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Scheduling of nutrient doses for rough lemon (*Citrus jambhiri*) rootstock under containerized primary and secondary nursery

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ABSTRACT

The study was carried out to investigate and standardize the nutritional requirement of commonly used rough lemon (*Citrus jambhiri* Lush) citrus rootstock for raising commercial primary and secondary containerized nursery. The aim of the study was also to reduce fairly high (2 years) time required traditionally for seedling production in citrus nurseries and to provide healthy seedlings. Two separate experiments, comprising different nutrient doses were conducted under primary and secondary containerized nursery. The results revealed that dry weight of all the plant parts and number of leaves was maximum with the application of 40+25+25 g NPK. Uptake of all the macro-nutrients, viz. N (31.2 mg), P (1.33 mg) and K (27.7 mg) by the plants was also highest under this treatment. While plant height and leaf chlorophyll contents were better in 20+10+10g NPK as compared to control. In secondary nursery, application of 4+2+2 g NPK recorded maximum plant height, stem girth, budding success rate (95.8%) and significantly reduced the time required for budding. Although availability of major nutrients was significantly highest in 60+25+25 g NPK treatment, it could not encourage the growth of the plants and induced plant mortality. In primary nursery, application of 40+25+25 g NPK and in secondary nursery, application 4+2+2 g NPK potting mixture were proved to be the superior nutrient dosage for rough lemon rootstock.

Keywords: Budding, Nutrient dose, Nutrient uptake, Rough lemon, Soil macronutrients

In India, citrus is the third most important fruit crop grown on 1.04 million ha area and 10.9 million tons of production with 9.7 tons/ha productivity. The total demand for citrus seedlings in India is 14.0 million, out of which 6.0 million is of Nagpur mandarin (*Citrus reticulata* Blanco). Mandarin is commonly propagated on rough lemon (*Citrus jambhiri* Lush) rootstock by 'T' budding method of vegetative propagation (Murkute *et al.* 2008, 2009). Traditionally, nurseries that are grown in the open field often take about two years to raise budlings, from seed sowing to reach to saleable size. This is fairly long period and incurring extra labour and input cost to the nurseryman. In the absence of proper nutrient management, plants do not attain proper height and stem girth and thus nursery owners sacrifice the required budding height (8 to 12 inches). The altered budding height leads to increased susceptibility of plants to soil borne diseases especially *Phytophthora* root and collar rot disease. With the escalating infestations of gummosis, wilt, root rot diseases, greening etc. in citrus, production of disease free planting material in protected environment has gained high importance. Containerized nurseries facilitate improvement in citrus orchard efficiency by avoiding disease perpetuation.

Nutritional programmes for citrus nurseries in vogue do emphasize maximum growth as preferred by growers, with the sole application of nitrogenous fertilizers that too for open field nursery (Gunjkar *et al.* 1999, Deshmukh and Joshi 2007). It is ranged from 1000–3000 kg of N/ha/annum, which leads to lanky and nutritionally imbalanced shoot growth of the seedlings. Adequate and balanced nutrition management is one of the most important components for the production of high quality citrus nursery plants (Goramnagar *et al.* 2000, Murkute *et al.* 2009). Therefore, it is necessary to evolve a balanced nutrient dosage for citrus nurseries to enhance growth of the seedlings and curtailing propagation period.With this background, an experiment was conducted in a containerized citrus nursery to standardize the nutritional requirements of rough lemon rootstock in primary and secondary nursery.

MATERIALS AND METHODS

An experiments were conducted during 2015–18 in a containerized nursery at ICAR-Central Citrus Research Institute, Nagpur, India located at 21°8' N latitude, 79°1' E longitude, at an altitude of 310.5 m amsl. The climate

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of the study area was tropical dry, sub-humid with hot and dry summer followed by mild winter and an average annual rainfall of about 983.3 mm. Primary nursery activities were comprised of seed sowing to growth of seedling till 30 cm height, which often takes nearly six months period. Plastic trays of 40 × 30 × 10 cm (length × breadth × depth) size having capacity to hold 8–10 kg potting mixture were used in primary nursery. In primary nursery, an experiment with 3 nutrient doses was laid out in a randomized block design with 5 replications having 2 trays per replication. Potting media (PM) included solarized mixture of soil, sand and well decomposed farmyard manure (4:3:3 v/v). 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+25+25, 40+25+25 and 20+10+10 g NPK were applied on per tray basis after 25 days of seed germination along with no fertilization control.

