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Standardization of potting media and nutrition protocol for raising acid lime seedling in containerized nursery

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ABSTRACT

The study was carried out on acid lime (*Citrus aurantifolia*) to investigate nutritional requirements *vis-a-vis* potting media i.e. potting mixture and cocopeat in primary and secondary protected citrus nursery with regard to nutrient availability and growth behaviour to shorten time required for production of seedlings. Three types of potting media *viz*., potting mixture (PM), sole cocopeat (CP) and mixture of PM and CP were used. Nutrient application treatments (NPK in g) for primary nursery were 60+25+25, 40+25+25 and 20+10+10, and for secondary nursery were 10+5+5, 8+4+4, 6+3+3, 4+2+2 and control. The results revealed that in primary nursery, seedling emergence and survival was maximum in PM + CP mixture. Plant height and leaf chlorophyll content was highest with the application of 40+20+20 in PM + CP media while number of leaves were highest in 20+10+10 g NPK in the same media. The highest dry weight of all the plant parts was obtained in PM + 20+10+10 g NPK. Extreme variation in soil pH (4.27-7.12), electrical conductivity (0.46-2.06 dS/m), organic carbon (2.19-23.6 %) as well as available N (180.6 – 1679.8 kg/ha), P (7.8 – 39.8 kg/ha) and K (1253.2 – 4894.5 kg/ha) was recorded under different treatments at the end of the experiment. In secondary nursery application of lowest dose of fertilizer i.e. 4+2+2 g NPK in PM + CP mixture recorded maximum plant height, number of leaves and chlorophyll content while stem girth was maximum in same dose applied with PM. Application of 4+2+2 g NPK in PM also had similar results without any plant mortality. Presented results showed that cocopeat, if cheaply available, can be used by mixing it with nursery potting mixture (50%) with supplementation of minimal dose of fertilizers for producing both types of nursery plants.

Key words: *Citrus aurantifolia*, primary nursery, nutrient dose, cocopeat.

INTRODUCTION

Acid lime is one of the most important commercially grown citrus species. India is the largest producer of acid lime in the world. In India area under acid lime is 0.282 million ha with the production of 2.54 million MT and productivity of 10.07 MT/ha (NHB, 11). Acid lime is one of the most common lime cultivars mainly grown in Andhra Pradesh, Tamil Nadu, Maharashtra, Gujarat, Rajasthan and Bihar states of India. It's adaptability to varied agroclimatic and soil conditions, low input cost, fruit bearing capacity thoroughout the year, better keeping quality and consistent demand in the domestic market have boosted its cultivation, mostly in semi-arid regions of central and western India.

The total demand for citrus seedlings in India is 14.0 million and mainly produced in open field (90-100%). However with the infestation of citrus canker (*Xanthomonas axonopodis* pv citri), due importance has been given for the production of disease free planting material in protected environment. Containerized nurseries facilitate improvement in citrus orchard efficiency by avoiding disease perpetuation. Current nutritional programmes for citrus nurseries emphasize maximum growth as preferred by growers with the sole application of nitrogenous fertilizers that too for open field nursery (Deshmukh and Joshi, 2). It ranged from 1000 to 3000 kg of N/ha/ annum, which leads to lanky and nutritionally imbalanced shoot growth of the seedlings leading to increased susceptibility to several pests and diseases. Research based fertilizer recommendations, especially with regard to nutrient dose, fertilizer source, toxicities, antagonistic or synergistic effects of nutrients in nursery plants is severely lacking for primary and secondary containerized nursery. By suggesting proper nutrient management schedules, we can reduce the multiplication time and thereby reducing production cost considerably. On the other hand the growers will get cheap, healthy and nutritionally balanced seedlings. The nurseryman will produce healthy seedling which will reduce incidence of canker disease and increase longevity of acid lime orchards.

Since last few years cocopeat, also known as coir dust or coconut mesocarp, a natural fiber made out of coconut husks, has been considered as a renewable substitute for potting media for the use in horticulture nurseries includes vegetables and floriculture (Yau and Murphy, 15; Treder, 13).

