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Effect of different growing media on selected growth performance parameters of *Raphanus pugioniformis* and *Raphanus raphanistrum*

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KEYWORDS

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Raphanus raphanistrum

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Soil type

Perlite

Sand

ABSTRACT

Raphanus raphanistrum and *R. pugioniformis* (*Brassicaceae*) are wild radishes, native to the Eastern Mediterranean region. This study aimed to evaluate the effect of growing soil media (perlite, sand, and terra rossa) on the growth performance of two *Raphanus* species. For this, seeds of the selected species were germinated and seedlings were transferred to plastic cylinders, filled with growing soil media. At harvest, various growth parameters including shoot length, shoot fresh weight, shoot dry weight, root length, root fresh weight, and root dry weight were determined. Root and shoot fresh and dry weight, before and after oven dry for 24 h at 70 °C was measured. Results of the study revealed statistically significant differences (P value ≤ 0.05) among the various studied growth parameters for the selected *Raphanus* species and are affected by different growing media including types of soil and growing time (days after potting from 33 to 78). After 33 days of potting, the average shoot length for *R. pugioniformis* was found 6.6, 8.0, and 8.6 cm in terra rossa, sand, and perlite growing media respectively. On the other hand, the fresh (0.8, 1.6, and 2.5g) and dry (0.25, 0.48, and 0.72g) shoot weight for *R. pugioniformis* was reported in terra rossa, sand, and perlite soil media respectively. From the results of the study, it can be concluded that among the tested growing media, perlite growing medium is the best medium for the growth of both studied *Raphanus* species. This study demonstrated that the three studied growing media affected all the growth performance parameters of both *Raphanus pugioniformis* and *Raphanus raphanistrum* differently.

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1 Introduction

Weedy radish belongs to the family *Brassicaceae* genus *Raphanus* and is a native population in the Mediterranean region (Conner et al. 2011; Al-Shehbaz 2012; Conner et al. 2014; Klinger et al. 1991). *Raphanus sativus* comprise four major types including two fruit crops (Oilseed and edible pod Rat-tail) and two root crops (European radish and Asian daikon) but the relationships among these species are not well known (Ziffer-Berger et al. 2020). According to the Campbell et al., (2006) cDNA sequence of *Raphanus* taxa revealed monophyly of native and weedy *R. raphanistrum.*

Under many ecological and evolutionary studies, weedy radish has been widely used as a genomic resource for both origins and adaptation studies of agricultural weeds (Irwin et al. 2003; Moghe et al. 2014). More populations of *R. raphanistrum* are found in sandy soils along the Mediterranean coastal plain in Palestine, while the *R. pugioniformis*, covers heterogeneous habitats along a gradient of environmental conditions (Ziffer-Berger et al. 2015). It is assumed that these two species differ in the structure of their population genetic, i.e., short-distance dispersal of *R. pugioniformis* contributed to inter-populations phenotypic differentiation, whereas long-distance dispersal reduces the possibility of ecotypic differentiation in *R. raphanistrum*. The various dispersal strategies of wild radishes and their consequence on their broad-scale geographical and small-scale spatial distribution, allow assessing the impact of environmental conditions on the phenotypic variation of ecologically important life history traits in annual plants, at the inter-species as well as intra-species levels (Waitz et al. 2021).

Different studies evaluated the effect of different growing media on the growth performance of different plants (Abbadi 2017a; Abbadi 2017b; Abbadi et al. 2017; Abbadi et al. 2019). Other investigators also confirmed the importance of the selection of an appropriate growth medium for better growth at different stages (Špulák and Hacurová 2021; Madhavi et al. 2021). A growing media consist of three components i.e. solid (33-50%), water and gases (50-70%), 12% oxygen, and dissolved nutrients. This combination was found good for vigorous growth and a stronger root system (Gil et al. 2012). Špulák and Hacurová (2021) investigated the influence of growing medium composition on pine and birch seedling response during the period of simulated spring drought. Results of this study showed that the birch responded more intensively to the fertilizer concentration than to the clinoptilolite admixture and was more vulnerable to drought damage. Similarly, Abid et al. (2017) studied the growth response of *Dracaena reflexa* to various growing substrates and reported that the combination of silt and farm yard manure is useful growing media for *D. reflexa* as compared to others. Sardoei and Shahdadneghad (2015) studied the effect of seven different growing media on the growth and development of zinnia (*Zinnia elegans*) under different climatic conditions. Similarly, Popescu and Popescu (2015) studied the effects of different potting growing media on photosynthetic capacity, leaf area, and flowering potential on two ornamental plants (*Petunia grandiflora* and *Nicotiana alata* Link & Otto and confirmed the effects of growing media on the studied parameters. Younis et al. (2015) also studied the influence of various growing substrates on the growth and flowering of the potted miniature rose cultivar “Baby Boomer” where four different growing substrates with variable composition and combinations were compared using garden soil as a control. Results of this study indicated that leaf compost exhibited overall better performance as compared to other media for plant height, number of leaves per plant, number and length of branches per plant, and the number and diameter of flowers. Similarly, Madhavi et al. (2021) studied the influence of different growing media on the growth and development of strawberry plants. The results of this study demonstrated that bio plus compost with synthetic nutrients act as a better source for the growth and production of strawberries in the greenhouse.

Therefore, this study aimed to evaluate the effect of different growing media (sand, perlite, and terra rossa) on selected growth performance parameters (shoot length, shoot fresh weight, shoot dry weight, root length, root fresh weight, and root dry weight) of two *Raphanus sps* namely *R. pugioniformis* and *R. raphanistrum.*

2 Materials and Methods

2.1 Experimental design

Ten seeds of each one of 10 representing populations (a total of 100 seeds) were collected and surface sterilized by 6% (v/v) hypochlorite solution for 1 min, followed by the many time washing with sterile distilled water. These surface sterilized seeds of both selected species were inoculated on the moistened Whatman filter paper No. 1 set in 9cm Petri dishes and placed in sufficient daylight. After 2 to 3 days of germination, seedlings were transferred to germination trays (when rootlets are about 2-3 cm long) having potting soil mixture as substrate. When they develop 4-5 true leaves, the seedlings were transplanted to the final cylindrical pots (20cm diameter x 150 cm height) with different potting soil types (perlite, sand, and terra rosa) separately. The experiment was conducted in a greenhouse in the nursery of Thinnaba cooperative in Tulkarm in November 2019 during the natural growing season. During the experimental period, the average day and night temperatures ranged from 20–22°C and 18–20°C with midday peak temperatures between 23 and 28° C in July, and relative humidity was reported between 40 -80%. Plants received sufficient water and nutrient by irrigating them with a Hoagland solution (0.01x) nutrient solution as per plant requirement. The pots of different soil treatments were arranged in a completely randomized design. At the flowering stage (50% flowering), plants were harvested and roots were washed for soil particle separation and morphological observations.

