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Standardization of media and container for improving seed and seedling growth in papaya (*Carica papaya*) cv. Red Lady

POOJA PANT[1]* and M K VERMA[2]

Shree Guru Gobind Singh Tricentenary University, Gurgaon, Haryana 122 505, India

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ABSTRACT

An experiment was conducted to standardize the suitable media and type of the container for improving seed germination and seedling growth of papaya (*Carica papaya* L.) cv. Red Lady during 2019–20. Five different types of media and three types of containers were used for study. Present experiment was conducted in a Complete Randomized Block Design (Factorial) with 15 treatment combinations replicated thrice. The observations were recorded on seed germination attributes and seedling growth parameters. The results showed that the plastic containers were found better followed by earthen pots and polybags using media mixture of soil + cocopeat + vermicompost (1:1:1) for improving seed germination (94.76%). However, the maximum plant height (17.40 cm), number of leaves (12.03), stem girth (6.42 mm), leaf area (131.02 cm^2), root length (18.60 cm) and seedling survival (97.30%) was observed in the earthen pots having rooting media mixture made up of garden soil + cocopeat + vermicompost + FYM (1:1:1:1). The seed germination and plant growth parameters, root length and seedling survival was recorded in polybags.

Keywords: Container, Germination, Media, Papaya, Seedling growth

Red Lady is choicest variety for papaya (*Carica papaya* L.) cv. Red Lady, growers in India and abroad due to its gynodioecious nature, precocious bearing, prolonged shelf life and tolerance to papaya ring spot virus. But the seed cost of Red Lady is very high (approx. 4.0 lakh per kg); therefore, increasing germination percent and maintaining low seedling mortality is the major challenge for growers. Initial mortality and incomplete germination are one of the causes of reduced survival percentage of papaya plants. High quality papaya seedlings for the formation of plants with high genetic potential can ensure the success of fruit production (Albano *et al*. 2014). Seedling quality is associated with factors such as adequate formation; robust and well-distributed root system and low relationship between shoot and root phytomass (Costa *et al*. 2015, Sanches *et al.* 2017). Use of suitable growing media is essential for production of healthy plants as it is directly affects the development and later maintenance of the extensive functional rooting system. Media composition used influences the quality of seedling (Wilson *et al*. 2001).

The container type also has great importance in seed germination and seedling growth. Plants grown in pots have nearly all of the roots remain in the ball of earth at the time of transplanting; whereas plants grown in flats or seedbed, many roots are lost during transplanting (Haber 2017). In general, container grown plants have a different root morphology than field seeded crops. The selection of correct containers and substrates allow a better use of other inputs employed in their production, providing saving in seed costs, ease in cultivation and a reduction of failures in the planting area, resulting in a greater economic efficiency in the cultivation (Kano *et al.* 2008). Container geometry and media selection also have a pronounced effect on soil moisture content and aeration. Based on the aforementioned and taking into account the wide range of containers and growing medium available for the production of seedlings, the aim of this study was to evaluate the seed and seedling growth of papaya under different media combinations and container types.

MATERIALS AND METHOD

Studies on seed and seedling growth were carried out on papaya variety Red Lady during 2019–20 at Horticulture Research Farm of Shree Guru Gobind Singh Tricentenary University, Gurugram, Haryana. The experiment was laid out in factorial RBD with two factors, viz. media at five levels, viz. T_1: Garden Soil + FYM (1:1), T_2: Garden Soil + Cocopeat+ FYM (1:1:1), T_3: Garden Soil + Vermicompost + FYM (1:1:1), T_4: Garden Soil + Cocopeat + Vermicompost (1:1:1), T_5: Garden Soil + Cocopeat + Vermicompost + FYM (1:1:1:1) and containers of three types, viz. Earthen pot (C_1), Plastic pot (C_2) and Polybag (C_3). The seed sowing was done in July (2019) about 2 cm deep in different containers with

[1]Shree Guru Gobind Singh Tricentenary University, Gurgaon, Haryana; [2]ICAR- Indian Agricultural Research Institute, New Delhi. *Corresponding author email: poojapant17@gmail.com

different media as per the treatments. The containers were irrigated immediately after sowing and repeated everyday till the final emergence. After the completion of germination, the containers were irrigated once in two days.

