to improve drainage. Planting materials were local peaches, with eleven plants per plot used. Before mixing, the growth media were analyzed separately, and the results are shown below (Table 1).

Table 1. Physico-chemical properties of the media before mixing

Media	Texture (%)			pH	N (%)	P (ppm)	K (meq/ 100g)	Ca (meq/ 100g)	Na (meq/ 100g)	Mg (meq/ 100g)	S (ppm)	Zn (ppm)
	Clay	Silt	Sand									
Compost	28.8	31.3	40.0	7.1	0.75	157.2	8.49	41.65	0.42	9.24	332.04	0.63
FYM	21.3	18.8	60.0	7.4	1.48	583.1	28.20	29.71	0.95	19.75	0.00	2.05
Topsoil	28.8	28.8	42.5	6.7	0.89	135.4	4.86	46.44	0.11	8.76	134.50	0.44

2.3. Data collection

The experiment was monitored for 245 days after transplanting (DAT), with growth parameters such as the number of leaves, plant height, collar girth, and leaf area measured. Following transplantation, measurements were taken every two weeks. For each treatment and replicate, eleven seedlings were used to collect data. The replicate was then represented by the average. Plant height (cm) was measured from polyethylene bag topsoil level to the terminal bud with a ruler while the number of leaves was counted. The collar girth (mm) was also measured using a calibrated digital caliper (Digital Caliper LCD Stainless Electronic Ruler Micrometer Measuring 0-6 inch 150 mm) about 2.5 cm just above soil level. Leaf area (cm^2) was obtained according to Demirsoy et al. (2004) as follows;

$$LA = -0.5 + 0.23\left[\frac{L}{W}\right] + 0.67LW$$

Where LA is leaf area, L is leaf length, and W is leaf width.

2.4. Data analysis

The collected data were subjected to analysis of variance (ANOVA), using both the R program and SAS software. Mean separation was computed with Least Significant Difference (LSD) at $p \leq 0.05$ to test the significant difference between treatment means.

3. Results and Discussions

Based on the results of this study, the composition of growing media significantly affected the growth of peach seedlings (Table 2).

Table 2. The number of leaves, plant height, collar girth, and leaf area means squares as influenced by the composition media within 245 DAT during the 2019 and 2020 cropping seasons

Year	DF	Number of leaves per seedling	Plant height (cm)	Collar girth (mm)	Leaf area (cm^2)
2018	9	459.56***	788.06***	0.024**	10.85*
2019	9	119.63***	504.72***	0.305***	39.72***

*, **and *** represent significant at 0.05, 0.01 and 0.001 probability level, respectively; DF, degree of freedom

3.1. Number leaves

Results presented in Table 2 and Figure 1 revealed that the composition of growth media had a highly significant ($p<0.001$) in determining the number of leaves per plant across treatments. The number of leaves per seedling in the Topsoil (25%) + Compost (75%) treatment was significantly higher (78.67 and 70) in 2019 and 2020, respectively, compared to all other treatments. However, treatments received Topsoil and compost have statistically parity results in 2020. The treatments with 100% FYM produced the fewest leaves in both 2019 and 2020 cropping years, with 41.33 and 50 leaves, respectively. The highest number of leaves in the Topsoil (25%) + Compost (75%) treatment was due to the nitrogen and potassium content (Table 1), which helps to increase photosynthesizing functional leaves (Borah et al., 1994). This might also be related to adequate organic matter and clay content that formed a well-balanced media composition (Figure 1). Plants produce the majority of their food via their leaves, which are influenced by a variety of factors, but the soil is one of the most crucial (Mathowa et al., 2014). Organic matter regulates water and nutrient availability, resulting in better seedling growth (Peter-Onoh et al., 2014). In contrast, Parasana et al. (2013) found that combining soil blends with farm yard manure increased the number of leaves on the plants.