2.2 Root and shoot measurements

Root structure was evaluated two times, first at the potting and second at the flowering stage. For this, five plants of each population were harvested, roots were washed and observation related to the root morphology and leaves length was recorded. At harvest, the plants were washed with water, and the vegetative growth length was measured with a measuring scale. Plant biomass (shoot and root) was also determined as root and shoot fresh and dry weight was measured by weighing them before and after oven drying for 24 h at 70 °C, respectively.

2.3 Statistical analysis

All statistical analyses were performed using SAS (SAS Institute Inc., Cary, USA, Release 8.02, 2001). Mean comparisons were carried out using the GLM procedure, treating main factors separately using one-way analysis of variance (ANOVA). The Bonferroni procedure was employed with multiple t-tests to maintain an experiment-wise of 5%. Differences were considered significant if P values were lower than 0.05.

3 Results

3.1 Effect of growing media on shoot length

In this study, the shoot length of *R. pugioniformis* and *R. raphanistrum* species was measured in three different growing media (perlite, sandy, and terra rossa soil). The shoot length (in cm) was measured with varying day's intervals (33 to 78 days) after potting. As presented in Figure 1A, pots containing perlite as growing media have a shoot length range between 8.6 - 21cm, and 11.7 - 32.6cm after 33 to 78 days of potting for *R. pugioniformis* and *R. raphanistrum*, respectively. Similarly, the shoot length of *R. pugioniformis* and *R. raphanistrum* was reported between 8 - 15cm, and 9.2 - 12.8cm for sandy soil as growing media (Figure 1B) and 8 - 15cm, and 7.3 - 29.4 cm for terra rossa soil as growing media (Figure 1C) after 33 to 78 days of potting respectively. This implies that shoot length increases as days after potting increase for both *Raphanus* species. Statistical analysis showed that shoot length for *R. raphanistrum* is significantly higher than that for *R. pugioniformis* after 33, 48, 63, and 78 days of potting in perlite and terra rossa soil growing media, while in the case of sandy soil shoot length was reported significantly higher for *R. raphanistrum* after 33 and 48 days of potting and the reverse was obtained at 63 and 78 days.

Further, figure 1D and 1E summarize the effect of growing media on the shoot length for both *Raphanus* species. Results presented in figure 1D show the *R. pugioniformis* shoot length in selected three-growing media. After 33 days of potting, the average shoot length was reported 6.6, 8.0, and 8.6cm in terra rossa, sand, and perlite growing media, respectively. Similar trends were observed after 48 and 63 days of potting. Further, it was reported that amongst the selected three growing media, the highest *R. pugioniformis* shoot length was reported in the plant grown in perlite growing media and it was followed by the sandy and terra rossa growing media. Further, results presented in figure 1E show the *R. raphanistrum* shoot length in selected three growing media. After 33 days of potting, the shoot length was reported as 7.3, 9.2, and 11.7cm using terra rossa, sand, and perlite growing media, respectively, and significant differences were reported in these three-growing media. A similar trend was observed after 48 days of potting for *R. raphanistrum* where shoot length was significantly different and increased in the order of terra rossa, sand, and perlite respectively. On the other hand, after 63, and 78 days of potting, the trend was found different and the highest shoot length was reported in perlite, followed by terra rossa and sand-growing media (Figure 1E).

3.2 Effect of growing media on shoot fresh weight

The effect of different growing media (perlite, sandy, and terra rossa soil) on *R. pugioniformis* and *R. raphanistrum* shoot fresh weight was studied and found significant differences with varying days after potting (33 to 78 days) and type of growing media (Figure 2). As presented in Figure 2A using perlite as growing media, the range of shoot fresh weight was found to be from 2.5 - 16.7g and 5.7 - 16g as 33 to 78 days after potting for *R. pugioniformis* and *R. raphanistrum*, respectively. While in the case of sandy soil potting medium, the range of shoot fresh weight was found 1.6 - 5g and 2.5 - 7.4g for *R. pugioniformis* and *R. raphanistrum* after 33 to 78 days after potting respectively (Figure 2B). When terra rossa soil was used as growing media, the range of shoot fresh weight was found from 0.8 - 25.4g and 1.2 - 16.2g for *R. pugioniformis* and *R. raphanistrum*, after 33 to 78 days of potting respectively (Figure 2C). These results imply that shoot fresh weight increases as days after potting increase for both *Raphanus* species. Statistical analysis of data suggested that in perlite growing medium, after 33 and 48 days of potting shoot fresh weight for *R. raphanistrum* is significantly higher than that for *R.pugioniformis* while the reverse was observed for 63, and 78 days of potting. While in the case of sandy soil, significantly higher fresh shoot weight was reported for *R. raphanistrum* than that for *R. pugioniformis* for four periods of days after potting studied (33, 48, 63, and 78 days). Statistical analysis of terra rossa soil growing media showed that the shoot fresh weight for *R. raphanistrum* is significantly higher than the *R. pugioniformis* for 3 periods of days after potting studied (33, 48, 63) while a reverse trend was observed after 78 days after potting.

