Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(6): 1535-1538
Received: 11-09-2020
Accepted: 21-11-2020

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Standardization of best growing medium and container type for quality stock production in *Emblica officinalis* Gaertn

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Abstract
The containerized production system has advantage over the bare root seedlings. The modern container systems currently being used are root trainers which avoid root spiraling provide air pruning, encourage lateral root developments and to limit the egress of roots from the container. Besides container type, the control of growing medium also assumes great significance as far as production of quality stock is concerned. The aonla (*Emblica officinalis* Gaertn.) is one of the most important wild fruit crop of India. Its fruit have its medicinal properties and also used in tannin and dyeing industries. Though, aonla is routinely raised through seed, the quality of stock is very poor due to low viability and germination seen in the species. Keeping in view the importance of species, studies were therefore conducted to examine the best growing medium and container type for quality stock production. The growing medium of M_3 consisting of soil + sand + mushroom compost (1:1:2) in combination with polybag C_2 having size 9x4.5 inches with sixteen bottom perforations i.e. M_3C_2, registered significantly maximum germination per cent (76.00) and growth parameters *viz*., height growth (51.89cm), collar diameter (3.9mm) and root length (34.41 cm), dry root weight (3.19g), dry shoot weight (4.23g) and stock quality index (0.51) in the seedlings. Whereas, maximum root shoot ratio ratio (0.95) was registered by M_4C_4 treatment combination. The good results might be attributed to larger container size 1131cc and perforations with good amount of growing mixture, good porosity, good moisture retention and low plant density, which helped in faster and better growth of the seedling.

Keywords: Root trainers, poly bags, container type, growing medium, root-shoot ratio

Introduction
There is a great pressure on the forest resource these days to meet the requirement of timber and other forest products in the country. To reduce this pressure, new approaches like plantation forestry, social forestry and other afforestation practices have been mooted as alternative strategies to prevent large scale decline in this valuable resource. It has been observed that nearly fifty per cent failure in the field establishment was due to poor quality seedlings and choice of species. The ultimate success of the various plantation programmes therefore, depends upon the right choice of species and quality of planting stock.

The nursery stocks are usually raised as bare root or the container seedling stock. Bare root seedlings are, however not produced in large quantity due to transpiration stress, packaging problems and greater planting shock which often results in high mortality rates in the field. The containerised production system which evolved during the last 50 years varies from simple tar paper pots of 1930s (Strachan.1974) [12], to wide variety of rigid-walled containers in use these days. The most common containers which are however extensively used in India are the polybags. These are easily available, cheap and can be used for raising large quantities of seedlings. The main problem with these, however is root coiling, as the bottom is closed and hence hamper development of quality stock production (Gera *et al.*, 1998) [4]. The containerized production system has advantage over the bare root seedlings. The modern container systems currently being used are root trainers which avoid root spiraling provide air pruning, encourage lateral root developments and to limit the egress of roots from the container.

Besides container type, the control of growing medium also assumes great significance as far as production of quality stock is concerned. The growing medium should be fertile, light, well drained and aerated. The commonly used growing media besides soil contain compost, animal manure and sawdust etc.

The container size also has a control on quality of raised stock. The aonla (*Emblica officinalis* Gaertn.) belonging to family euphorbiceae is one of the most important wild fruit crops of India. The species is indigenous to South-east Asia, particularly central and southern India, where it is preferred for cultivation since time immemorial. The species is quite hardy and found mostly in dry deciduous forests in the country. The fruit is highly nutritious and regarded as the richest source of vitamin C (400-1300 mg/100 g). Medicinally, it is an important constituent of chyavanprash and triphala-the ayurvedic tonic. The species is also used to cure chronical infections of ear, nose and throat and widely used for gastrointestinal disorders and stomach ailments. It is also used in tannin and dyeing industries in the country.

Methodology

The experiment was conducted in polyhouse of the Department of Silviculture and Agroforestry, Dr. Y. S. Parmar UHF, Nauni, Solan from march 2013 to April 2014 till outplanting. Seeds were raised in 4 type of container i.e. 9x4.5″polybag with 8 side perforations (C_1), 9x4.5″with 8 side and 8 bottom perforations (C_2), 7x4.5″with 8 side perforations (C_3), 7x4.5″with 8 side and 8 bottom perforations (C_4), Root trainers 300cc (C_5) and growing media soil, sand and FYM (1:1:1)(M_1), soil, sand and mushroom compost (1:1:1) (M_2), soil, sand and mushroom compost (1:1:2) (M_3), soil, sand and mushroom compost (1:1:3) (M_4), Soil, sand and vermicompost (1:1:1) (M_5) and soil, sand and compost(1:1:2) (M_6). The experiment was in Randomized Block Design (factorial), no. of treatment combinations were 30 and replicated thrice.