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However, it needs to be tested for raising acid lime nursery. With this background, an experiment was conducted in containerized nursery to standardise the nutritional requirements *vis-s-vis* potting media for acid lime in primary and secondary nursery under protected environment.

MATERIALS AND METHODS

Experiments were conducted during 2014–2017 in a containerized nursery of ICAR – Central Citrus Research Institute, Nagpur India. The climate of the study area was tropical dry sub-humid with hot and dry summer and mild winter with a mean annual maximum and minimum temperature of 40.4 °C and 14.9 °C, respectively. The average annual rainfall of about 983.3 mm occurs mostly during the months of July–September.

Primary nursery comprised of the activities of seed sowing, seed emergence and growth of seedling till it attained the height of 30 cm, which often takes nearly six months period. Plastic trays of 40 cm × 30 cm × 10 cm (length × breadth × depth) size having capacity to hold 8 to 10 kg potting mixture was used in primary nursery for growing the seedlings. In primary nursery, an experiment was laid out in a randomized block design with 3 replications having 2 trays per replication. Three type of potting media included regularly used solarized mixture of soil, sand and well decomposed farm yard manure (4:3:3 v/v) (PM), sole coco-peat (CP) and mixture of PM + CP in 1:1 ratio. In each tray, 200 seeds were manually sown in 10 rows with 20 seeds in each row and data on seedling emergence was recorded. Three nutrient doses viz. 60 g N + 25 g P + 25 g K, 40 g N + 25 g P + 25 g K, 20 g N + 10 g P + 10 g K were applied on per tray basis after 25 days of seed emergence along with no fertilization control.

In secondary nursery, an experiment was laid out in a randomized block design using 3 types of potting media supplied with 4 nutrient doses with 3 replications having 4 plants per replication. Healthy seedlings with same vigour and growth (30 cm height) were selected from primary nursery and transplanted in polythene bags (30 cm × 18 cm) containing 2.5 kg different types of potting mixture as mentioned above. Seedlings were allowed to grow and establish for 15 days. Four nutrient doses viz. 10 g N + 5 g P + 5 g K, 8 g N + 4 g P + 4 g K, 6 g N + 3 g P + 3 g K, 4 g N + 2 g P + 2 g K per seedling were applied along with control (no fertilizer) treatment in all types of potting mixture.

At the end of the experiment, composite soil samples were collected from each tray / bag and analysed for various chemical properties and fertility status using standard procedures (Jackson, 6; Watanabe and Olsen, 14; Lindsay and Norvell, 7). Similarly, whole plants were uprooted, washed thoroughly and separated in roots, stem and leaves. Plant parts were washed and dried at 70°C till constant weight was attained. Dry weight of each plant part was recorded. In primary and secondary nurseries, various growth parameters like plant height and number of leaves were measured using a measuring stick, while stem thickness was measured monthly using digital vernier caliper. Chlorophyll content in the leaf was measured periodically and at the end of the experiment using chlorophyll meter (KONICA MINOLTA SPAD-502) as indicated by SPAD values.

To detect significant difference among different treatments and interaction, statistical analysis for shortest significant range tests was performed using OP Stat (Sheoran *et al*., 12).

RESULTS AND DISCUSSION

Extreme variations in the soil pH (4.27-7.12), electrical conductivity (0.46 - 2.06 dS/m) and organic carbon content (2.19-23.6 %) were recorded at the end of the experiment (Table 1). In treatments with PM, pH values (6.80-7.12) were in normal range for the growth of the plants, slightly acidic (5.29 - 5.66) in PM+CP and was strongly acidic (4.27 - 4.95) in coco-peat treatments which was detrimental for the normal plant growth of acid lime. Electrical conductivity (EC) values were very high in CP followed by PM+CP and was significantly lowest (0.69 – 0.79 dS/m) in PM. Application of different fertilizer doses increased EC values but remained at par with same potting media without fertilization. Organic carbon content was exceedingly high (20.6 - 23.6 %) in CP treatments. It was in normal range (2.19 – 2.67 %) in PM and (3.17 – 3.86 %) in PM+CP treatments. In PM and PM + CP treatments, organic carbon increases with the application of fertilizers except 60+25+ 25 g NPK.

