Australian Journal of Agricultural Engineering AJAE
AJAE 2(5):147-154 (2011) ISSN:1836-9448

Influence of soilless growing media, pot size and sieved media on the production of *Hibiscus Sabdariffa* L. seedlings

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Abstract

This study was conducted to determine the potential of raising roselle (*Hibiscus sabdariffa* L.) seedlings, using different types of coarse and sieved media in various pot sizes up to thirty days after germination. Roselle seeds of cultivar 'Locale' and formulated rooting media were characterized for certain physico-chemical characteristics. The media were different in terms of pH, electrical conductivity (EC), container capacity and percent aeration porosity ($p<0.05$). Root dry weight (DW) of roselle seedlings differed significantly among rooting media ($p<0.05$) and pot sizes ($p<0.05$). Root DW of roselle seedlings from medium M4 (2-mm sieved scoria) was 0.188±0.046 g, while under the control treatment (soil), root DW was much lower (0.069±0.020 g). Number of leaves and shoot DW of seedlings from M4 treatment were considerably higher than the control seedlings. An interaction effect between type of media and pot size on the whole seedling DW ($p<0.05$) was also observed. Pot size P1 produced roselle seedlings of higher seedling DW in the coarse media. Under sieved media, pot sizes differed in shoot DW ($p<0.05$), whereby P2 and P3 produced roselle seedlings of higher seedling DW than P1. Scoria has the potential as soilless substrate for roselle seedling production.

Keywords: Bagasse fly-ash; coir; dry weight; seedling; rooting substrate; roselle; and scoria.
Abbreviations: AREU – Agricultural Research and Extension Unit; DAG – Days after germination; DW – Dry weight; EC – Electrical Conductivity; MSIRI – Mauritius Sugar Industry Research Institute; UoM – University of Mauritius; and w/w – weight by weight.

Introduction

Hibiscus sabdariffa L., commonly known as Roselle, belongs to the Malvaceae family and is native of the tropical regions of Africa (Omobuwajo et al., 2000, McClintock and El Tahir, 2004). It is an annual shrub that has been commonly grown as an ornamental by virtue of its decorative flowers and red coloured stems (Morton, 1987). Recently, the plant has received increased interest due to its multifunctional attributes. Roselle calyces contain high amount of anthocyanins that act as a good source of antioxidants, thereby contributing to health benefits (Chumsri et al, 2008). Roselle also serves as a natural source of food colorants, pharmaceuticals and cosmetics (Mazza and Miniati, 1993). The fleshy calyces are widely used for drink preparations because of their high anthocyanin and organic acid contents (Gomez-Leyva et al., 2008). Roselle is mainly propagated by seeds and the seedlings are then established in open fields for commercial calyx production. Benedictos (1994) proved that pot-produced tomato seedlings are superior to seedlings produced from seedbeds. Soil is mostly used as rooting medium for Roselle seedling production, which jeopardises the production of quality seedlings. Soil-borne diseases have been reported as a major limiting factor to the production of Roselle worldwide (Amusa et al., 2005). For instance, the susceptibility of Roselle to fungal pathogens like *Phoma sabdariffae* and *Fusarium oxysporum* was reported by Sié et al. (2010). Moreover, soil is not a proper medium for containerised plant production as it settles down, leading to drainage and aeration problems. Plugs cannot be easily removed from the container when soil is used as a rooting medium, which is essential to avoid damage to the roots and reduce transplanting shock (McDonald, 2005). In Mauritius, the commonly used soilless rooting media for seedling production are coconut coir and vermiculite, both of which are imported and costly. The current trend is to decrease the use of expensive substrates (NeSmith and Duval, 1998). This calls for exploiting freely available local resources as potential agricultural inputs. Bagasse fly-ash and scoria are by-products of the sugar industry, which are produced in large quantities annually and are of little economic use. Disposal of these by-products is a real problem and consequently large amounts of scoria and fly-ash are freely available. According to Chen et al. (1991), scoria has the potential to serve as a component in growing media. However, literature on its use, characteristics and evaluation as a rooting media is scanty. Containers that are used for seedling production should be of minimal size to decrease cost of production and transportation (Vavrina, 1996) but yet they need to enable full growth and development of the seedlings. In this line, the aim of the study is to propose an alternative rooting medium to soil and determine an appropriate pot size for the production of quality roselle seedlings. The objectives of the study were to: characterise roselle seeds and rooting media under study; investigate the effects of different container size on number of leaves, stem height, stem diameter, number of roots, root dry weight (DW), shoot DW and total seedling DW; and investigate the effect of rooting media on the above mentioned parameters of roselle seedlings.