Fig 1: *Emblica officinalis* seedlings raised in the containers

Growing medium preparation

Mushroom compost, vermicompost, FYM, sand and soil were sieved with a fine mesh (1cm²) to remove the undecomposed part, stones and other foreign material and then the media for respective treatments were prepared by mixing different ingredients in required proportions.

Table 1: Main features of containers

Containers	Volume (cc)	Length (cm)	Top diameter (cm)	Growing density/m²
C_1	1130	22.50	8.00	169
C_2	1130	22.50	8.00	169
C_3	955.17	19.00	8.00	150
C_4	955.17	19.00	8.00	150
C_5	300	15.00	7.00	148

After sowing, weeding was done regularly as and when required and seedlings irrigated twice a day during summer months.

Results and Discussion

Seedlings raised in polybag of size 9 x 4.5" having eight side + eight bottom perforations, filled with medium consisting of soil + sand + mushroom compost (1:1:2) (M_3C_2) resulted in significantly maximum germination of 76.00 per cent. This was however, closely followed by seedlings raised in M_2C_1 and M_3C_4 each giving a value of 74.67 per cent in this regard. This was at par with the seedlings raised in M_4C_2 (71.00%), M_6C_4 (68.33%), M_3C_5 (64.00%) and M_3C_3 and M_5C_1 each giving a value of 63.67 per cent in this regard. The significantly least value of 21.33 percent was obtained for M_2C_5 consisting of root trainer (300cc) filled with soil + sand + vermicompost (1:1:1). The growing medium M_3 medium of soil + sand + mushroom compost (1:1:2) in polybag C_2 attained significantly maximum height growth (51.89cm) of the seedlings. It was closely followed by M_3C_3 combination treatment giving value of 49.03cm of the seedlings. This was however, followed by M_4C_2, M_2C_4 and M_3C_4 treatment combinations giving values of 47.25cm, 46.06cm and 45.97cm respectively in that order. The treatment combination M_1C_5 produced the significantly smallest seedling height (27.82cm) growth in the species. Similarly, polybag of size 9 x 4.5" having eight side + eight bottom perforations (C_2) filled with growing media of soil + sand + mushroom compost (1:1:2) (M_3) mixture, resulted in significantly highest collar diameter of 3.90mm, being superior to all other combinations in this regard. This was however, closely followed by M_5C_2, M_2C_1, M_2C_5 and M_2C_3 treatment combinations giving values of 3.63mm, 3.50mm, 3.46mm and 3.45mm respectively in descending order. The treatment combination M_1C_5 resulted in significantly least diameter growth of 2.45mm in the seedlings. The interaction of container type and growing medium was found to exert significant influence on root length of *Emblica officinalis* seedlings (Table 2). The significantly maximum root length (34.41cm) was observed in M_3C_2 treatment combination, being superior compared to other treatment combinations. This was closely, followed by M_5C_4 (31.52cm), M_5C_2 (31.3cm), M_3C_5 (31.27cm), M_3C_1 (30.95cm) M_3C_4 (30.89cm), M_6C_2 (30.88cm), M_2C_3 (30.82cm), M_3C_3 (30.68cm), M_5C_3 (30.19cm) and M_4C_1 (30.13cm) treatment combinations giving values in descending order. The significantly minimum root length (21.08cm) was recorded in M_1C_5 treatment combination.