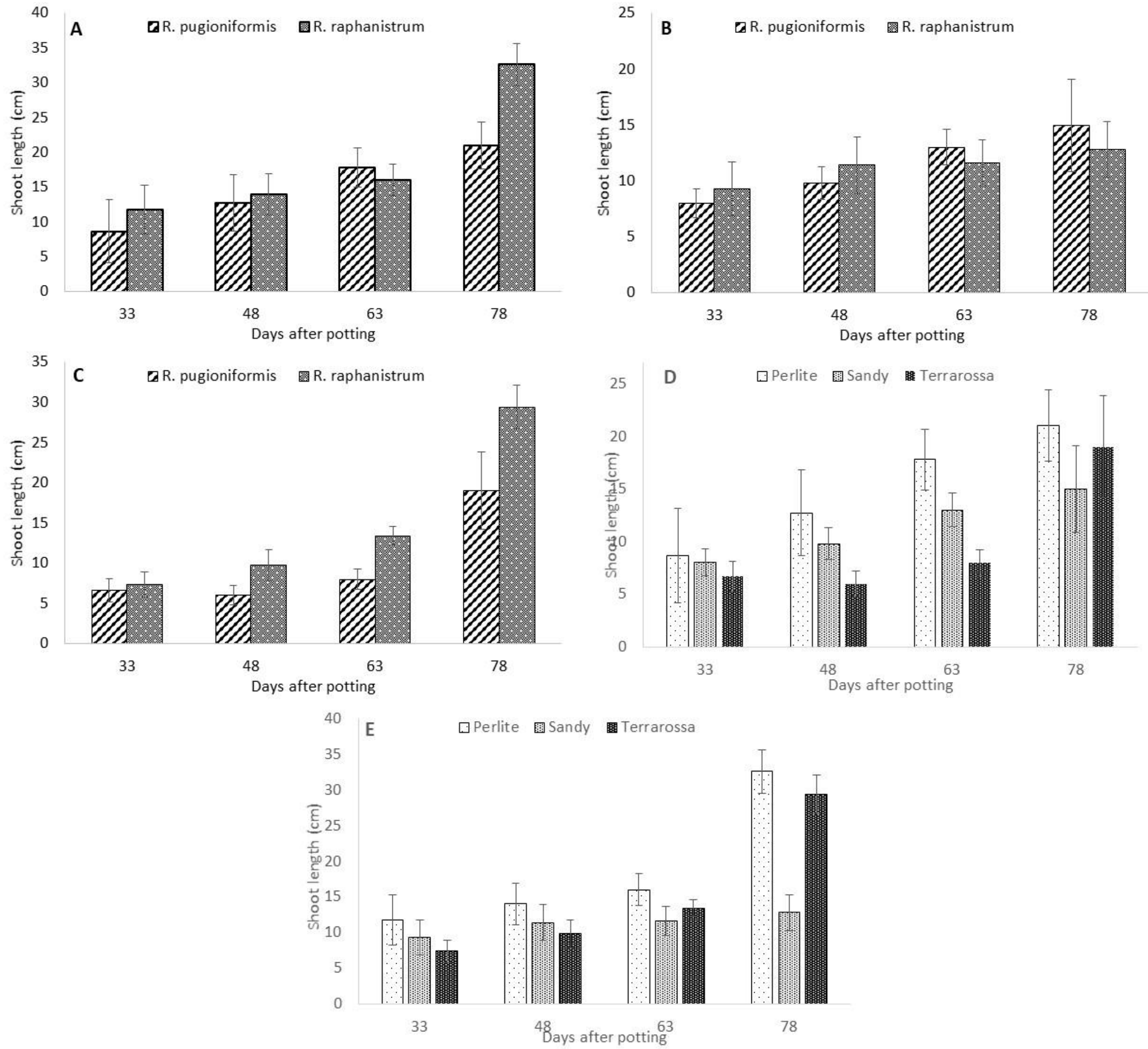

Figure 1 Effect of three growing media (perlite, sandy, and terra rossa soil) on shoot length (cm) of *R. pugioniformis* and *R. raphanistrum*; A: perlite growing media, B: sandy soil growing media, C: terra rossa growing media, D: shoot length of *R. pugioniformis* in all three growing media, and E: shoot length of *R. raphanistrum* in all three growing media

Figures 2D and 2E summarize the effect of growing media on the shoot fresh weight for both *Raphanus* species. Results presented in figure 2D show the *R. pugioniformis* shoot fresh weight for the used three-growing media. After 33 days of potting, the shoot fresh weight was found 0.8, 1.6, and 2.5g using terra rossa, sand, and perlite growing media, respectively. The same trends were observed after 48 days of potting while different trends were observed after 63 and 78 days of potting (Figure 2D). After 63 days, shoot fresh weight was not significantly different in terra rossa and sand as growing media which is significantly lower than shoot fresh weight when the growing media is perlite. On the other hand, after 78 days of potting the trend was found to be different where the shoot fresh weight was highest when terra rossa is the growing media followed by perlite, and the least was found for sand as the growing media (Figure 2D).

Figure 2E shows the shoot fresh weight for *R. raphanistrum* using the three-growing media. After 33 days of potting, the shoot fresh weight was found 1.2, 2.5, and 5.7g using terra rossa, sand, and perlite growing media, respectively. The same trend was observed for shoot fresh weight after 48 days of potting for *R. raphanistrum*. On the other hand, after 63 days of potting, the trend was found different where the shoot fresh weight was recorded highest when perlite is growing medium (Figure 2E) and after 78 days of potting, the highest shoot fresh weight was for both terra rossa, and perlite growing media, and these two are significantly higher than that of the sandy growing media.

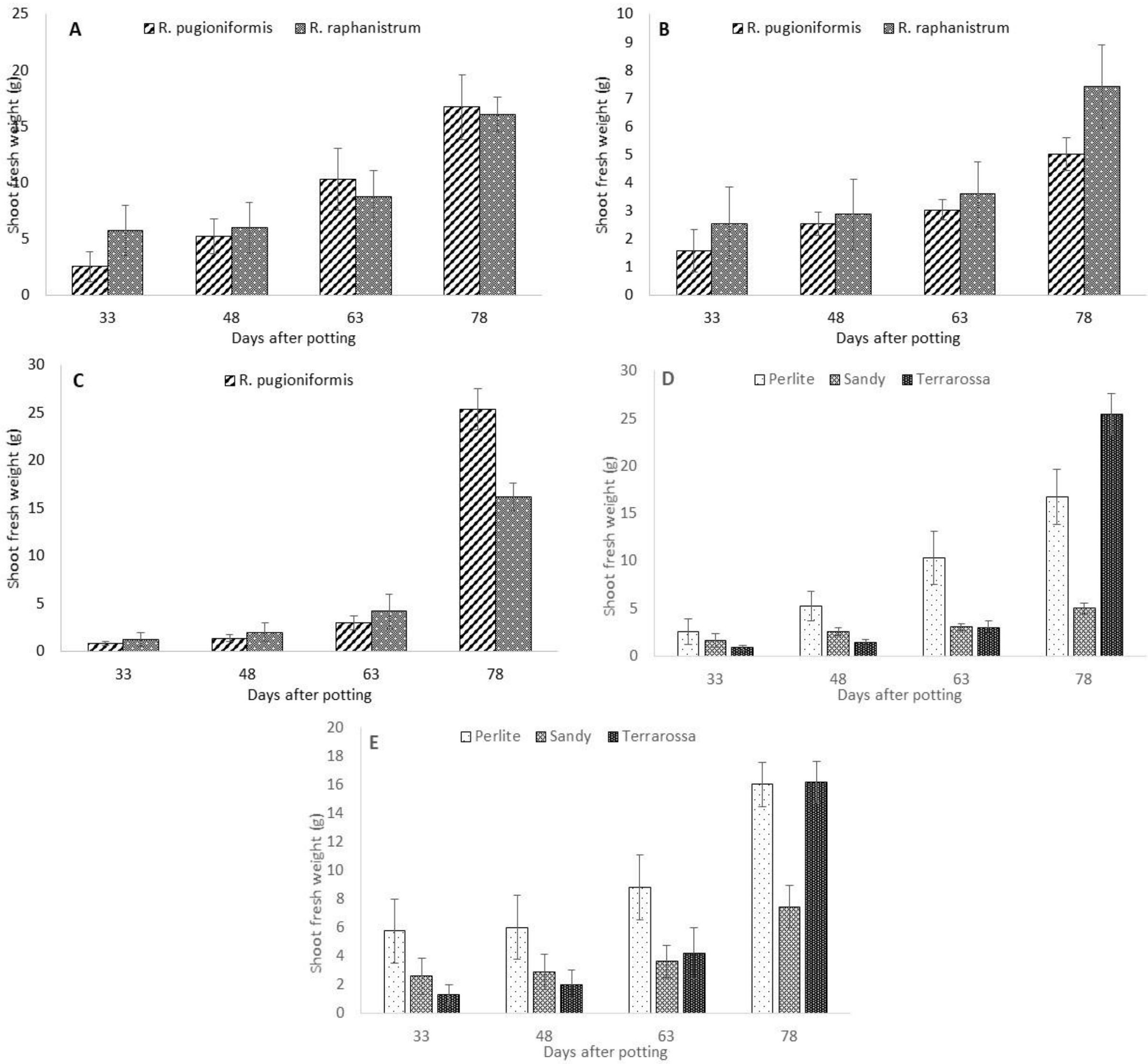

Figure 2 Effect of different growing media on shoot fresh weight (g) of *R. pugioniformis* and *R. raphanistrum*, A: perlite growing media, B: sandy soil growing media, C: terra rossa growing media, D: shoot fresh weight of *R. pugioniformis* in all three growing media, and E*:* shoot fresh weight of *R. raphanistrum* in all three growing media