Results and Discussion

Seed Characteristics

Maximum yield is achieved in vegetable crop production when there is better emergence and stand establishment of seedlings (Sudhakar et al., 2008). In this study, mean germination percentage of roselle seeds was 93.5±1.5 and mean percentage viability was 96.4±1.2 (Table.4). The roselle seed lot had thus a very high % viability, which proved that it could express fully its physiological, physical, pathological, and genetic characteristics on emergence (Basra, 1995). Another parameter that affects seed quality is moisture content, which consequently determines seed storability. The mean seed moisture content of roselle seeds was 9.8±0.3%, falling within the recommended range of seed moisture content of 6-12% for safe storage of agricultural seeds (AREU, 2005). Thousand seed mass of roselle seeds was 30.012±0.182g, which was slightly lower than what was obtained by Omobuwajo et al. (2000). The geometric mean diameter (3.59±0.09) of seed lots used in our study was also lower than that reported by Bamgboye and Adejumo (2009). These may be attributed to the different locality where roselle was planted (Bamgboye and Adejumo, 2009) and/or to varietal effect. Roselle seed length and width were within the range of values reported by Bamgboye and Adejumo (2009), however the mean seed thickness (2.40-4.41) was much lower. Therefore lower seed thickness of the local seeds may explain the lower values obtained for thousand seed mass and geometric mean diameter.

Characteristics of Growing Media

Availability of plant nutrients is highly dependent on medium pH. At neutral pH, most essential nutrients are available for plant growth. Roselle grows best in soil having pH ranging from 6 to 7 (Morton, 1987). Initially the pH of scoria and fly-ash was 8.69 and 8.86 respectively. When pH is above 7.5, iron, manganese, phosphorus, copper and zinc are unavailable to the plant roots. After washing using potable water, the pH of both media was reduced to 7.05 (scoria) and 7.25 (fly-ash) and they are close to the recommended pH range of 5-7, where most plants can grow. In this study, the pH of the rooting media differed from each other ($p<0.05$). The pH of soil was almost neutral, but was similar to that of media M4 and M5 (Table.5). S, M4, and M5 are thus suitable for seedling production of roselle. On the other hand, media M1, M2 and M3 were slightly alkaline (pH range 7.68- 8.30) and hence theoretically not suitable for roselle culture. EC can be used to distinguish between saline and non-saline medium. The higher the EC, the higher is the salt content of the medium. Initially EC of scoria and fly-ash was 0.435 and 4.810 dS/m respectively and after washing EC of both media were reduced to 0.122 and 2.850 dS/m respectively. Knoxfield (1995) observed that a potting media with EC higher than 1.5 dS/m was detrimental to plant growth. Although roselle plants are moderately tolerant to salinity (El-Saidi and Hawash, 1971), growers need to be careful about salt concentration of growing media as this may negatively affect crop yield. Soil at the experimental site had the lowest EC (0.122±0.018 dS/m) and differed from all the other media ($p<0.05$) – Table.5. EC of M5 was high (2.850±0.061 dS/m) and theoretically not suitable for seedling production. M2, M3 and M4 had EC ranging from 0.272 to 0.383 dS/m, which are not likely to be toxic to roselle plants. As water is mostly held in the micropores, the higher the ratio of micropores in a medium, the higher will be its container capacity (Hanan, 1998). The media under study were different in terms of container capacity ($p<0.05$) – Table.5. The average container capacity of medium M1, M2 and M5 was almost twice the container capacity of soil. M4 had a container capacity comparable to soil, although it was significantly higher ($p<0.05$). Porosity is termed as the total pore space of a growing medium and it affects the moisture-holding and nutrient-holding characteristics of media (Jeyaseeli and Paul Raj, 2010). Percent porosity of the different media under study were statistically different ($p<0.05$). Soil had the lowest % porosity (53.73±0.97), while M4 had the highest % porosity (68.33±0.65), as depicted in Table.5. Percent porosity of scoria was altered by different magnitude by the addition of different amendments. Havis and Hamilton (1976) stated that a good growing substrate for seedling should have a total porosity of more than 50% and consequently all media under study are judged appropriate, based on % porosity attribute only.