Observation on germination parameters was recorded from the first germination until no further germination at two days interval. The imbibition period, number of days from sowing to commencement of germination was recorded for all treatments. Germination percentage was calculated by number of germinated seedlings divided by total number of seed sown in containers multiplied by 100. The germination period was calculated as the difference between initial and final emergence (number of days) recorded. Seed vigour was calculated as:

$$\text{Seed vigour} = \frac{\text{Total number of healthy seedlings}}{\text{Total number of seedlings}} \times 100$$

Data on growth parameters were recorded at the time of transplanting (45 days after sowing). Seedling height was measured with a metric scale and consisted of distance from plant collar to its apex, while stem girth was measured using Vernier caliper. Counting of number of leaves was done after emergence of true leaves. Leaf area was calculated by leaf area meter model no EMP-171492. Root length was measured by uprooting the plant. Seed vigour index was calculated as (Gupta 1993):

$$\text{Seed vigour index} = \text{Germination percent} \times \text{seedling length}$$

Survival percent was recorded as:

$$\text{Survival percent} = \frac{\text{Total survived transplanted plants}}{\text{Total transplanted plants}} \times 100$$

All data was subjected to analysis of variance (ANOVA) to determine significant differences and comparison of mean at a significant level of 5%.

RESULTS AND DISCUSSION

Seed germination attributes: Perusal of data (Table 1) showed that all seed germination parameters were significantly affected by different growing media composition and type of container. Growing media having Garden Soil + Cocopeat + Vermicompost + FYM (1:1:1:1) i.e. T_5 showed significant effect on imbibition period and germination period and recorded lowest imbibition period (9.44 days) and germination period (2.58 days), whereas growing media having Garden Soil + FYM (1:1) (T_1) recorded highest imbibition period (13.73 days) and germination period (6.41 days). Between containers, C_2 (plastic container) recorded significantly lowest imbibition period (10.89 days) and germination period (3.92 days) as compare to C_1 and C_3. Germination period of papaya seeds in earthen pot (C_1) and poly bag (C_3) was at par. Interaction between media and container type was also found significant for both the characters and the lowest imbibition period (8.97 days) and germination period (2.30 days) was recorded with media having Garden Soil + Cocopeat + Vermicompost + FYM (1:1:1:1) in plastic container ($T_5 \times C_2$).

Table 1 Effect of media and container type on seed germination and seedling growth of papaya cv. Red Lady

Treatment	Imbibition period (Days)				Germination (%)				Germination period (Days)				Seed vigour (%)				Seedling height (cm)				Stem girth (mm)			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
T_1	13.82	13.14	14.23	13.73	68.23	71.27	65.80	68.44	6.28	6.35	6.61	6.41	61.94	64.07	61.94	62.65	10.57	9.71	9.41	9.90	3.89	2.87	2.11	2.96
T_2	11.48	10.90	11.78	11.39	87.18	85.73	76.05	82.98	3.70	3.41	4.36	3.82	78.17	79.43	60.21	72.60	14.15	13.50	13.15	13.60	4.86	4.37	3.90	4.38
T_3	12.76	11.67	12.76	12.40	72.06	76.11	70.14	72.77	5.34	5.16	5.66	5.39	71.70	75.08	74.18	73.65	12.27	11.64	10.91	11.60	4.29	3.74	3.51	3.85T3
T_4	10.18	9.78	11.24	10.40	87.31	90.51	84.64	87.49	3.86	2.65	3.36	3.29	84.43	88.18	70.34	80.98	16.05	16.78	15.56	16.13	5.01	4.55	4.33	4.63
T_5	9.53	8.97	9.81	9.44	89.62	94.76	87.28	90.55	2.64	2.03	3.08	2.58	91.18	92.73	81.97	88.63	19.40	18.68	18.17	18.75	6.42	4.50	3.90	4.94
Mean	11.56	10.89	11.96	11.47	80.88	83.68	76.78	80.45	4.36	3.92	4.61	4.30	77.48	79.90	69.73	75.70	14.49	14.06	13.44	14.00	4.90	4.01	3.55	4.15
CD ($P<0.05$)	Treatment (T) – 0.17				Treatment (T) – 1.78				Treatment (T) – 0.31				Treatment (T) – 2.52				Treatment (T) – 0.31				Treatment (T) – 0.41			
	Container (C)– 0.13				Container (C)– 1.38				Container (C)– 0.24				Container (C)– 1.95				Container (C) – 0.24				Container (C) - 0.32			
	T×C– 0.30				T×C – 3.07				T×C– 0.54				T×C– 4.36				T×C- 0.54				T×C- 0.72			