Moreover, treatment M_3C_2 recorded significantly maximum dry root weight of 3.19g in the seedlings. This value however, was statistically at par with M_3C_1 (3.15g), M_4C_4 (3.09g), M_3C_4 (2.98 g), M_3C_3 (2.96g) M_4C_2 (2.92g), M_5C_2 (2.67g), M_5C_3 (2.64g), M_1C_2 (2.63g), M_4C_3 (2.59g) and M_6C_2 (2.52g). The significantly least root weight (1.66g) however, was recorded in seedling raised with M_1C_3 treatment combination. For dry shoot weight seedlings raised in polybag (C_2) containing growing medium M_3 recorded significantly maximum value 4.23g in the seedlings. This was however, followed by M_3C_1 treatment combination giving values of 3.66g. The significantly minimum shoot weight (2.0g) was observed in

M_1C_1 treatment combination. On the other hand significantly maximum root-shoot ratio (0.95) was registered by M_4C_4 treatment combination. This was however, statistically at par with M_3C_3 (0.91), M_1C_1, M_1C_2, M_4C_3 and M_5C_3 each giving a value of 0.89, M_3C_4 (0.88), M_1C_4 and M_3C_1 each giving a value of 0.85, M_2C_5 and M_4C_2 each giving a value of 0.83 and M_6C_3 (0.82) in this regard. However, significantly minimum value was recorded in M_2C_3 treatment combination giving value of 0.55.

Table 2: Effect of growing media and container type on germination and other growth parameters of *Emblica officinalis* gaertn. Seedlings

Treatment	Germination (%)	Height growth (cm)	Collar diameter (mm)	Root length (cm)	Dry root weight (g)	Dry shoot weight (g)	Root-shoot ratio	Stock quality index
M_1C_1	48.33 (44.02)	35.14	2.69	26.58	1.77	2.00	0.89	0.26
M_1C_2	61.00 (51.66)	36.48	3.50	26.06	2.63	2.94	0.89	0.47
M_1C_3	43.33 (41.02)	36.47	2.89	28.87	1.66	2.72	0.61	0.32
M_1C_4	42.67 (40.63)	33.01	3.19	23.26	1.71	2.02	0.85	0.33
M_1C_5	37.33 (37.28)	27.82	2.45	21.08	1.70	2.75	0.62	0.38
M_2C_1	74.67 (59.86)	38.79	3.50	28.47	2.19	3.00	0.73	0.42
M_2C_2	66.67 (55.73)	34.4	2.84	27.99	2.29	2.88	0.79	0.4
M_2C_3	54.00 (47.29)	45.07	3.45	30.82	1.94	3.32	0.55	0.31
M_2C_4	52.33 (46.33)	46.06	3.30	28.56	2.36	3.50	0.67	0.38
M_2C_5	21.33 (27.08)	37.57	3.46	28.13	2.13	2.54	0.83	0.37
M_3C_1	63.00 (52.55)	44.44	3.73	30.95	3.15	3.66	0.85	0.48
M_3C_2	76.00 (60.69)	51.89	3.90	34.41	3.19	4.23	0.76	0.51
M_3C_3	63.67 (53.22)	49.03	3.39	30.68	2.96	3.25	0.91	0.4
M_3C_4	74.67 (59.84)	45.97	3.32	30.89	2.98	3.38	0.88	0.42
M_3C_5	64.00 (53.43)	38.42	3.22	31.27	2.38	3.43	0.67	0.42
M_4C_1	57.00 (49.01)	45.89	3.05	30.13	2.51	3.21	0.74	0.33
M_4C_2	71.00 (57.43)	47.25	3.15	27.88	2.92	3.50	0.83	0.39
M_4C_3	52.00 (45.99)	44.43	2.58	28.94	2.59	2.90	0.89	0.3
M_4C_4	42.67 (40.54)	40.12	3.12	28.88	3.09	3.26	0.95	0.46
M_4C_5	43.00 (40.96)	36.99	3.10	21.93	1.91	2.41	0.67	0.23
M_5C_1	63.67 (53.22)	33.74	2.90	26.99	1.84	2.26	0.81	0.32
M_5C_2	62.67 (52.4)	42.55	3.63	31.30	2.67	3.39	0.78	0.45
M_5C_3	46.67 (42.96)	30.70	2.69	30.19	2.64	2.99	0.89	0.44
M_5C_4	48.00 (43.84)	38.37	3.16	31.52	1.96	2.99	0.65	0.37
M_5C_5	41.33 (39.91)	36.64	3.73	25.22	2.01	2.41	0.82	0.38
M_6C_1	48.00 (43.71)	40.14	3.24	24.35	2.70	3.28	0.78	0.41
M_6C_2	57.33 (49.2)	44.07	3.50	30.88	2.52	3.20	0.79	0.41
M_6C_3	48.67 (44.2)	33.18	3.45	25.74	2.04	2.49	0.82	0.41
M_6C_4	68.33 (55.8)	35.82	3.37	29.97	1.92	2.35	0.81	0.33
M_6C_5	60.00 (50.83)	30.54	2.79	27.12	2.03	2.33	0.71	0.35
SE+	6.37	3.94	0.38	2.97	0.35	0.35	0.90	0.07
$CD_{0.05}$	12.76	7.88	0.76	5.94	0.71	0.71	0.19	0.14