Effects of rooting media on seedling parameters, irrespective of pot size

There was no significant difference in the number of leaves and roots produced by the roselle seedlings among the rooting media ($p>0.05$). However, M4 produced the highest number of leaves and roots per seedling. M2 and M3 produced the least number of leaves and roots respectively. There was no significant difference in stem height and diameter among the studied rooting media ($p>0.05$). Stem height was nevertheless highest in M4 and soil. Shoot DW did not differ ($p>0.05$) among the rooting media. However, M4 produced shoots with the highest DW (0.194±0.031). The control medium soil had a shoot DW of 0.104±0.034. Root DW differed significantly among rooting media ($p<0.05$). There was a marked difference in root DW between M4 and other media (Table.6). Adequate soil aeration is extremely vital in order to optimise plant growth (Bhattarai, 2005). M4 had the highest aeration porosity and would possibly lead to greater root growth. In fact, root DW of M4 was significantly higher than other rooting media. Following Nicola and Bassocu (2000) statement that a seedling with enough dry mass would surmount transplanting shock and lead to better field establishment, it can be postulated that seedlings produced in M4 may perform well in the field.

Effects of pot size on plant parameters, irrespective of media

It is important to select the appropriate container size for each specific crop, based on its growth rate and final desired size and growing conditions (Raviv et al., 2008). Pot sizes did not influence number of leaves and roots, stem height and diameter, and shoot DW of roselle seedlings ($p>0.05$). Nevertheless, P2 produced the highest number of leaves and roots per seedling, and greater stem height and diameter than P1 and P3 (Table.7). Bar-Tal, et al., (1995) affirmed that plant height, number of leaves as well as shoot and root dry

Table 1. Average daily meteorological data at the University of Mauritius Farm, Réduit

Months (Year: 2009)	Rainfall (mm)	Minimum Temperature (°C)	Maximum Temperature (°C)	Sunshine hours per day
January	12.9	20.6	29.8	7.8
February	6.7	21.9	28.7	7.2
March	6.1	21.2	28.8	7.2

Source: Réduit Agro-meteorological Station (MSIRI pers. comm., 2009)

Table 2. Composition of rooting media

Rooting Medium	% composition by volume basis
S	(100% 2-mm sieved soil)
M1	(20% scoria / 60% fly-ash /20% coir)
M2	(40% scoria / 40% fly-ash /20% coir)
M3	(60% scoria / 20% fly-ash /20% coir)
M4	(100% 2-mm sieved scoria)
M5	(100% fly-ash)

weight increases with increasing container size. This corresponds to the findings in this study with regard to the increase of pot size from P1 to P2, but further increase of pot size to P3 did not lead to an increase in studied plant parameters, except shoot DW. Hoffmann and Jungk (1995) and Keever et al. (1985) reported that root confinement within a limited volume results in reduced root growth. These citations corroborate with our results, whereby P1 had the least values for all the parameters studied (Table.7).