*T_1, Garden Soil + FYM (1:1); T_2, Garden Soil + Cocopeat+ FYM (1:1:1); T_3, Garden Soil + Vermicompost + FYM (1:1:1); T_4, Garden Soil + Cocopeat + Vermicompost (1:1:1); T_5, Garden Soil + Cocopeat + Vermicompost + FYM (1:1:1:1). **C_1, Earthen container; C_2, Plastic container; C_3, Polybags.

Among the different treatments, maximum germination (Fig 1) percent (90.55%) and highest seed vigour (88.63%) was obtained with media Garden Soil + Cocopeat + Vermicompost + FYM (1:1:1:1) (T_5) which was significantly higher than other treatments. Garden Soil + FYM (1:1) (T_1) showed minimum germination percent (68.44%) and lowest seed vigour (62.65%). Between containers, maximum germination percent (83.68%) and highest seed vigour (79.90%) was obtained with plastic container (C_2), whereas, polybags (C_3) showed the least results in both cases. The interaction between media and container type was also found significant in increasing germination percent and seed vigour. Maximum value of germination percent (94.76%) and seed vigour (92.73%) was found with media having Garden Soil + Cocopeat + Vermicompost + FYM (1:1:1:1) in plastic container ($T_5 \times C_2$). The reason for best performance of Garden Soil + Cocopeat + Vermicompost + FYM is high organic matter content which increases the water and nutrient holding capacity of the medium, leading to improve the water utilization capacity of plant. Vermicompost and soil provides a uniform physical structure which ensures close contact between seeds and media, increases balanced moisture supply, facilitates root respiration and encourages overall plant growth. It exhibits a beneficial effect on soil health and all these germination parameters might have enhanced the seed germination and seedling growth of papaya at the initial stage. The similar results were also reported by Bhardwaj (2014) and Arvind *et al*. (2015) in papaya seedlings and Yadav (2012) in acid lime. Better germination traits could be attributed due to less evaporation of moisture from plastic pots ultimately provides congenial conditions for fast germination. Similar results were obtained in by Saroj *et al.* (2000) in aonla and Vaghamshi and Delvadia (2006) in mango seedling.

Seedling growth attributes: Data (Table 1 and 2) showed that all seedling growth attributes of papaya cv. Red Lady were significantly influenced by different media composition, container types and their interaction. Among the treatments, T_5 i.e. media having Garden Soil + Cocopeat + Vermicompost + FYM (1:1:1:1) recorded maximum seeding height (18.75 cm), stem girth (4.94 mm) and root length (17.59 cm) and T_1 i.e. Garden Soil + FYM (1:1) recorded minimum seeding height (9.90 cm), stem girth (2.96 mm) and root length (9.80 cm). Between containers, maximum seedling height (14.49 cm), stem girth (4.90 mm) and root length (15.01 cm) were recorded in earthen container (C_1), whereas polybags (C_3) showed minimum seeding height (13.44 cm), stem girth (3.55 mm) and root length (13.31 cm). The interaction between media and container recorded maximum seeding height (19.40 cm), stem girth (6.42 mm) and root length (18.60 cm) with media having Garden Soil + Cocopeat + Vermicompost + FYM (1:1:1:1) in earthen container ($T_5 \times C_1$).