3.3 Effect of growing media on shoot dry weight

The effect of different growing media on the shoot dry weight of *R. pugioniformis* and *R. raphanistrum* species was studied after 33 to 78 days of potting (Figure 3). As it is obvious from Figure 3A using perlite as growing media, the range of shoot dry weight was found from 0.72 - 4.7 g, and 1.6 - 4.0 g for *R. pugioniformis* and *R. raphanistrum* respectively as the days after potting increases from 33 to 78. When sandy soil was used as growing media, the range of shoot dry weight was recorded as 0.48 - 1.6g and 0.85 - 2.5g as the days after potting increased from 33 to 78 for *R. pugioniformis* and *R. raphanistrum*, respectively (Figure 3B). Regarding the shoot dry weight of *R. pugioniformis* and *R. raphanistrum* species using terra rossa soil as growing media, results showed that the range of shoot dry weight was found from 0.25 - 4.5g and 0.29 - 3.6g for *R. pugioniformis* and *R. raphanistrum* respectively as the days after potting increases from 33 to 78 (Figure 3C). Results of the study also revealed that the shoot dry weight of *R. raphanistrum* is significantly higher than that of *R. pugioniformis* when the growing media is perlite and terra rossa at 33, 48, and 63 days after potting while the reverse was observed for 78 days of potting. While in the case of sandy soil, statistical analysis of data showed that shoot dry weight for *R. raphanistrum* is significantly higher than that for *R. pugioniformis* for 4 periods of days after potting studied (33, 48, 63, and 78 days).

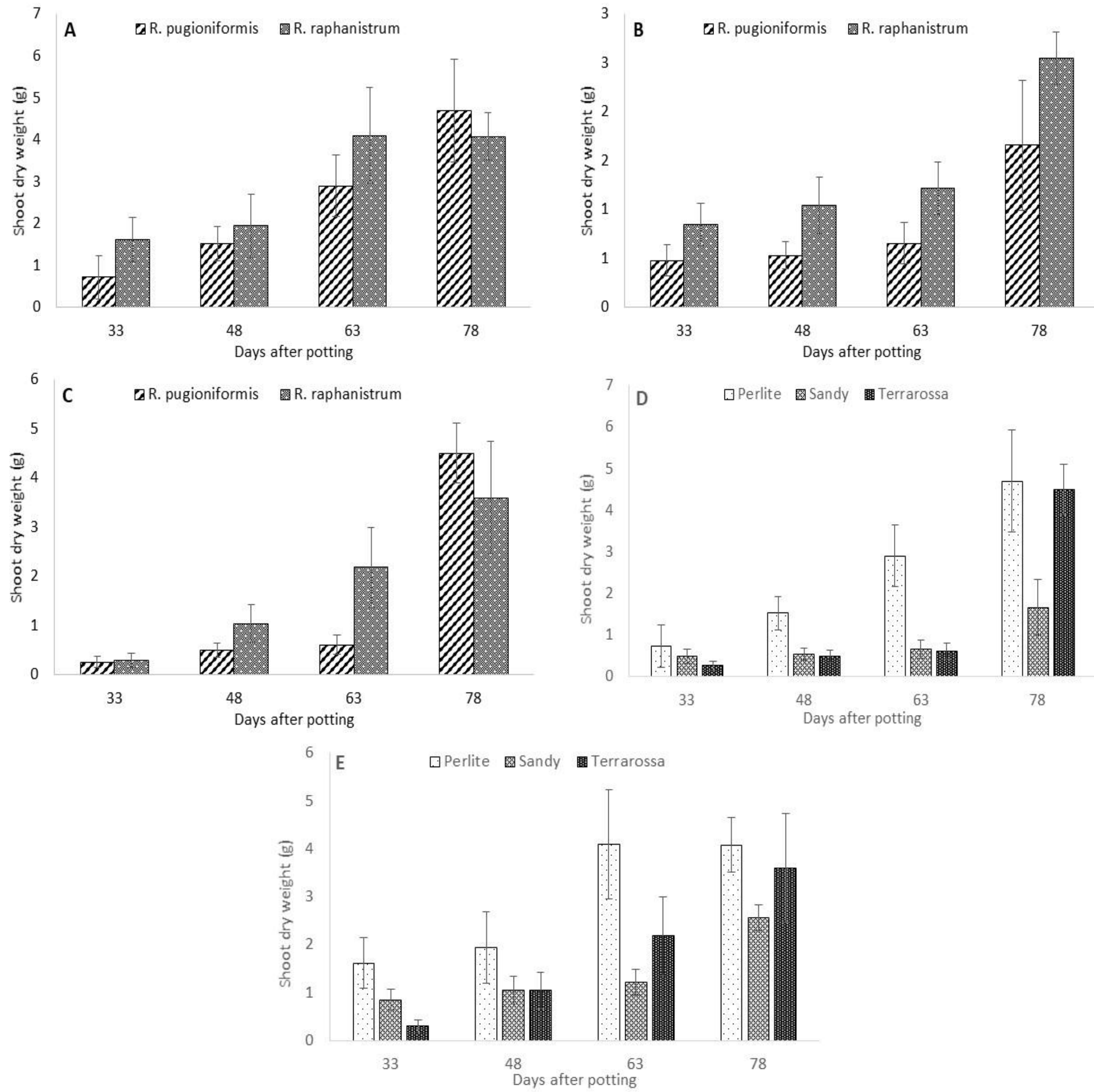

Figure 3 Effect of different growing media on shoot dry weight (g) of *R. pugioniformis* and *R. raphanistrum*, A: perlite growing media, B: sandy soil growing media, C: terra rossa growing media, D: shoot dry weight of *R. pugioniformis* in all three growing media, and E: shoot dry weight of *R. raphanistrum* in all three growing media

Further, figure 3D shows the shoot dry weight for *R. pugioniformis* using the three-growing media. After 33 days of potting, the shoot dry weight of *R. pugioniformis* was reported 0.25, 0.48, and 0.72g using terra rossa, sand, and perlite growing media, respectively. Different trends were observed for shoot dry weight after 48, 63, and 78 days (Figure 3D). Figure 3E shows the shoot dry weight for *R. raphanistrum* using the three-growing media. After 33 days of potting, the shoot dry weight was recorded as 0.29, 0.85, and 1.61g using terra rossa, sand, and perlite growing media, respectively. While the different trend was observed for shoot dry weight after 48, 63, and 78 days (Figure 3E).