Shoot, Root & Seedling DW

In coarse media, shoot DW was different among pot sizes ($p<0.05$). P1 produced the highest shoot DW, while P3 yielded the lowest shoot DW. Regarding sieved media, pot sizes differed in shoot DW ($p<0.05$), whereby P2 and P3 resulted in higher shoot DW than P1 (Fig.1A). While comparing the media and pot sizes independently, there was significant difference in root DW both among pot sizes and media ($p<0.05$). For medium M4, both P2 and P3 produced seedling with relatively high root DW. Whereas for the other sieved media, P2 outperformed the other pot sizes (Fig.1B). M4 produced seedlings with the highest root DW. The most important parameter for a good seedling is its root quality. Nurseries should produce strong seedlings with well-developed root systems so as to resist transplanting shock (AREU, 2004b). The weight of roots produced by M4 in P2 and P3 was approximately three times greater than that of the coarse media (Fig.1B). Whole seedling DW did not differ both among pot sizes and media, when analysed independently ($p>0.05$). When conducting ANOVA on coarse media only, seedling DW was significantly different among pot sizes ($p<0.05$). Based on seedling DW, P2 and P3 were the most suited containers for sieved media, while P1 produced seedlings with higher dry weight among the coarse media (Fig.1C). Significant interaction effect was observed between type of media and container size on whole seedling DW ($p<0.05$). An increase in seedling DW, from coarse to sieved media for both P2 and P3 was observed (Fig.2). Conversely, seedling DW decreased from coarse to sieved media for P1. Similar interaction plots (data not shown) were obtained for root DW and shoot DW. When using the coarse media, P1 produced seedlings of higher dry mass, while P2 and P3 were more suitable containers for sieved media. Particulate size of media and depth of container influence aeration and drainage in pot culture and these factors may subsequently influence growth of plants in containers. According to Leskovar et al., (1990) optimal root growth depends on favourable soil or rooting media conditions including water, fertility and the physical environment. Depth of growing container had a more significant effect than its volume on successful plant development (Dominguez-Lerena et al., 2006). Generally, the deeper the medium, the larger is the ratio of air to water spaces in that medium (Nelson, 2003). In pot culture, there is an equilibrium point reached after irrigation and drainage, resulting in the formation of a water table. In shallow containers, water is available to the root zone as the water table is higher up in the pot. In deep containers, conversely, the water table is at the bottom of the container, often far from the root zone of developing seedlings, which restricts water availability to plants. According to Hanan, (1998), water must be in contact with the roots if it is to be absorbed in meaningful quantities. In P1, containing coarse rooting medium there will be quick drainage. However, due to its swallower depth, water table is likely to be closer to the root zone. Hence seedlings can probably absorb significant amount of water and nutrients for growth. On the other hand P2 and P3 may not perform well under coarse media possibly due to the water table being further from the root zone. However, when P2 and P3 were packed with sieved media, although the water table was lower, water could have risen up via capillarity and consequently supplied water and nutrients to the roots, leading to good seedling performance.

Materials and Methods

Plant material and experimental conditions

Roselle seeds of cultivar 'Locale' (a voucher seed sample was deposited at the Herbarium of the Mauritius Sugar Industry Research Institute – MSIRI, Réduit) were obtained from the New Crop Technology Research Group, Faculty of Agriculture, University of Mauritius, Réduit. The field experiment was carried out at the University of Mauritius Farm (UoM) Farm at Réduit. Table 1 depicts the climatic data on the above-mentioned site.

Roselle seed characterisation

Percent germination: 200 randomly selected roselle seeds were germinated, as per International Seed Testing