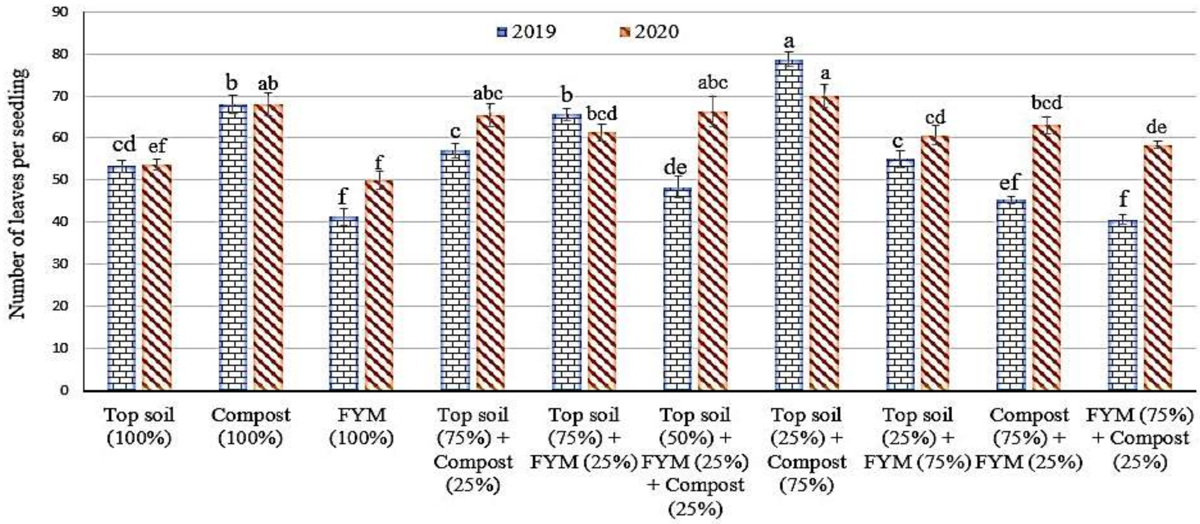

Figure 1. The response of different media compositions on the number of peach seedling leaves per plant at 245 DAT
[Note: FYM, Farmyard manure, LSD (5%) = 5.27 and 6.92 for 2019 and 2020 cropping years, respectively; CV (%) = 5.56 and 6.54 for 2019 and 2020 cropping years, respectively and ***Significant at 0.001]

3.2. Plant height and collar girth

Peach growth and development are greatly affected by the growing media composition, particularly seedling height and collar girth (Tables 2 and 3). Highly significant differences ($p<0.001$) were observed between treatments for plant height and collar girth. The tallest seedlings (112.34 cm and 95.90 cm) were recorded in the Topsoil (25%) + Compost (75%) treatment during 2019 and 2020, consecutively. While, FYM (75%) + Compost (25%) treatments produced the shortest heights (55.44 cm in 2019 and 58.71 cm in 2020). In regards to collar girth, the composition of growing media had a highly significant effect ($p<0.001$) on collar girth, with the treatment Topsoil (25%) + Compost (75%) achieving the widest girth of 2.31 mm and 3.07 mm in 2019 and 2020, respectively. Comparative results were obtained by Navamaniraj et al. (2008) in the Arnott (*Bixa orellana* L.) plant. The significant increase in height and collar girth of the plant observed in the Topsoil (25%) + Compost (75%) treatment might be attributed to better water holding capacity and availability of nutrients (Jafer, 2020), as well as the synergistic combination of both topsoil and compost in improving the physical conditions of the soil and the availability of nutrients (Sahni et al., 2008). Alternatively, Topsoil (25%) + Compost (75%) might also has a is capable of preserving soil humidity, increasing nutrient content, and improving soil structure, allowing for increased water absorption and maintaining cell turgidity and cell elongation, and improving respiration, resulting in increased plant height and collar girth (Rahman et al., 2007; Osaigbovo and Orhue, 2012).

Table 3. The height and girth response of peach seedlings to different media compositions within 245 DAT

Treatment	Seedling height (cm)		Collar girth (mm)	
	2019	2020	2019	2020
Topsoil (100%)	62.75de	58.71f	2.08de	2.29e
Compost (100%)	68.94cd	87.55bc	2.14bc	2.62bc
FYM (100%)	56.81e	57.58f	2.07de	2.46d
Topsoil (75%) + Compost (25%)	79.44b	86.22bc	2.18b	2.68b
Topsoil (75%) + FYM (25%)	74.54bc	83.07c	2.16bc	2.71b
Topsoil (50%) + FYM (25%) + Compost (25%)	73.09bc	90.10ab	2.15bc	3.01a
Topsoil (25%) + Compost (75%)	112.34a	95.90a	2.31a	3.07a
Topsoil (25%) + FYM (75%)	67.08cd	70.60e	2.12bcd	2.53cd
Compost (75%) + FYM (25%)	62.83de	68.03e	2.10cde	2.46d
FYM (75%) + Compost (25%)	55.44e	76.71d	2.05e	2.30e
Mean	71.32	77.45	2.14	2.6
Significant level	***	***	***	***
LSD (5%)	9.71	6.06	0.06	0.12
CV (%)	7.93	4.56	1.7	2.71