At the end of the experiment, variation in soil available macronutrients was very high (Table 1). Availability of N (1679.8 kg/ha) and K (4894.5 kg/ha) was significantly highest in CP + 60 g N + 25 g P + 25 g K treatment while P availability (39.8 kg/ha)was maximum in PM + 60 g N + 25 g P + 25 g K treatment. In cocopeat, high initial amount of potassium and sodium were reported earlier by Treder (13). PM and PM+CP media contains optimum content of N and P in all the treatments while available K was extremely high in all the types of potting media. Significantly positive correlation between organic carbon of potting media and macro- and micro-nutrients was reported earlier in pomegranate (Marathe *et al*., 8; Marathe *et al*., 9).

Table 1. Physico-chemical properties and available nutrient contents as influenced by the growing medium and fertilizer doses.

Treatments N + P + K (g)	pH	EC (dS/m)	Organic carbon (%)	Available macro-nutrients (kg/ha)		
				N	P	K
Potting mixture (PM)	7.12	0.46	2.43	180.6	22.5	1253.2
PM + 60 + 25 + 25	6.8	0.65	2.19	283.8	39.8	2048.4
PM + 40 + 25 + 25	6.98	0.60	2.55	256.7	34.9	1806.8
PM + 20 + 10 + 10	6.93	0.51	2.67	226.7	29.2	1715.4
Cocopeat (CP)	4.95	1.71	22.3	1140.3	7.8	3223.0
CP + 60 + 25+ 25	4.27	2.04	20.6	1679.8	16.3	4894.5
CP + 40 + 25 + 25	4.38	2.06	21.3	1465.6	15.6	4784.0
CP + 20 + 10 + 10	4.46	1.86	23.6	1351.3	13.4	4423.8
PM + CP (1:1 v/v)	5.66	0.94	3.66	280.6	14.4	2081.8
PM + CP + 60 + 25 + 25	5.29	1.11	3.17	387.1	24.9	2924.6
PM + CP + 40 + 25 + 25	5.47	1.16	3.42	369.6	22.5	2647.6
PM + CP + 20 + 10 + 10	5.58	1.08	3.86	319.3	20.2	2455.8
CD (p=0.05)	0.42*	0.31*	2.80*	99.4*	5.47*	544.9*

Availability of N (1140.3-1679.8 kg/ha) and K (3223.0 – 4894.5 kg/ha) was excessive in CP treatments. Incorporation of CP in PM also increased availability of N and K. The increased availability of N and K in sole CP or its incorporation with PM is due to very high organic carbon content of this media. On the contrary P (8.4 – 17.8 kg/ha) availability under CP treatments was very less. Very low pH of this media might have resulted in fixation of P, thereby reducing P availability. In all types of media, considerable increase in availability of macronutrients was observed with the increasing dose of fertilizers. Highest increase by virtue of the highest application of nutrients was common in all media.

Emergence of seedlings (67.5 – 85.7 %) and its survival (25.8 – 97.6 %) till the end of the experimental period was affected significantly by growing media and fertilization (Table 2). Seedling emergence and survival was better in PM + CP followed by sole PM treatment and reduced with the application of fertilizers. Seedling emergence was significantly highest in PM +CP +20+10+10 g NPK treatment while survival was in PM + CP without any fertilization treatment. Application of higher fertilizers doses especially 60+25+25 g NPK was detrimental for the survival of seedlings in all types of potting media. Survival of the seedlings increased with the decreasing dose of fertilizers. Mortality of rough lemon seedlings to the extent of 49.6 % was reported with the application of 200 kg N per ha in open field nursery (Gunjkar *et al*., 5). Increased osmotic stress at higher fertilizer dozes could have reduced growth of the seedlings (Marathe *et al*., 10).