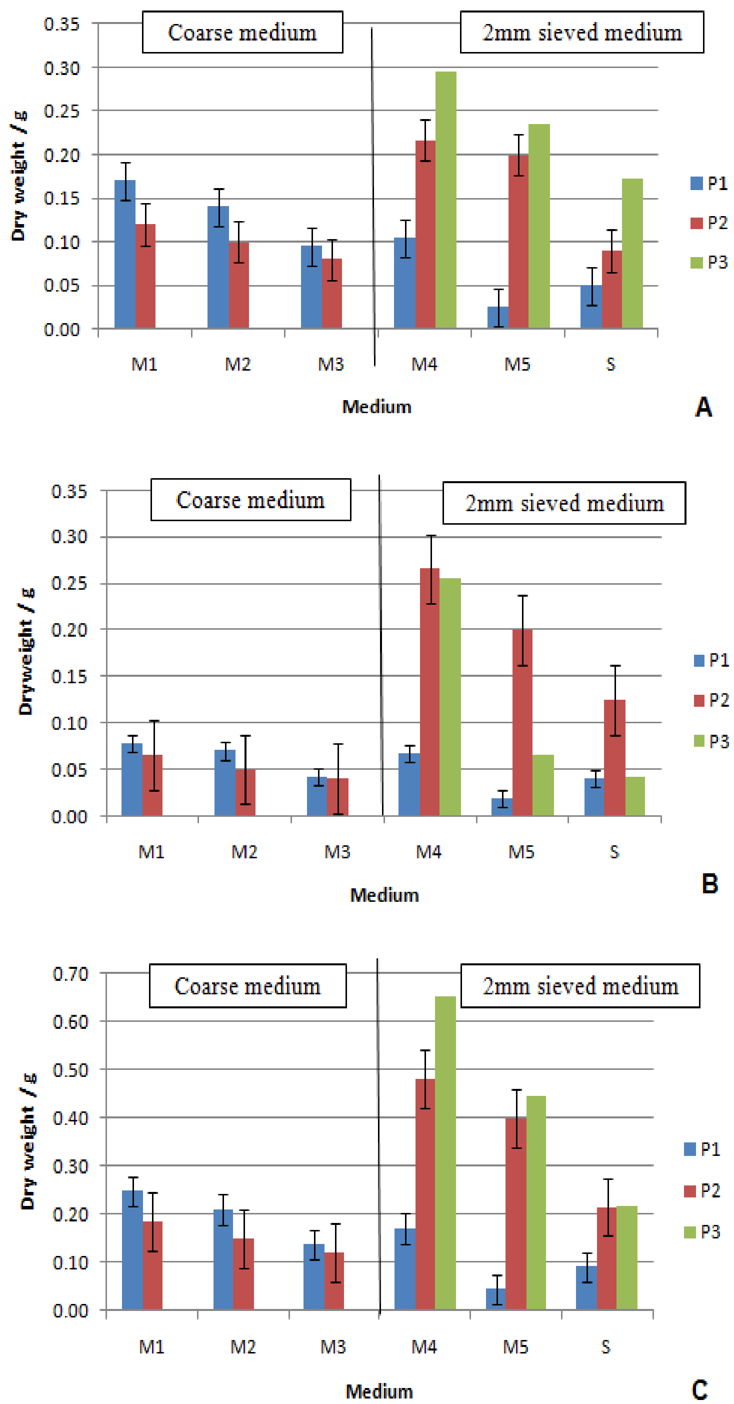

Fig1. Effect of pot size, sieving and type of media on shoot (A), root (B) & seedling (C) DW. Growing Media: S-2mm sieved soil; M1-20% scoria, 60% fly-ash, 20% coir; M2-40% scoria, 40% fly-ash, 20% coir; M3-60% scoria, 20% fly-ash, 20% coir; M4-2mm sieved scoria; and M5-100% fly-ash. Volume and depth of containers: P1-91 cm^3& 4.5 cm; P2-378 cm^3& 10.5 cm; and P3-1470 cm^3& 15 cm

Association (ISTA) (1993), in four replicates for a period of ten days. Percent germination was calculated from the number of normal seedlings observed out of the number of seeds evaluated. *Mean germination time (MGT)*: MGT was determined on 6 random replicates of 50 seeds each and was calculated according to a modified formula of Ellis and Roberts (1981) and expressed in hours (h):

$$MGT(h) = \frac{\sum H \cdot n}{\sum n}$$

where n is the number of seeds which germinated on count H, and H is the time in hours elapsed from the start of the germination test.

Tetrazolium seed viability test: Seed viability test was performed on three replicates of 100 seeds each, as per ISTA (1993). The number of viable seeds was expressed as a percentage of total number of seeds used.

Seed moisture content determination: Moisture content was determined as per ISTA, 1993. It was expressed as a percentage of the original weight of the roselle seeds.