Figures in the parenthesis are arc sin transformed values

M_1C_1 (medium consisting of soil, sand and FYM 1:1:1 ratio in poly bag of size 9x4.5″with 8 perforations); M_1C_3 (consisting of soil, sand and FYM 1:1:1 ratio in poly bag of size 7x4.5″with 8 bottom perforations); M_1C_5 (medium consisting of soil, sand and FYM 1:1:1 ratio in root trainers 300cc); M_2C_3 (medium consisting of soil, sand and mushroom compost 1:1:1 ratio in poly bag of size 7x4.5″with 8 perforations); M_2C_5 (medium consisting of soil, sand and mushroom compost 1:1:1 ratio in root trainers 300cc); M_3C_2 (medium consisting of soil, sand and mushroom compost 1:1:2 ratio in poly bag of size 9x4.5″with 16 perforations); M_4C_4 (medium consisting of soil, sand and mushroom compost 1:1:3 ratio in poly bag of size 7x4.5″with 16 bottom perforations).

It is apparent from the data in table 2 that significantly maximum stock quality index of 0.51 was recorded in M_3C_2 treatment combination. This value was however, closely followed by M_3C_1 (0.48), M_1C_2 (0.47), M_5C_2 (0.45), M_5C_3 (0.44), M_1C_2, M_2C_1, M_3C_4 and M_3C_5 (0.42 each), M_6C_1, M_6C_2 and M_6C_3 (0.41 each) giving values in descending order. Significantly minimum stock quality index of 0.26 was recorded in M_1C_1 treatment combination. The results might be attributed to larger container size 1131cc and side + bottom perforations with good amount of growing mixture, good porosity, good moisture retention and low plant density, which helped in faster and better growth of the seedling. The results are thus, in agreement with the findings of Chand (2008) who reported that growing media and container type interacted positively and performed better in the form of growth and biomass of *Terminalia chebula*, *Terminalia bellirica and Emblica officinalis* seedlings.

Earlier, Magotra (2005) [9] had also found that interaction between growing media and container type significantly affected the growth and biomass in *Dendrocalamus strictus and Dendrocalamus hamiltonii*. Similar results were recorded by Thakur *et al*. (2000) [13] in *Terminalia chebula* and Kumar *et al*. (2005) [7] in *Pinus roxburghii* where they found that size of container significantly affected plant growth under each growing media. Similarly, the dry weight of stock was significantly affected by interactions between bag size and potting mixtures (Mishra and Jaiswal, 1993) [10]. The reason for varied seedling growth in container and media interactions might be attributed to the variation in container size and nature of potting mixture which control the moisture retention capacity, aeration and nutrient availability to the seedlings (Jabula and Sargenta 1977) [6]. The growing medium in combination with container size has a significant role in carrying capacity of potting mixture, favorable pH, EC and availability of nutrients. The larger volume of container size and low growing density allowed the seedlings to grow vigorously and healthy compared to smaller size container. The favorable results might also be due to larger container

size supporting seedling for longer periods by providing nutrients and moisture as these are the basic requirements for establishment and faster growth as suggested by Gupta *et al.* (1992) [5].

Many other researchers have also observed similar influence of growing media x container type interaction on seedling growth and development. For example, Bahuguna and Pyare Lal (1990) [2] in *Acacia nilotica*; Rathore *et al.* (2004) [11] in *Casuarina equisetifolia*; Al-Menaie *et al.* (2010) [1] in *Cassia nodosa* and *Cassia fistula* and Lambert *et al.* (2010) [8] in *Taxodium distichum*, *Acer rubrum* and *Pinus palustris*.

Conclusion

The combination M_3C_2 i.e. polybag (C_2) of size 9"x4.5"with eight side + eight bottom perforations filled with soil, sand and mushroom compost in the ratio of 1:1:2 (M_3) exhibited significantly maximum values for germination per cent, growth and biomass parameters (height growth, collar diameter and root length) in the seedling.

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