In secondary nursery, another experiment was laid out in a randomized block design with 5 nutrient doses and 4 replications having 4 plants per replication. Healthy seedlings with same vigor and growth (about 30 cm height) were selected from primary nursery and transplanted in polythene bags (30 cm × 17 cm) containing 2.5 kg potting mixture. Seedlings were allowed to grow and establish for 15 days. Five nutrient doses of g NPK, viz. 10+5+5, 8+4+4, 6+3+3, 4+2+2 and 2+1+1 g NPK per seedling were applied along with control (no fertilizer). Budding was done at 15 days interval as per the cambial growth of the plants and maintained till it attended the saleable height (70–80 cm). In both primary and secondary nursery, nutrients were applied in 23 split dozes along with irrigation water using urea, 17:44:0 grade water soluble fertilizer and muriate of potash.

At the end of the experiment, composite soil samples were analyzed for various chemical properties and fertility status using standard procedures (Jackson 1973). Similarly, whole plants were uprooted, washed thoroughly and separated in roots, stem and leaves. The dried leaf samples were ground, mixed well and used for analyzing macro and micronutrients following standard procedures (Chapman and Pratt 1960). Plant height and stem thickness was measured using a measuring stick and digital caliper, respectively. Chlorophyll content in the leaf was measured periodically using chlorophyll meter (KONICA MINOLTA SPAD-502) and expressed as 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.* 1998).

RESULTS AND DISCUSSION

Seedling emergence and survival of plants: The emergence of seedlings and its survival till the end of the experimental period was significantly affected by fertilization treatments (Table 1). Since it was reported that potting media need to be amended with various fertilizers doses before planting (Gunjkar *et al.* 1999), half dose of P and K and one third dose of N were applied in potting mixtures. However, it was experienced that prior incorporation of any nutrients drastically reduced the emergence and survival of the seedling to the tune of 43.5-62.1 and 15.3-30.7% in different treatments against 85.4 and 80.3% under sole potting mixture, respectively and was mainly due to increased EC (1.34-1.59 against 0.61 dS/m in control). Similar results were observed where sawdust and sugarcane trash material was used in pomegranate nursery (Marathe *et al.* 2010); where, the seedlings were unable to grow or remained stunted, turned yellow and eventually died.

The whole experiment was repeated again after standardization of method of nutrient application where complete dose of nutrient was applied in 23 split dozes along with irrigation water using urea, 0:17:44 or muriate of potash fertilizers. However, application of higher fertilizer doses especially 60+25+25g NPK was found detrimental for the survival (67.0%) of seedlings. Gunjkar *et al.* (1999) reported higher mortality of rough lemon seedlings (49.6%) with the application of 200 kg N/ha in open field nursery.

Growth and dry weight of the plants: The plant height (21.0 cm) and leaf chlorophyll content (0.718) were significantly highest with the application of 20+10+10 g NPK, while maximum number of leaves (15.6) was recorded in 40+25+25 g NPK (Table 1). Application of higher dose, i.e. 1000 kg N/ha/annum (Davis and Albrigo 2003) and 15–19 mg/l 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 showed detrimental effect on growth as well as chlorophyll contents of the leaves.

The dry weight of various plant parts, viz. leaves, stem, roots and total plant were significantly varied from 0.490

Table 1 Influence of fertilization on growth and dry weight partitioning in the plants in primary nursery

Treatment (g NPK)	Seedling survival	Plant height (cm)	Number of leaves per seedlings	Dry weight (g) of				Leaf chlorophyll content
				Leaves	Stem	Root	Total	
Potting mixture (PM)	82.5	18.9	14.5	0.490	0.231	0.238	0.960	0.683
PM +60+25+25	67.0	18.4	12.2	0.656	0.421	0.333	1.410	0.670
PM + 40+25+25	84.2	20.0	15.6	0.694	0.481	0.335	1.510	0.693
PM + 20+10+10	80.3	21.0	14.4	0.548	0.280	0.252	1.080	0.718
CD(P=0.05)	9.16*	1.92	1.56*	0.065*	0.039*	0.033*	0.152	0.017

*Significant at 0.01 level

-0.694 g, 0.231-0.481 g, 0.238-0.335 g and 0.960-1.510 g amongst various nutrient doses (Table 1). The plants supplied with fertilization had better plant growth as compared to unfertilized plants in the same medium. However, the highest dry weight of all the plant parts was obtained with the application of 40+25+25 g NPK. The proper nutrient supply and good physico-chemical conditions could have proved beneficial to plants growth.

Soil fertility status and nutrient uptake by the plants: Organic carbon content was exceedingly high (1.93-2.17 %) in all the treatments. The highest organic carbon content was recorded in 20+10+10 g NPK treatment, which might be due to the luxurious growth of fibrous roots of the plants which might have added to the soils. Application of 60+25+25 g NPK rather recorded decrease in organic carbon content as compared to control. The higher dose of fertilizers might have induced osmotic stress and thereby restricting the normal growth of plant roots. At the end of the experiment, considerable increase in availability of macronutrients was observed with the increasing dose of fertilizers (Table 2). Availability of N (289.1 kg/ha), P (32.8 kg/ha) and K (1990.0 kg/ha) was significantly highest in 60+25+25 g NPK treatment. The highest increase by virtue of the highest application of nutrients was common. In all the treatments, availability of N and P was in optimum range while available K was extremely high that might be due to very high content of organic carbon in these treatments. There used to be significantly positive correlation between organic carbon of potting media and macro- and micro-nutrients (Marathe *et al.* 2007, Marathe *et al.* 2017).