Seed size: The length (L), width (W) and thickness (T) of roselle seeds were measured with a calibrated digimatic vernier calliper (CD-6" CS, Mitutoyo Corporation, Japan), to an accuracy of 0.01 mm. Three replicates of 100 seeds per replicate were used. Using these measurements, the geometric mean diameter (D_g) of the seeds was calculated using the formula given by Mohsenin (1986):

$$Dg = \sqrt[3]{L \cdot W \cdot T}$$

Thousand seed mass determination: Thousand seed weight was obtained (Bamgboye and Adejumo, 2009) in triplicates by using a digital weighing balance of 0.0001g accuracy (Metler AE 163, Metler Instrument, Zurich).

Analysis of rooting media

Approximately 100 kg of bagasse fly-ash and scoria were collected from the Central Thermique de Belle-Vue (CTBV), Belle-Vue, Mauritius. Low-Humic-Latosolic soil was collected on the UoM Farm. *pH and Electrical Conductivity (EC) determination:* The media were sieved using 2mm-arpetured sieve. EC and pH of media with 1:2.5 (w/v) water extracts were analysed in triplicates at the start and end of experiment with an EC meter (Jenway, Model 4020) and a pH meter (Metler Toledo, MP220 *Percent Porosity*: Bulk density (BD) and particle density (PD) measurements were carried out in triplicates for each medium as per Landon (1991). The percent porosity of a medium was calculated as follows:

$$\% \, porosity = \left(1 - \frac{BD}{PB}\right) * 100$$

Container capacity: Container capacity was determined using a method adapted from Landon (1991). A petri-dish (as base) with an empty coring cylinder fitted with a filter paper tied at its base-end was carefully labelled and their weight (W1) noted.

Table 3. Potting sizes used in the experiment

Container	Size/cm (Length x width x depth)	Volume (cm^3)
P1	4.5 x 4.5 x 4.5	91
P2	6.0 x 6.0 x 10.5	378
P3	14.0 x 7.0 x 15.0	1470

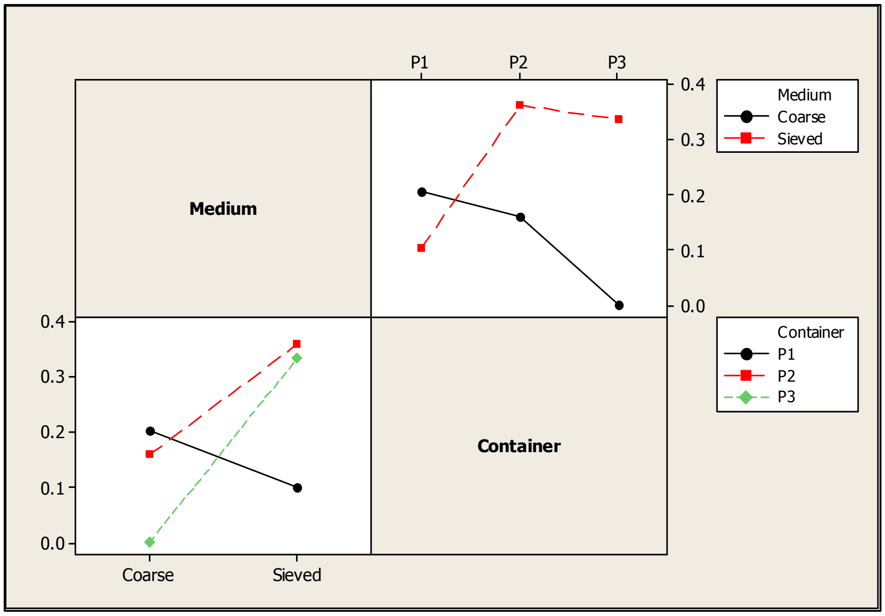

Fig 2. Interaction plot of seedling DW versus container size and type of media. **Volume and depth of containers: P1**-91 cm^3& 4.5 cm; **P2**-378 cm^3& 10.5 cm; and **P3**-1470 cm^3& 15 cm