As it is obvious from figure 3D, Perlite was the best-growing media for *R. pugioniformis* for the 4 different potting periods while terra rossa and sand-growing media have a similar effect for 33, 48, and 63 days. Terra rossa has a higher effect on shoot dry weight compared to sand at 78 days (Figure 3D). Regarding *R. raphanistrum*, Perlite was the best-growing media for the 4 different potting periods while terra rossa and sand growing media have a similar effect at 48 days (Figure 3E). Terra rossa has a higher effect on shoot dry weight compared to sand at 63 and 78 days, while the reverse was observed at 33 days after potting (Figure 3E).

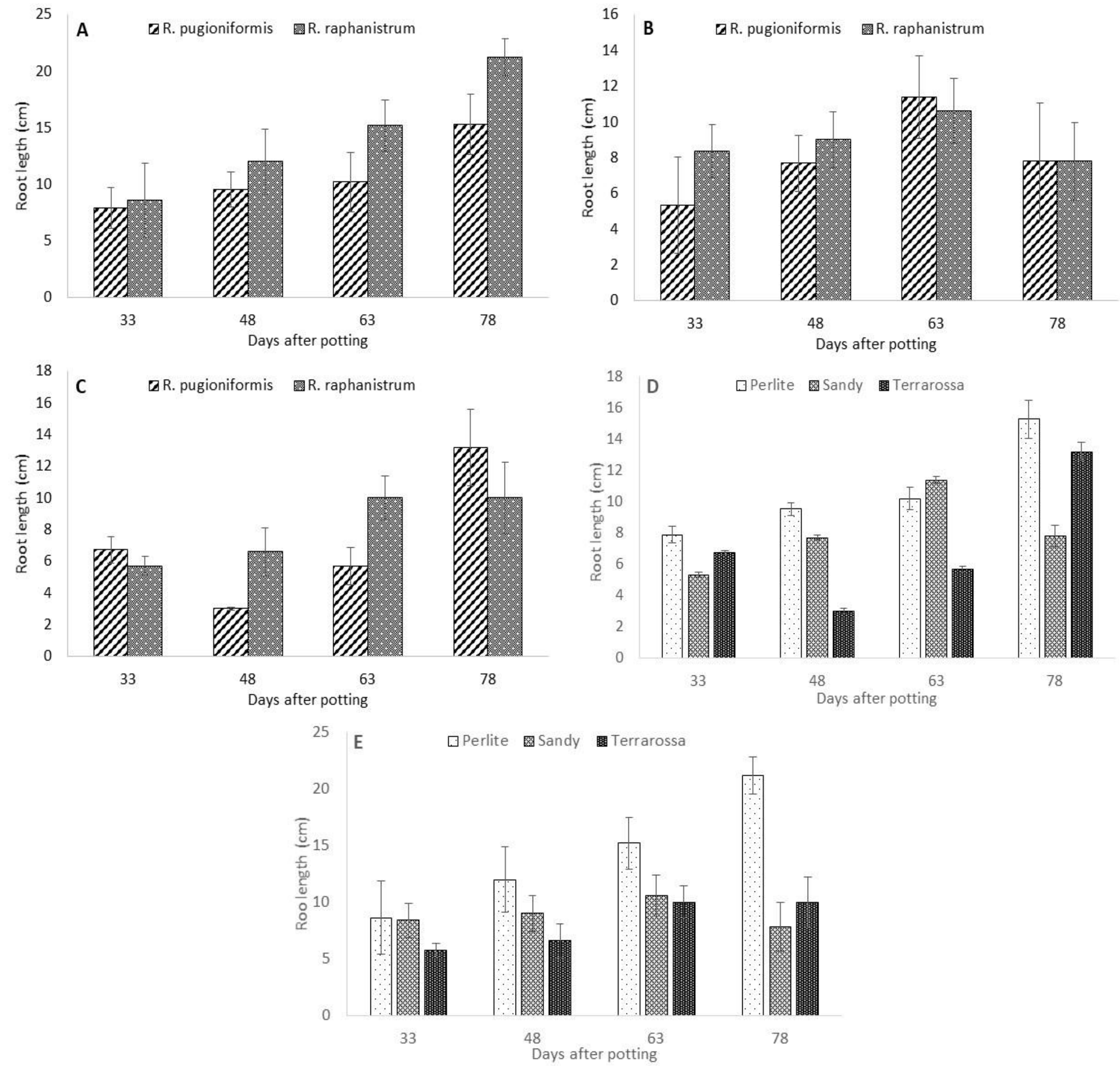

Figure 4 Effect of different growing media on root length (cm) of *R. pugioniformis* and *R. raphanistrum;* A: perlite growing media, B: sandy soil growing media, C: terra rossa growing media, D: root length of *R. pugioniformis* in all three growing media, and E*:* root length of *R. raphanistrum* in all three growing media

3.4 Effect of growing media on root length

The effect of selected growing media on *R. pugioniformis* and *R. raphanistrum* root length was studied after potting from day 33 to 78 days (Figure 4). The range of root length was recorded from 7.9 - 15.3 cm and 8.62 - 21.2 cm for *R. pugioniformis* and *R. raphanistrum* has grown under a pot containing perlite growing media after 33 to 78 days of potting. Using sandy soil as a growing media, the range of root length was recorded from 5.32 - 11.4cm, and 7.8 - 10.6cm for *R. pugioniformis* and *R. raphanistrum*, respectively (figure 4B). While in the case of terra rossa soil, root length was reported 5.72 - 10.0cm, and 3.02 - 13.2cm for 33 to 78 days after potting for *R. pugioniformis* and *R. raphanistrum*, respectively (Figure 4C). This implies that root length increases as days after potting increase for both *Raphanus* species. Statistical analysis showed that root length for *R. raphanistrum* is higher than that for *R. pugioniformis* when the growing media is perlite and sandy soil for the 4 periods of days after potting studied (33, 48, 63, and 78 days), with a significant difference at 63 and 78 days. While in the case of terra rossa soil, statistical analysis of obtained data showed that root length for *R. raphanistrum* is higher than that for *R. pugioniformis* for 48 and 63 days after potting, while the reverse trend was observed after 33 and 78 days after potting but this difference was not significantly different.

Further, amongst the tested growing medium, perlite was found the best growing media in terms of root length for *R. pugioniformis* for the 3 different potting periods (33, 48, and 78 days) with significant differences (figure 4D), while sand growing media have significantly higher effect at 63 days compared to perlite and terra rossa growing media. Regarding *R. raphanistrum*, here also perlite gave the highest root length for 3 potting periods (48, 63, and 78 days) while perlite and sandy growing media have a similar effect at 33 days (Figure 4E).