Uptake of various macro-nutrients by rough lemon seedling showed significant variation amongst the treatments (Table 2). Maximum uptake of all the macro-nutrients, viz. N (31.2 mg), P (1.33 mg) and K (27.7 mg) was observed in the plants supplied with 40+25+25 g NPK. Increased nutrient uptake by citrus plants with the increased availability in soil was reported by Marathe *et al.* (2012). Nevertheless, there was no relation found between nutrient availability in media and its uptake by the plants. Determination of available nutrient contents at the end of experiments, i.e. five months after initiation of the experiment could have affected the result as all the nutrients get released in available form during that period. In general, it was observed that commonly used potting mixture had sufficient quantity of organic manure which could have augmented nutrient availability. Thus, little addition of nutrients in PM was sufficient to promote rapid growth of the seedlings in primary nursery.

Plant growth in secondary nursery: Plant height (72.8 cm) and stem girth (7.35 mm) was significantly highest in 4+2+2 g NPK while number of leaves was better in 6+3+3 g NPK than control (Table 3). It was found that higher dose of fertilizers than optimum, rather made harm to the plants. Growth of the plants supplied with 10+5+5 g NPK was very less and recorded very high (30.2%) plant mortality. Present finding was in line to the growth suppression effect with an increase in concentration of NH_4-N in the nutrient solution in Swingle citrumelo rootstock (Dou *et al.* 1999). In another study, Diego *et al.* (2009) observed that in Rangpur lime, increased application of P and K above 100 and 790 mg/dm, respectively did not increase their absorption. Chlorophyll contents in the leaves of rough lemon rootstock significantly varied from 0.659-0.711 (Table 3) and found increased with the decreasing dose of fertilizers. It was significantly highest in 2+1+1 g NPK treatment. To increase the height and stem diameter of Rangpur lime in open field nursery, the application of 200 kg N/ha and 100 kg P/ha (Gunjkar *et al.* 1999), P along with fungicide sprays (Davis and Albrigo 2003) as well as spray of 1% urea solution every month after transplanting of seedlings (Deshmukh and Joshi 2007) were recommended.

Budding time and success rate: Budding is the most important operations in citrus nursery and all nutrient management practices are performed to reduce the time to acquire budding stage and to increase budding success. Data revealed that time required to acquire required plant height, stem girth, cambial growth, i.e. bark slipping with proper sap flow condition was significantly reduced with the application of 4+2+2g NPK in PM as compared to PM media without fertilization treatment (Table 3). In this treatment, during first budding operation, 62.5% plants were budded as compared to 25.0% plants under PM without any fertilization. In the same treatment, i.e. 4+2+2 g NPK, all remaining plants (37.5%) attainted budding conditions during second budding, i.e. 15 days after of first budding. On the contrary 33.3 percent seedlings grown in the same PM without any nutrients took 15 days more to attain required budding stage. Similarly, plants grown in this treatment recorded highest budding success, i.e. 95.8% as compared to 87.5% in PM without fertilization. In treatments PM, PM+4+2+2 g NPK and PM+2+1+1 g NPK,

Table 2 Influence of fertilization on soil fertility status and nutrient uptake by the plants

Treatment N + P + K (g)	Organic carbon (%)	Available macro-nutrients (kg/ha)			Nutrient uptake by the plants		
		N	P	K	N	P	K
Potting mixture (PM)	1.93	235.5	20.2	1529.4	18.0	0.69	17.3
PM + 60+25+25	1.84	289.1	32.8	1990.0	21.6	1.21	23.2
PM + 40+25+25	2.04	266.1	31.1	1708.6	31.2	1.33	27.7
PM + 20+10+10	2.17	230.9	24.9	1648.8	18.4	1.07	19.4
CD (P=0.05)	0.26	33.2	4.05	164.0	2.85*	0.14*	2.49*

*Significant at 0.01 level

Table 3 Influence of fertilization on growth of the plants grown in secondary nursery