The coring cylinder was then carefully driven in the rooting medium and dug out. The whole set together with the petri-dish were weighed and the weight (W2) noted. The latter was afterwards placed in a tray filled with water at a level about one-third to the height of the core cylinder and left to stand for 24 hours to allow the sample to be saturated with water. After saturation, when equilibrium was reached, the core containing the sample was weighed and the mass (W3) noted. The set was then transferred in an oven for drying at 105°C. After 24 hours the dry weight (W4) of medium was determined. Container capacity (CC) was determined using the formula below:

$$CC = \frac{(W2 - W1)}{(W4 - W3)} * 100\%$$

Preparation of Rooting Media

Scoria, coir and bagasse fly-ash are either alkaline or saline. They were soaked in potable tap water overnight in the ratio of 1:10 (volume basis) and allowed to drain and dry the following day. Media was mixed on a volume basis and pre-fertilisation of media was practised using Triple Super Start^{TM} (N:P:K ratio of 8:15:8 + microelements) at the rate of 2.8% (w/w basis).

Seedling culture

Selected seeds were soaked in water for a few hours prior to sowing. Three seeds were sown in each cell to a depth of approximately 1.5 cm and watered immediately. After germination, only one seedling was kept per cell. Plant protection practices were conducted as per Agricultural Research and Extension Unit (AREU) (2004a). Irrigation was effected manually using a seedling watering can, twice per day up to the point of media saturation. Foliar fertilisation was performed by spraying the seedlings with foliar fertiliser Bi-Wang No.1^{TM} at the rate of 1g per litre of water on 10 and 20 days after germination (DAG).

Experimental design

The treatments included six types of rooting media (Table 2) disposed in three different pot sizes (Table 3). The experiment was laid in a completely randomised design (CRD) comprising of 14 treatment combinations (SP1; SP2; SP3; M1P1; M1P2; M1P3; M2P1; M2P2; M2P3; M3P1; M3P2; M3P3; M4; M5) replicated three times.

Plant Parameters

Measurements on plant parameters were taken at ten-day

Table 4. Characteristics of roselle seeds

Seed Parameters	Mean ± Standard Error (SE) of Mean
% Germination	93.5±1.5
Germination Time (Hours)	194.1±0.7
Viability (%)	96.4±1.2
Moisture Content (%)	9.8±0.3
Thousand seed mass (g)	30.012±0.182
Geometric mean diameter (mm)	3.59±0.09

Table 5. Physico-chemical characteristics of rooting media

Rooting media	pH	Electrical conductivity (µS/cm)	Container capacity (%)	Porosity (%)
M1	7.84±0.18b	582.70±26.70c	95.83±0.99f	58.33±0.92b
M2	8.30±0.13b	310.00±8.33b	82.71±1.06e	56.24±0.96b
M3	7.68±0.41b	383.00±14.00b	72.98±0.34c	61.83±0.20c
M4	7.05±0.01a	272.70±9.81b	52.82±0.77b	68.33±0.65d
M5	7.25±0.01ab	2850.0±60.8d	78.12±1.23d	63.24±0.34c
S	6.86±0.30a	122.00±17.60a	41.86±0.13a	53.73±0.97a

Mean±SE followed by different letters are significantly different at 5% level of significance, using Fischer's LSD test. Growing media: M1-20% scoria, 60% fly-ash, 20% coir; M2-40% scoria, 40% fly-ash, 20% coir; M3-60% scoria, 20% fly-ash, 20% coir; M4-2mm sieved scoria; M5-100% fly-ash; and S-2mm sieved soil.

Table 6. Effect of media on seedling parameters (irrespective of pot size)

Treatment	No. of leaves	No. of roots	Stem Height (mm)	Stem Diameter (mm)	Shoot DW (g)	Root DW (g)
M1	2.67±0.56	16.7±3.4	73.3±14.9	1.32±0.27	0.125±0.028	0.061±0.013a
M2	2.00±1.00	12.7±6.7	60.7±30.5	1.05±0.54	0.080±0.042	0.040±0.015a
M3	2.50±0.87	8.5±5.6	56.3±23.1	1.12±0.40	0.068±0.038	0.031±0.015a
M4	4.38±0.53	20.6±3.5	84.3±8.8	1.85±0.16	0.194±0.031	0.188±0.046b
M5	3.71±0.64	12.6±0.9	58.0±20.3	1.92±0.25	0.135±0.044	0.084±0.046a
S	3.22±0.43	18.4±1.9	100.1±10.2	1.95±0.17	0.104±0.034	0.069±0.020a
p-value	0.144	0.142	0.273	0.061	0.238	0.014
Significance	NS	NS	NS	NS	NS	S
$LSD_{0.05}$	-	-	-	-	-	0.093