3.5 Effect of growing media on root fresh weight

The effect of different growing media on the fresh root weight of *R. piriformis* and *R. raphanistrum* species was studied, and it varies with the study time from day 33 to 78 (Figure 5). As shown in figure 5A using perlite as growing media, the range of root fresh weight was recorded from 0.25 - 0.71 g, and 0.82 - 1.10 g for *R. pugioniformis* and *R. raphanistrum*, respectively for various time intervals i.e. 33 to 78 days after potting. This implies that root

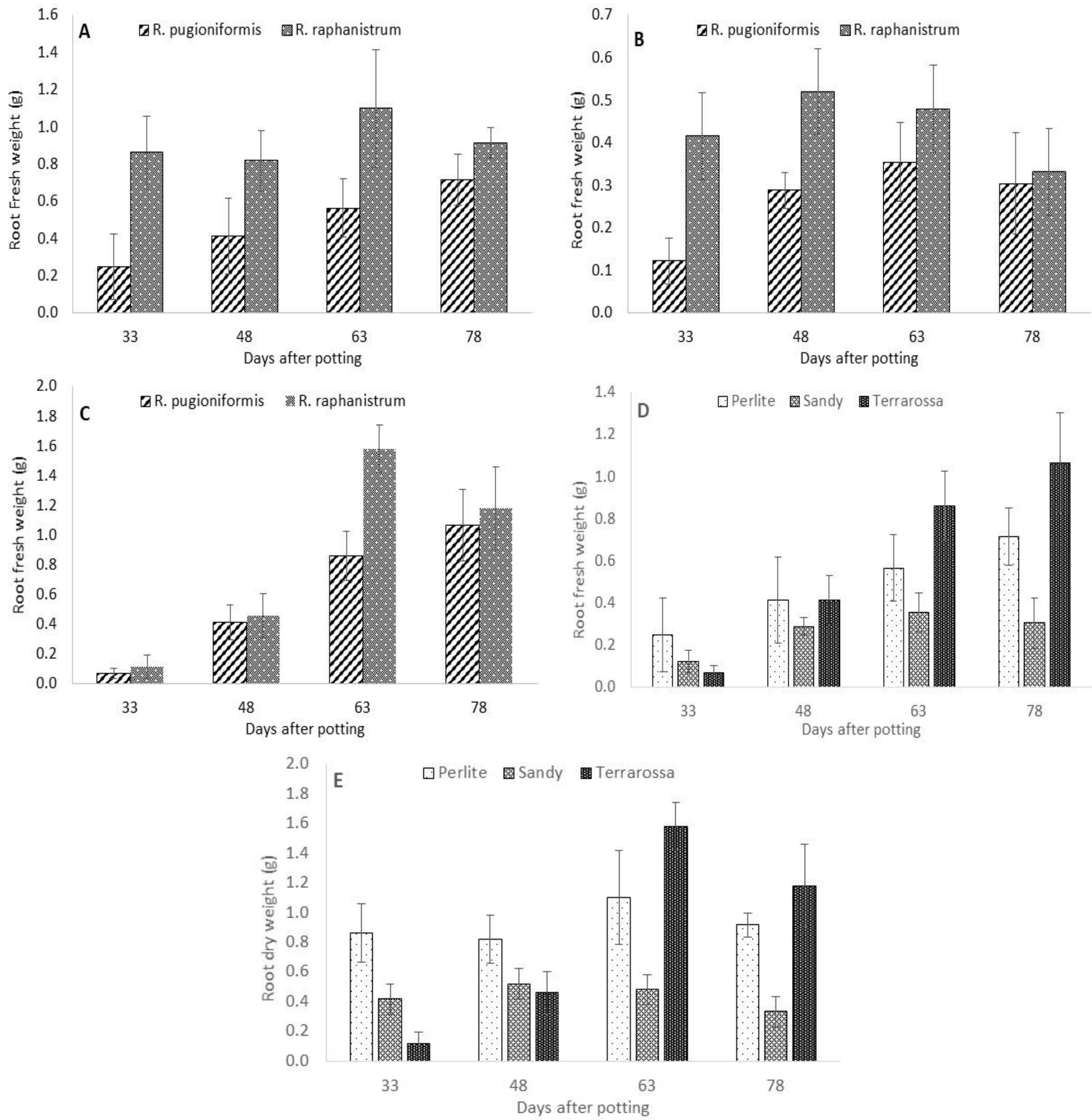

Figure 5 Effect of different growing media on root fresh weight of *R. pugioniformis* and *R. raphanistrum;* A: perlite growing media, B: sandy soil growing media, C: terra rossa growing media, D: root fresh weight of *R. pugioniformis* in all three growing media, and E*:* root fresh weight of *R. raphanistrum* in all three growing media

fresh weight increases as days after potting increased and it was reported highest for *R. raphanistrum* followed by the *R. pugioniformis* grown in perlite grown media and differences in these two are significantly different for all four observation periods (33, 48, 63, and 78 days). Using sandy soil as growing media, the range of root fresh weight was found 0.12 - 0.35g and 0.33 - 0.52g for *R. pugioniformis* and *R. raphanistrum*, respectively and statistical analysis of the obtained data suggested that the root fresh weight for *R. raphanistrum* is higher than that for *R. pugioniformis* for 4 periods of days after potting but only for 33 and 48 days a significant difference was reported (figure 5B). Regarding the root fresh weight of *R. pugioniformis* and *R. raphanistrum* species using terra rossa soil as growing media (Figure 5C), results showed that the range of root fresh weight was found to be from 0.07 - 1.06g and from 0.12 to 1.58g for the days after potting from 33 to 78 for *R. pugioniformis* and *R. raphanistrum*, respectively. Statistical analysis showed that root fresh weight for *R. raphanistrum* is higher than that for *R. pugioniformis* for the 4 periods of days after potting studied, but it showing statistically significant differences only at 63 days.

Among the tested growing media, perlite was reported as the best-growing media in terms of root fresh weight for *R. pugioniformis* at 33 days after potting, while terra rossa growing media have significantly higher root fresh weight at 63 and 78 days compared to perlite and sandy growing media, and perlite and terra rossa gave comparable root fresh weight at 48 days (Figure 5D). Regarding *R. raphanistrum*, perlite gave the highest root fresh weight for two potting periods (33, and 48 days) with significant differences, while terra rossa growing media gave the highest root fresh weight for 63 and 78 days (Figure 5E).