Similarly, maximum value for number of leaves (10.67) and leaf area (118.13 cm^2) was obtained with media having Garden Soil + Cocopeat + Vermicompost + FYM (1:1:1:1) (T_5), whereas the minimum value for

Table 2 Effect of media and container type on seedling growth of papaya cv. Red Lady

Treatment	Number of leaves				Leaf area (cm^2)				Root length (cm)				Seed vigour index				Survival percent (%)			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
T_1	6.19	5.45	4.86	5.50	50.51	43.03	35.97	43.17	10.58	9.76	9.06	9.80	1443.44	1388.44	1215.17	1349.02	76.43	72.48	68.57	72.50
T_2	9.85	8.61	7.59	8.69	89.29	80.73	72.74	80.92	15.22	14.65	14.29	14.72	2559.37	2413.83	2086.75	2353.32	87.26	81.15	76.23	81.55
T_3	9.52	8.51	8.10	8.71	68.63	60.09	50.87	59.86	13.66	12.07	11.31	12.34	1869.05	1804.26	1556.19	1743.17	85.01	79.71	74.55	79.76
T_4	10.58	9.51	8.76	9.62	117.26	101.88	86.48	101.87	16.96	16.27	15.23	16.16	2881.85	2991.11	2605.98	2826.31	93.81	86.09	79.46	86.45
T_5	12.03	10.52	9.46	10.67	131.02	119.90	103.46	118.13	18.60	17.52	16.66	17.59	3405.34	3430.81	3040.43	3292.19	97.30	88.35	82.44	89.36
Mean	9.64	8.52	7.76	8.64	91.34	81.13	69.91	80.79	15.01	14.06	13.31	14.12	2431.81	2405.69	2100.90	2312.80	87.97	81.56	76.25	81.92
CD ($P<0.05$)	Treatment (T) – 0.24 Container (C) – 0.19 T×C - 0.42				Treatment (T) - 3.435 Container (C) - 2.66 T×C- 5.95				Treatment (T) - 0.245 Container (C) - 0.19 T×C - 0.425				Treatment (T) - 53.125 Container (C) - 41.15 T×C - 92.02				Treatment (T) - 1.61 Container (C) - 1.25 T×C - 2.79			

*Treatment details are given in footnote of Table 1.

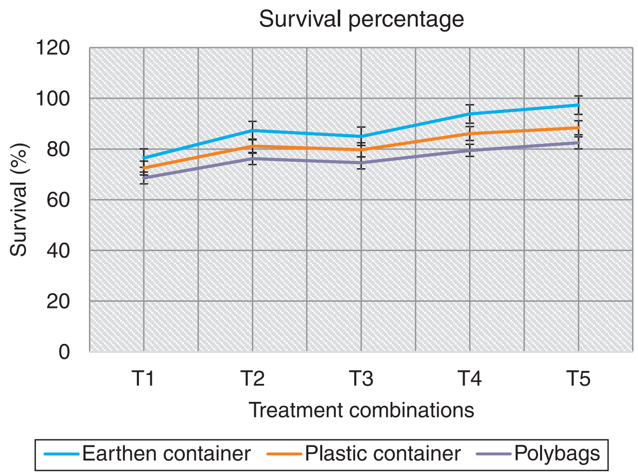

Fig 1 Effect of media mixture and types of containers on the seed germination. *Treatment details given in footnote of Table 1.