Mean±SE followed by different letters are significantly different at 5% level of significance, using Fischer's LSD test. Growing media: M1-20% scoria, 60% fly-ash, 20% coir; M2-40% scoria, 40% fly-ash, 20% coir; M3-60% scoria, 20% fly-ash, 20% coir; M4-2mm sieved scoria; M5-100% fly-ash; and S-2mm sieved soil.

interval, from 10 to 30 DAG. In each sampling, measurements were made on five plants per replicate. Plant height, number of leaves, stem diameter, and number of roots (> one-mm length) were recorded. Roots and shoots were separated and dried in a pre-heated oven (Philip Harris Ltd, Shenstone, England) at 70ºC, until constant weights were obtained.

Data handling and analysis

The mean and standard error values of all parameters under study were calculated using the spreadsheet, Microsoft Excel® 2007. Analysis of Variance (ANOVA) of the data was performed using Minitab® Version 15 statistical software for Windows. Fischer's LSD test at 5% significance level was used to compare the difference in means.

Conclusion

Among the six media under study, including soil as control, media M1, M2 and M3 were found to produce weaker roselle seedlings, which was probably due to their alkaline pH. Based on number of leaves and roots, shoot DW and root DW, M4 outperformed soil (the control treatment), while on the stem parameters M4 nearly equalled seedling performance under soil. M4 likely has the desired physical properties in terms of pH (7.05), EC (0.272 dS/m), container capacity (52.8%) and aeration porosity (68.3%) for seedling production. M4 (2-mm sieved scoria) may thus be proposed as an alternative soilless media for roselle seedling production. With regard to pot size, P2 produced seedlings with higher root DW while P3 produced seedlings with higher shoot DW. Since P2 uses only 25.7% of the volume of media needed by P3, it is rather more economical to use P2-sized seedling trays. Interaction was significant between pot size and type of media with respect to whole seedling DW. P1 was the container producing quality seedlings among coarse media while P2 and P3 were the most appropriate containers for producing quality roselle seedlings using the sieved media. Two-mm sieved scoria seems to be a promising soilless media for roselle seedling production as it produced good quality seedlings, it is free of charge, and the plugs are easily removable from the seedling trays.

Table 7. Effect of potting size on plant parameters, irrespective of media

Trt	No. of leaves	No. of roots	Stem Height (mm)	Stem Diameter (mm)	Shoot DW (g)	Root DW (g)
P1	2.73±0.23	14.30±0.61	63.9±5.8	1.49±0.06	0.092±0.016	0.051±0.009a
P2	4.00±0.35	18.00±1.61	86.8±10.9	1.91±0.13	0.145±0.022	0.149±0.031b
P3	3.30±0.78	15.60±2.60	82.8±18.7	1.61±0.37	0.158±0.045	0.077±0.029a
p-value	0.122	0.563	0.291	0.272	0.176	0.014
Significance	NS	NS	NS	NS	NS	S
$LSD_{0.05}$	-	-	-	-	-	0.069

Mean±SE followed by different letters are significantly different at 5% level of significance, using Fischer's LSD test. Volume and depth of containers: P1-91 cm^3 & 4.5 cm; P2-378 cm^3 & 10.5 cm; and P3-1470 cm^3 & 15 cm

Acknowledgments

We are thankful to Dr. A. Ruggoo, Biometrician at the Faculty of Agriculture, University of Mauritius (UoM) for the guidance provided on statistical analysis of the experimental data. The authors also acknowledge the former Dean of Faculty of Agriculture, UoM for providing the financial and institutional resources for undertaking this study. Last but not least, we expressed gratitude to Mr. B. Rajkomar, retired Senior Lecturer and Team Leader of the New Crop Technology Research Group, for his valuable contributions and insights to roselle research in Mauritius.

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