Treatment	Plant mortality (%)	Plant height (cm)	Stem girth (mm)	No. of leaves per plant	Leaf chlorophyll (SPAD)	First budding	Second budding	Third budding	Budding success
						(% plants)			
T_1	0.0	66.3	7.19	45.5	0.706	25.0	41.7	33.3	87.5
T_2	30.2	46.9	4.87	25.2	0.659	0.0	0.0	29.2	52.1
T_3	0.0	55.2	5.29	33.0	0.676	0.0	0.0	54.2	52.1
T_4	0.0	67.9	7.07	55.5	0.692	33.3	37.5	0.0	95.8
T_5	0.0	72.8	7.35	50.8	0.693	62.5	37.5	0.0	95.8
T_6	0.0	68.8	7.26	53.2	0.711	29.2	50.0	20.8	91.7
CD (P=0.5)	2.41*	4.30*	0.29*	5.71*	0.015*	9.90*	11.50*	11.85	17.9*

T_1, Potting mixture (PM); T_2, PM+10+5+5; T_3, PM+8+4+4; T_4, PM+6+3+3; T_5, PM+4+2+2 and T_6, PM+2+1+1 g NPK; *significant at 0.01 level.

all plants attained budding condition with the success rate of 87.5, 95.8 and 91.7% respectively. Balanced nutrient application in these treatments might have stimulated the growth of the plants as revealed by the highest stem girth, number of leaves and required plant height, which in turn favored early budding operation. It was interesting to note that under application of higher dose of fertilizers, viz. 10+5+5, 8+4+4 and 6+3+3 g NPK in PM, time required to attain budding condition was higher as compared to the best performing treatment. Further, in these treatments only 29.2, 54.2 and 70.8%, respectively plants acquired budding conditions with success rate of 52.1, 52.1 and 95.8% under corresponding treatments.

REFERENCES

Chapman H D and Pratt P F. 1961. *Methods of Analysis for Soil, Plants and Water.* Division of Agricultural Sciences, University of California, USA, pp 182–86.

Davis F S and Gene Albrigo L. 2003. *Citrus*, CAB International, UK, pp 111.

Deshmukh P P and Joshi P S. 2007. *Commercial Citrus of India*. Kalyani Publishers, New Delhi, p 60.

Diego Wyllyam do Vale, Renato de Mello Prado, Henrique Antunes de Souza, AntônioBaldo Geraldo Martins. 2009. Nitrogen, phosphorus and potassium levels in nutrition of citrus rootstock Rangpur lime. *Scientia Agraria* Curitiba **10**: 61–66.

Dou H, Alva A K and Bondada B R. 1999. Growth and chloroplast ultra structure of two citrus rootstock seedlings in response to ammonium and nitrate nutrition. *Journal of Plant Nutrition* **11**: 1731–44.

Goramnagar H B, Gondane S U, Rafeekher M, Sorte P N and Murkute A A. 2000. Studies on integrated nutrient management in Nagpur oranges. *Journal of Soils and Crops* **10**: 289–91.

Gunjkar S N, Tandle J J, Shinde N N and Purandare N D. 1999. Effect of different dates of sowing and levels of nitrogen on growth and seedling yield of rangpur lime (*Citrus limonia* Osbeck). *Proceedings of the International Symposium on Citriculture,* ICAR – NRC for Citrus, Nagpur, India, pp 464–69.

Jackson M L. 1973. *Soil Chemical Analysis*. Prentice Hall of India Pvt Ltd, New Delhi.

Marathe R A, Bharambe P R, Sharma Rajvir and Sharma U C. 2012. Leaf nutrient composition, its correlation with yield and quality of sweet orange and soil microbial population as influenced by INM in Vertisol of central India. *Indian Journal of Horticulture* **69**: 317–21.

Marathe R A and Bharambe P R. 2007. Correlation of integrated nutrient management induced changes in soil properties with yield and quality of sweet orange (*Citrus sinensis*) on Udic Haplustert. *Journal of the Indian Society of Soil Science* **55**: 270–75.

Marathe R A, Sharma Jyotsana, Murkute A A and Dhinesh Babu K. 2017. Response of nutrient supplementation through organics on growth, yield and quality of pomegranate. *Scientia Horticulturae* **214**: 114–21.

Marathe R A, Ram Chandra and Jadhav V T. 2010. Influence of different potting media on soil properties, plant nutrient content and nutrient uptake by pomegranate (*Punica granatum*) seedlings. *Indian Journal of Agricultural Sciences* **80**: 544–47.

Murkute A A, Satyawati S, Singh S K and Patel V B. 2009. Response of mycorrhizal citrus rootstock plantlets to salt stress. *Indian Journal of Horticulture* **66**: 456–60.

Murkute A A, Satyawati S and Singh S K. 2008. Rapid clonal in vitro multiplication of *Citrus jambhiri* and *Citrus karna*. *Indian Journal of Horticulture* **65**: 127–33.

Sheoran O P, Tonk D S, Kaushik L S, Hasija R C and Pannu R S. 1998. Statistical software package for agricultural research workers. *Recent Advances in Information Theory, Statistics and Computer Applications*, pp 139–43. Hooda D S and Hasija R C (Eds). Department of Mathematics Statistics, CCS HAU, Hisar.