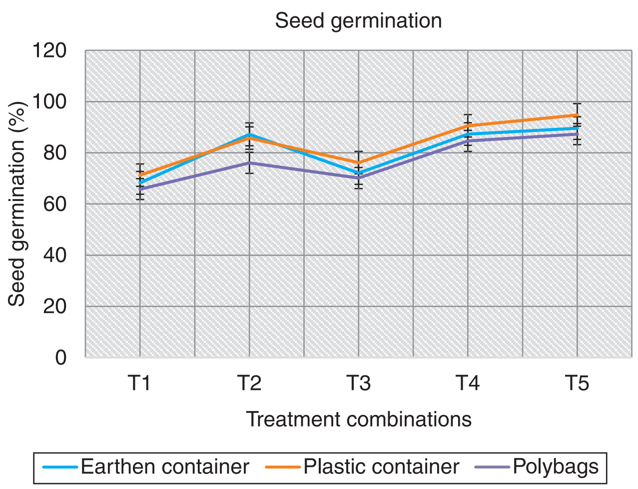

Fig 2 Effect of media mixture and types of containers on the survival of papaya seedlings. *Treatment details given in footnote of Table 1.

number of leaves (5.50) and leaf area (43.17 cm^2) was obtained with media having Garden Soil + FYM (1:1) (T_1). Between containers, maximum value for number of leaves (9.69) and leaf area (91.34 cm^2) was obtained from earthen container (C_1), while minimum value for number of leaves (7.76) and leaf area (69.91 cm^2) was obtained from polybags (C_3). The combined effect of media with Garden Soil + Cocopeat + Vermicompost + FYM (1:1:1:1) in earthen container ($T_5 \times C_1$) recorded maximum value for number of leaves (12.3) and leaf area (131.02 cm^2). In case of seed vigour index, treatments T_5 i.e. Garden Soil + Cocopeat + Vermicompost + FYM (1:1:1:1) and T_1 i.e. Garden Soil + FYM (1:1) showed highest (3292.12) and lowest (1349.02) values, respectively. Similarly, Container C_1 (earthen container) and C_3 (polybags) recorded highest (2431.81) and lowest (2100.90) values of seed vigour index, respectively. The interaction between media and container recorded highest value of seed vigour index (3430.81) with media having Garden Soil + Cocopeat + Vermicompost (1:1:1) in earthen container ($T_4 \times C_1$). Highest survival (Fig 2) percent (89.36%) of papaya seedling was obtained in media having Garden Soil + Cocopeat + Vermicompost + FYM (1:1:1:1) (T_5) and lowest (72.50%) was obtained under T_1 i.e., Garden Soil + FYM (1:1). Earthen container (C_1) and polybags recorded highest (87.97%) and lowest (76.25%) survival percent, respectively. The combined effect of media with Garden Soil + Cocopeat + Vermicompost + FYM (1:1:1:1) in earthen container ($T_5 \times C_1$) recorded highest survival percent (97.30%).

Promising results in seedling growth and development with combined application of vermicompost, cocopeat and FYM in the treatment T_5 might be attributed to the conducive effect of this media composition on water holding capacity, porosity, soil aeration and supplying substantial amount of nutrient specially nitrogen and micro nutrients for improving root and shoot growth (Chopde *et al.* 1999). Increase in number of leaves and leaf area might be due to better nutrient availability leading to higher production of photosynthetically functional leaves by growing media. Cocopeat and vermicompost had positive effect on root development, which is helpful in increasing survival percent of seedling in main field after transplanting (Abirami *et al.* 2010). The similar results were obtained by Yadav (2015) in papaya. Superior growth traits in earthen container might be due to favourable conditions for better growth of the seedling, particularly for good development of a root system because in these pots there was less coiling of roots. Due to more root growth, seedlings absorbed more nutrients and thus produced seedlings with more number of leaves and increase the photosynthesis which leads to increase fresh weight of seedlings and there by dry weight of seedlings. Furthermore, earthen container permit to leach out excess amount of irrigation water and porous surface facilitates aeration which leads to better growth and development of seedlings. These findings are in close conformity with Arvind *et al*. (2015) in papaya and Vaghamshi and Delvadia (2006) in mango.

So, on the basis of results obtained from present study, it can be concluded that the growing media and container type significantly influenced the germination and growth parameters of papaya variety Red Lady.

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