Plant growth in terms of plant height (3.9 – 26.9 cm) and number of leaves (4.06 – 15.38) was affected significantly by both growing media and nutrient application (Table 2). Amongst different types of media plant growth was more in PM as compared to the mixture of PM and CP. However, the fertilization in PM and CP combination and PM alone was at par in respect of plant height and number of leaves. The highest plant height and number of leaves of acid lime were recorded with the application of 40+20+20 and 20+10+10 g NPK in PM + CP media, respectively. Application of higher dose i.e. 1000 kg N ha^{-1} $annum^{-1}$ (Davis and Albrigo, 1) and 15 – 19 mg l^{-1} of irrigation water is common in many nurseries under the erroneous assumption that trees will become saleable sooner. In this experiment, excessive fertilizers dose i.e. 60+25+25 g NPK had detrimental effect on growth of the plants.

Chlorophyll content in the leaves (SPAD values) of acid lime significantly varied from 0.447 – 0.740 (Table 2). In all types of potting mixture chlorophyll content increased with the decreasing dose of fertilizers. Chlorophyll content of rough lemon was significantly better in PM + CP + 40+25+25 g NPK and PM + 20+10+10 g NPK treatments. Plants grown in cocopeat had almost yellow colour leaves as indicated by very low chlorophyll content (0.447 – 0.615) which could be attributed to findings of Yau and Murphy (15).

Table 2. Influence of growing medium and fertilizer doses on seedling emergence, survival and growth parameters in primary nursery.

Treatments N + P + K (g)	Seedling emergence (%)	Seedling survival (%)	Plant height (cm)	Number of leaves per seedlings	Leaf Chlorophyll content (SPAD value)
Potting mixture (PM)	80.3	97.3	18.9	12.62	0.702
PM + 60 + 25 + 25	80.2	72.3	18.4	9.54	0.688
PM + 40 + 25 + 25	84.5	90.7	20.2	12.76	0.733
PM + 20 + 10 + 10	78.0	97.6	21.2	15.38	0.740
Cocopeat (CP)	71.3	62.1	4.1	4.06	0.585
CP + 60 + 25+ 25	57.5	25.8	3.9	4.06	0.447
CP + 40 + 25 + 25	63.5	27.8	7.5	7.45	0.615
CP + 20 + 10 + 10	56.7	40.3	9.2	8.49	0.596
PM + CP (1:1 v/v)	82.0	98.8	15.4	10.97	0.664
PM + CP + 60 + 25 + 25	81.3	83.6	19.5	12.17	0.696
PM + CP + 40 + 25 + 25	82.8	93.6	26.9	14.87	0.740
PM + CP + 20 + 10 + 10	85.7	97.3	20.9	15.38	0.735
CD (p=0.05)	8.65*	27.4*	5.28*	2.54*	0.086*

The dry weight of various plant parts viz. leaves, stem, roots and total plant were significantly influenced by both growing media and nutrient doses (Table 3). Dry weight of leaves, stem, roots and of total plant varied from 0.11 – 7.15 g, 0.63 – 6.22 g, 0.53 – 3.99 g and 1.28 – 17.36 g respectively in primary nursery plants. The dry weight of plant parts grown in PM + CP was better as compared to sole PM without any fertilizer. The highest dry weight of all the plant parts was obtained on PM + 20+10+10 g NPK. It seems that proper nutrient supply and good physico-chemical conditions had positive effect on growth of the plants. Plants grown in cocopeat were unable to grow properly and recorded lowest dry weight of all the plant organs. Cocopeat, has been reported to contain phytotoxic elements which inhibit plant growth (Yau and Murphy, 15). PM with lowest dose of fertilizers performed superior in rough lemon while in rangpur lime at par with PM + CP combination with similar fertilizer doses.

In secondary nursery, all acid lime seedlings survived in sole PM and CP while plant mortality to the extent of 25% was observed in cocopeat media. In PM, no mortality was observed with the application of 6+3+3 and 4+2+2 g NPK while in PM + CP media, same dose of fertilizers recorded some mortality (11.7%) of acid lime seedlings (Table 4). Maximum plant growth in terms of height and number of leaves was observed with the application of 4+2+2 g NPK in PM + CP while stem girth was in PM+4+2+2 g NPK treatment. Both these treatments were at par with each other with regards to plant growth.