3.6 Effect of growing media on root dry weight

Like other growth parameters, the effect of different growing media on the root dry weight of *R. piriformis* and *R. raphanistrum* species was also reported (Figure 6). Using perlite as growing media, the range of root dry weight was found from 0.1 - 0.21 g and 0.12 - 0.39 g as the days after potting increased from 33 to 78 for *R. pugioniformis* and *R. raphanistrum*, respectively. Similarly, in the case of sandy soil, the root dry weight was recorded from 0.04 to 0.19g and 0.12 - 0.52g for *R. pugioniformis* and *R. raphanistrum*, respectively (Figure 6B), and this was reported from 0.0**3** - 0.24g and 0.03 - 0.88g for *R. pugioniformis* and *R. raphanistrum* grown in terra rossa soil respectively (Figure 6C). These results suggested that root dry weight was higher for *R. raphanistrum* and it was followed by the *R. pugioniformis* for all studied growing media. In the case of perlite, a significant difference was reported between the two *Raphanus* sps., and three growing periods i.e. 33, 63, and 78 days after potting while the reverse was observed at 48 days without significant difference. Like perlite, in the case of sandy soil, the highest root dry weight

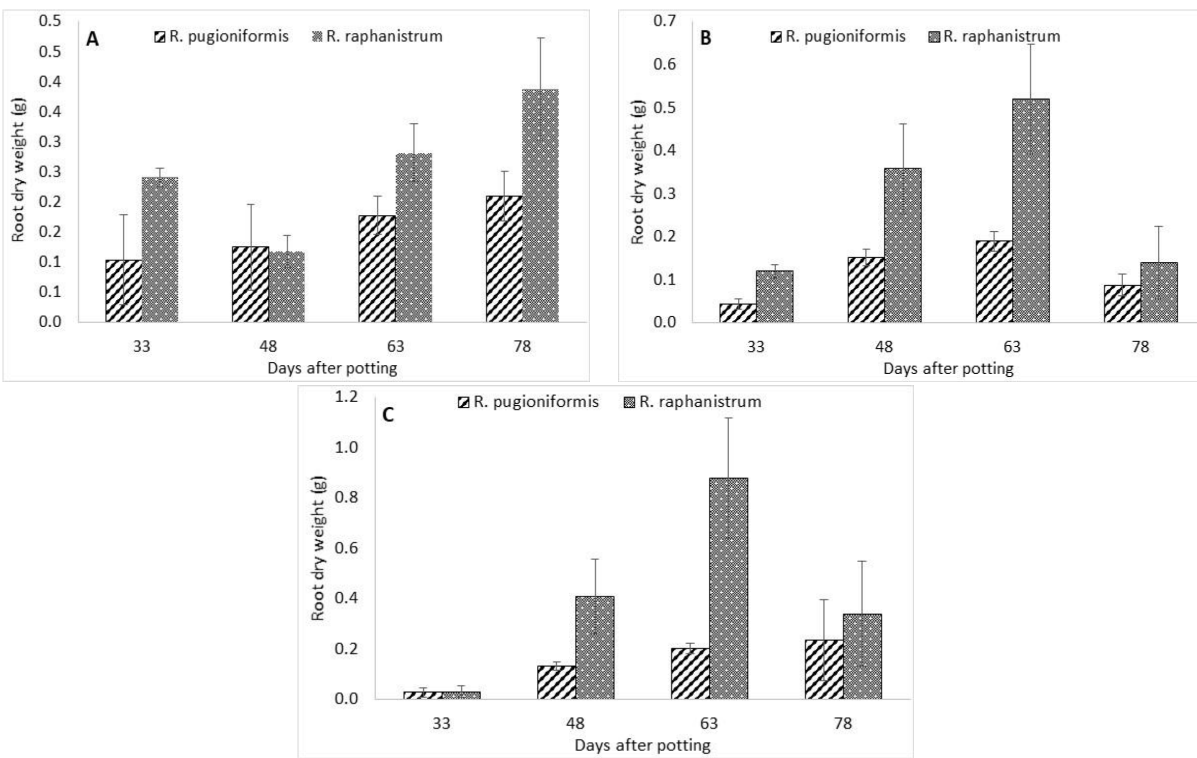

Figure 6 Effect of different growing media on root dry weight (g) of *Raphanus pugioniformis*and*Raphanus raphanistrum;* A: perlite growing media, B: sandy soil growing media, C: terra rossa growing media

was reported for *R. raphanistrum* and it shows a statistically significant difference for 33, 48, and 63 days after potting while the reverse was observed at 78 days. Among the plant grown in terra rossa soil also, *R. raphanistrum* is showing higher root dry mass and it was significantly different from the *R. pugioniformis* for the 3 growing periods (48, 63, and 78 days) while the reverse was observed at 33 days. The individual effects of the soil growing media on root dry weight of *Raphanus* sps., and its association with four-time intervals was not studied.

4 Discussion

The present study determines the efficiency of three potting media (perlite, terra rossa, and sandy soils) on the various growth parameters (shoot and root) of two *Raphanus* species. Terra rossa (Italian for "red soil") is a well-drained, reddish, clayey to silty soil with neutral pH conditions and is typical of the Mediterranean region. Compared to most clay-rich soils, terra rossa has good drainage characteristics (Popescu and Popescu 2015). On the other hand, perlite is a non-organic additive used to aerate the media. Growth parameters like shoot length, shoot fresh and dry weights, root fresh and dry weight, and root length was measured after different periods of potting from 5 to 11 weeks (33, 48, 63, and 78 days). Results of the study revealed that all the studied growth parameters were reported highest for perlite growing media for both *R. pugioniformis* and *R. raphanistrum* and significant differences were reported after 33, 48, and 63 days of potting. In the case of individual *Raphanus* sps., *R. raphanistrum* showed superiority over the *R. pugioniformis* in all studied plant growth parameters. Plant biomass (root and shoot) is frequently used for the calculation of net primary productivity and growth rates of plants and also plays an important role in determining their adaptive responses to stress situations (Cornelissen et al. 2003; Moghe et al. 2014; Umar et al 2019; Gyewali et al. 2020), and considered as an important parameter in growth analysis (Niklas and Enquist 2002). Nutrient absorption by plants from the soil depends on the interactions between plant roots and soil, and it is highly influenced by the nutrient quantity, availability, mobility in soil, and the uptake kinetics of the root system (Lambers et al. 2006). Further, nutrient uptake by plants is also affected by root morphological characteristics (Fageria and Moreira 2011), and the root morphology and root length have been shown higher influence on nutrient uptake efficiency (Jia et al. 2008). The root length is an important root property that affects the contact between soil nutrients and root surface, root distribution in different soils, and transport of nutrients (Barber 1984).

Conclusion

Wild radish (*Raphanus*) is an invasive weed that hurts different land use types and more research has not been done yet on the weed. Therefore, this study was conducted to understand differences in growth patterns in two allopatric and closely related *Raphanus* species i.e. *R. raphanistrum* and *R. pugioniformis* of the East-Mediterranean (Med.) under three different soil types. Results of the study can be concluded that soil type has a significant effect on the selected Raphanus sps., and among the studied three soil types, perlite is the best-growing media in terms of root length and root fresh weight for *R. pugioniformis* and *R. raphanistrum*. Further, the growth parameters of the two *Raphanus sps.*, are different and these are depending on the used soil type, which indicates that *R. raphanistrum* and *R. pugioniformis* have different adaptive strategies in different soil types.

Conflicts of interest and financial disclosures

Authors declare no conflict of interest.