Means that do not share a letter are significantly different. ***Significant at 0.001 probability level. LSD, least significant difference; CV, Coefficient of Variation; FYM, Farmyard manure

3.3. Leaf area

Leaf area responded significantly ($p<0.05$) to the different proportions of media composition in both years, 2019 and 2020 (Table 2). Seedlings planted in media containing 25% topsoil and 75% compost had a significantly greater effect on leaf area (17.14 and 18.90 cm^2) in the 2019 and 2020 cropping years in order. Whereas, topsoil (100%) in 2019 plus FYM (100%) in 2020 recorded the least leaf areas of 8.70 and 5.15 cm^2, sequentially (Figure 2). Similar findings were reported by Shah et al. (2006) and Popescu and Popescu (2015), who found that the media type affected the leaf area. Perhaps this is because compost enhances soil conditions in terms of nutrient level and physical properties (Jafer, 2020), and the leaf area affects light interception, plant growth, and productivity (Zhang and Pan, 2011).

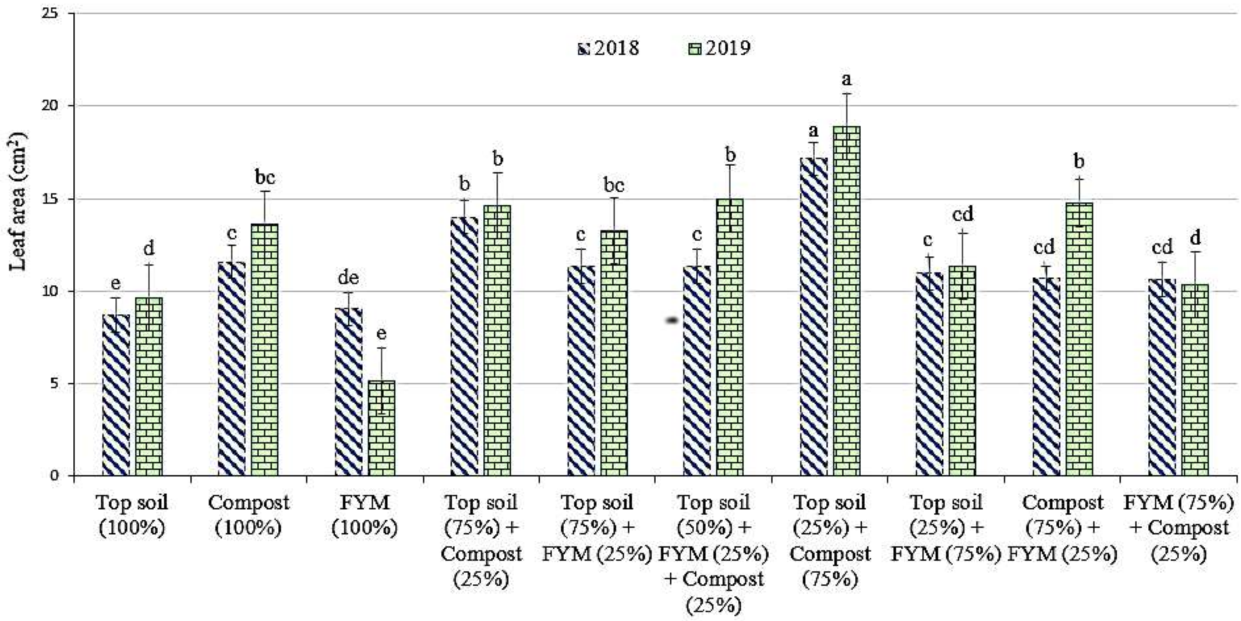

Figure 2. The response of different media compositions to the leaf area (cm) of peach seedlings
[Note: FYM, Farmyard manure; LSD (5%) = 5.27 and 6.92, and CV (%) = 5.56 and 6.54 for 2019 and 2020 cropping years, respectively]

4. Conclusion and Recommendations

Based on results obtained from this study, there was a significant influence of media composition on the growth and development parameters of peach local variety rootstock seedlings. Topsoil (25%) + Compost (75%) treatments had showed positive results for most of the parameters studied; and hereafter, it could be advised to use for peach root seedling propagation.

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