Increase in plant growth by virtue of the application of nutrients was common in all nursery plants. But higher dose of fertilizers rather made harm to the plants. Growth of the plants supplied with 10+5+5 g NPK was very less and recorded very high plant mortality (91.7 - 96.7 %), followed by plants supplied with 8+4+4 g NPK nutrients (66.7 – 90.0 % mortality). Distinct growth suppression effect with an increase

Table 3. Influence of growing medium and fertilizer doses on dry weight partitioning in the plants in primary nursery.

Treatments N + P + K (g)	Dry weight of different plant parts (15 seedlings)			
	Leaves	Stem	Root	Total
Potting mixture (PM)	4.72	3.69	3.17	11.58
PM + 60 + 25 + 25	1.92	2.98	1.76	6.66
PM + 40 + 25 + 25	6.63	5.57	3.77	15.97
PM + 20 + 10 + 10	7.15	6.22	3.99	17.36
Cocopeat (CP)	0.55	0.74	1.05	2.34
CP + 60 + 25+ 25	0.11	0.63	0.53	1.28
CP + 40 + 25 + 25	1.02	0.82	1.06	2.90
CP + 20 + 10 + 10	1.27	1.42	1.67	4.36
PM + CP (1:1 v/v)	3.00	3.23	3.94	10.17
PM+CP + 60 + 25+ 25	2.62	2.28	1.68	6.59
PM+CP + 40 + 25 + 25	4.18	3.34	2.47	9.99
PM +CP+20+ 10 + 10	5.15	4.58	3.32	13.05
CD (p=0.05)	0.90*	0.93*	0.67*	2.10*

Table 4. Influence of growing medium and fertilization on growth of the plants in secondary nursery. Acid lime.

Treatments N + P + K (g)	Plant mortality (%)	Plant height (cm)	Stem girth (mm)	No of leaves per plant	Chlorophyll content
Potting Mixture (PM)	0.0	62.2	6.18	56.3	0.682
PM + 10 + 5 + 5	91.7	38.3	4.07	22.3	0.455
PM + 8 + 4 + 4	66.7	44.3	4.37	41.3	0.560
PM + 6 + 3 + 3	0.0	58.7	5.64	51.7	0.656
PM + 4 + 2 +2	0.0	67.8	6.38	59.7	0.701
Coco-peat (CP)	25.0	47.6	4.78	42.7	0.413
CP + 10 + 5 + 5	96.7	21.5	3.17	15.3	0.345
CP + 8 + 4 + 4	90.0	31.2	4.3	22.3	0.411
CP + 6 +3 + 3	81.7	23.8	4.34	26.3	0.438
CP + 4 + 2 + 2	66.7	36.4	3.78	37.7	0.514
PM + CP (1:1 v/v)	0.0	55.4	5.88	54.7	0.602
PM + CP + 10+ 5+5	91.7	31.8	3.96	35.7	0.443
PM + CP + 8 + 4 + 4	81.7	53.4	4.44	34.3	0.567
PM + CP + 6 +3 +3	11.7	64.8	5.74	54.7	0.687
PM + CP + 4 + 2 +2	11.7	70.5	6.24	61.2	0.702
CD (p = 0.05)	11.85*	2.76*	0.87	4.60	0.051

in concentration of NH_4-N in the nutrient solution was observed in Swingle citrumelo rootstock (Dou *et al*., 4). In another study Diego *et al*. (3) observed in rangpur lime that increased application of P and K above 100 and 790 mg/dm, respectively did not increase their absorption.

The study clearly indicated that acid lime seedlings were very sensitive to higher doses of fertilizers. For the production of healthy, nutritionally balanced vigorous seedlings of acid lime, it is recommended to apply 20+10+10 g NPK per each plastic tray (40 × 30 × 10 cm size, 8 to 10 kg potting mixture) in primary containerized nursery. While for secondary nursery 4+2+2 g NPK in per each polythene bags (30 × 18 cm, 2.5 kg potting mixture) should be applied in commonly used nursery potting mixture (sand, soil and farm yard manure in equal proportion).

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