References

Abbadi, J. (2017a). Phosphorous use efficiency of safflower and sunflower grown in different soils. *World Journal of Agricultural Research*, *5*(4), *212-220.*

Abbadi, J., Dittert K., Steingrobe B., & Claassen N. (2017). Mechanisms of Phosphorous Uptake Efficiency of Safflower and Sunflower Grown in Different Soils. *Research in Plant Sciences*, *5* (1) 26-42.

Abbadi. J. (2017b). Potassium Use Efficiency of Safflower and Sunflower Grown in Different Soils. *World Journal of Agricultural Research*, *5*(5): 244-257.

Abbadi. J., Dittert K., Steingrobe B., Claassen N. (2019): Mechanisms of potassium uptake efficiency and dynamics in the rhizosphere of safflower and sunflower in different soils, *Journal of Plant Nutrition*, 42 (19), 2459-2483. DOI: 10.1080/01904167.2019.1655035.

Abid, M., Asif, M., Bashir, M., & Nasir, A. (2017). Growth response of song of India (Dracaena reflexa) to various growing substrates, *International Journal of Chemical Science*, *1*(2), 105-109.

Al-Shehbaz, I. A. (2012). A generic and tribal synopsis of the Brassicaceae (Cruciferae). *Taxon, 61* (5), 931-954.

Barber, S. A. (1984). *Soil nutrient bioavailability*. New York: Wiley.

Campbell, L. G., Snow, A. A., & Ridley, C. E. (2006). Weed evolution after crop gene introgression: Greater survival and fecundity of hybridsin a new environment. *Ecology Letters*, *9*(11), 1198–1209.

Conner, J. K., Karoly, K., Stewart, C., Koelling, V. A., Sahli, H. F., & Shaw, F.H. (2011). Rapid independent trait evolution despite a strong pleiotropicgenetic correlation. *The American Naturalist*, *178*(4), 429–441.

Conner, J. K., Mills, C. J., Koelling, V. A., & Karoly, K. (2014). Artificialselection on anther exsertion in wild radish, *Raphanus raphanistrum*. *Scientific Data*, *1*, 140027.

Cornelissen, J. H. C., Lavorel, S., Garnier, E., Diaz, S., et al. (2003). A handbook of protocols for standardized and easy measurement of plant functional traits worldwide. *Australian Journal of Botany*, *51*(4), 335–80.

Fageria, N. K., & Moreira, A. (2011). The role of mineral nutrition on root growth of crop plants. *Advances in agronomy*, *110*, 251–331. https://doi.org/10.1016/B978-0-12-385531-2.00004-9

Gyewali, B., Maharjan, B., Rana, G., Pandey, R., Pathak, R., & Poudel, P.R. (2020) Effect of different organic manure on growth, yield and quality of Radish (*Raphanus sativus* L.). *SAARC Journal of Agriculture*, *18*(2):101-114. doi: https://doi.org/10.3329/sja.v18i2.51112

Gil, P.M., Bonomelli, C., Schaffer, B., Ferreyra, R., & Gentina, C. (2012), Effect of soil water-to-air ratio on biomass and mineral nutrition of avocado trees. *Journal of Soil Science and Plant Nutrition*, *12*, 609-630.

Irwin, R. E., Strauss, S. Y., Storz, S., Emerson, A., & Guibert, G. (2003). Therole of herbivores in the maintenance of a flower color polymorphismin wild radish. *Ecology*, *84*(7), 1733–1743.

Jia, Y. B., Yang, X. E., Feng, Y., & Jilani. G. (2008). Differential response of root morphology to potassium deficient stress among rice genotypes varying in potassium efficiency. *Journal of Zhejiang University Science B*, *9*(5), 427–34.

Klinger, T., Elam, D., & Ellstrand, N. C. (1991). Radish as a model system for the study of engineered gene escape rates via crop-weed mating. *Conservation Biology*, *5*(4), 531–535.

Lambers, H., Shane, M. W., Cramer, M. D., Pearse, S. J., & Veneklaas. E. J. (2006). Root structure and functioning for efficient acquisition of phosphorus: Matching morphological and physiological traits. *Annals of Botany*, *98*(4), 693–713.

Madhavi, B.G.K., Khan, F., Bhujel, A., Jaihuni, M., et al. (2021), Influence of different growing media on the growth and development of strawberry plants. *Heliyon*, *7* (6), e07170.

Moghe, G. D., Hufnagel, D. E., Tang, H., Xiao, Y., et al. (2014). Consequences of whole-genome triplication as revealed by comparative genomic analyses of the wild radish *Raphanus raphanistrum* and three other *Brassicaceae* species. *The Plant Cell*, *26*(5), 1925–1937.

Niklas, K. J., & Enquist. B. J. (2002). On the vegetative biomass partitioning of seed plant leaves, stems, and roots. *The American Naturalist*, *159*(5), 482–97.

Popescu, G.C., & Popescu, M. (2015), Effects of different potting growing media for *Petunia grandiflora* and *Nicotiana alata* Link & Otto on photosynthetic capacity, leaf area, and flowering potential. *Chilean Journal of Agricultural Research*, *75*(1), 21-26.

Sardoei, A.S., & Shahdadneghad, M. (2015). Effect of Different Growing Media on the Growth and Development of Zinnia (*Zinnia elegans*) under the Agro-Climatic Condition of Jiroft. *Research Journal of Environmental Sciences*, *9* (6), 302-306.

Špulák, O.M., & Hacurová, J. (2021). The influence of growing medium composition on pine and birch seedling response during the period of simulated spring drought. *Journal of Forest Science*, *67* (8), 385–395.

Umar U.M., Iro, I.I., Obidola S.M. (2019), Growth and yield of radish (*Raphanus sativus* L.) as influenced by different levels of kalli organic fertilizer on the Jos Plateau. *Asian Journal of Research in Crop Science*, *4*(4): 1-8. DOI: 10.9734/AJRCS/2019/v4i430078.

Waitz, F., Schnaiter, M., Leisner, T., & Järvinen, E. (2021) Phips-halo: the airborne particle habit imaging and polar scattering probe – part 3: Single particle phase discrimination and particle size distribution based on angular scattering function. *Atmospheric Measurement Techniques*, *14* (4), 3049-3070.

Younis, A., Riaz, A., Javaid, F., Ahsan, M., et al., (2015). Influence of various growing substrates on growth and flowering of potted miniature rose cultivar "Baby Boomer". *Specialty Journal of Agricultural Sciences*, *1* (2), 28-33.

Ziffer-Berger, J., Hanin, N., Fogel, T., Mummenhoff, K., & Barazani, O. (2015). Molecular phylogeny indicates polyphyly in *Raphanus* L. (Brassicaceae). *Edinburgh Journal of Botany*, *72*, 1-11.

Ziffer-Berger, J., Waitz, Y., Behar, E., Joseph, O.B., et al. (2020). Seed dispersal of wild radishes and its association with within-population spatial distribution. *BMC Ecology*, 20, 30.