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Effect of nitrogen on growth and nutrient status of bael (*Aegle marmelos* Correa) under sand culture

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Abstract

A pot experiment on Bael (*Aegle marmelos* Correa) seedlings was conducted during September 2005 to May 2006 in completely randomized design with three replications and nine treatments of each element at the Department of Horticulture, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand. Nine different treatments of nitrogen and phosphorus each were applied in the experiment. Results of the present investigation revealed that nitrogen and phosphorus deficiency resulted in reduced vegetative growth attributes of bael seedling. In nitrogen deficiency maximum height of seedling (13.67 cm), number of leaves (15.00), length of leaf (11.20 cm), breadth of leaf (3.23 cm) were found with T_5 (control) and total chlorophyll content (1.814 mg/g fresh weight) was found with T_6. While minimum values were obtained with T_1 (without nitrogen). In the present results, the critical level of nitrogen was considered as 0.65 per cent on dry weight basis.

Key words: Bael, *Aegle marmelos*, leaf analysis, nitrogen deficiency, critical level.

Introduction

Bael (*Aegle marmelos* Correa) is one of the important minor fruit crops with high nutritive and medicinal value. It can thrive well in swampy, alkaline, stony soils. Bael tree flowers in May-June and fruits become ready by April-May. It requires substantial amount of nutrients for maximizing yield and improving quality. Hence, its nutrient requirements have to be carefully monitored through leaf analysis for high productivity and quality. No established standards are available for efficient nutrient programme and fixing of critical levels for the deficiency of nutrients. There are scanty reports in the literature about the development of deficiency symptoms and fixing critical levels of nutrients in fruit crops. Therefore, an investigation was carried out to develop nutrient critical levels in the leaves of bael seedlings which in addition showed the effect of nitrogen on growth attributes of bael seedlings.

Materials and methods

The experiment was conducted during September 2005 to May 2006 in the glass house at College of Agriculture of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, district Udham Singh Nagar (Uttarakhand), India. bael cv. PB 10 seedlings were initially raised in sand for a period of two months and then they were transplanted into plastic pots of size 25 cm diameter, containing quartz sand. The sand was thoroughly washed with running tap water and later on immersed in solution prepared by dissolving 170 ml concentrated HCl and 10 g oxalic acid making up the volume of one litre in a volumetric flask with distilled water. The sand was kept in this solution for 48 hours. This treatment brought the pH of sand to near one. Later on washing was done with distilled water until the pH rose to 6.5. After transplanting, plants were kept in glass house. Complete nutrient solution as suggested by Hoagland and Arnon (1938) used to raise seedlings for the first 30 days, so that the planted material could establish itself well and acclimatize to the new anchoring medium. Stock solution of all the macro-elements and iron were prepared separately. A solution was also prepared containing all the macro-nutrients except Fe. Volume of working solutions was made up with double distilled water. Plants were supplied with 18 different of treatments including a control (complete nutrient solution). For nitrogen, treatments were N_1 (without nitrogen), N_2 ¼x (25% of N), N_3 ½x (50% of N), N_4 ¾x (75% of N), N_5 x (100% of N), N_6 1.25x (125% of N), N_7 1.5x (150% of N), N_8 1.75x (175% of N), N_9 2x (200% of N) and nine similar concentrations were given to the phosphorus. Composition of stock solution and method of making complete nutrient solution as suggested by Hewitt (1966).

The seedlings were transplanted in three plastic pots each containing nine seedlings. Thus, there were 54 pots containing 486 seedlings. Each pot was supplied with 50 ml of nutrient solution every day split into two equal dose of 25 ml of nutrient solutions, throughout the experimental period till the last observations. Growth attributes i.e., height of seedling, number of leaves per seedling, leaf length and breadth, fresh and dry weight of leaves, leaf area, stem girth, length of primary root, chlorophyll a, chlorophyll b and total chlorophyll content were recorded at monthly intervals throughout the experimental period till the last observation. Leaf samples were collected at monthly intervals in the morning hours and then brought to the laboratory on the same day. After collection, leaf samples were washed in tap water and placed for drying of water. The samples were placed in muslin cloth bags and kept in oven at 60±2°C for 48 hours to get constant dry weight. Grinding of the leaf samples was done with Rally Mixi to the powder form and analysed for nutrient content of leaves. For estimation of nitrogen digestion done by Kjeldhal method. For digestion of P, K, Ca, Mg, Cu, Mn, Fe and Zn used 9:4 of HNO_3: $HClO_4$ solution. The data for the just noticeable deficiency symptoms of nutrients were noted and corresponding levels of nutrient content of each of the element was estimated as critical level of leaves.

Results and discussion

Data presented in Table 1 showed that the nitrogen deficient plants developed uniform chlorosis on the lower most leaves and progressed with the age of the seedling. They become pale green with yellowish tinge in the later stage. Different levels of nitrogen influenced all the growth characters significantly. Maximum height of seedling (13.76 cm), number of leaves (15.00), length of leaf (11.20 cm) and breadth of leaf (3.23 cm), fresh weight of leaves (1.10 g), dry weight of leaves (0.48 g), leaf area (85.00 cm²), stem girth of seedling (1.39 cm) and length of primary root (19.96 cm) were observed with T_5 (100% of N) in contrast minimum values of height of seedling (9.90 cm), number of leaves (9.00), length of leaf (4.63 cm), breadth of leaf (1.96 cm), fresh weight of leaves (0.90 g), dry weight of leaves (0.29 g), leaf area (66.33 cm²), stem girth (0.19 cm) and length of primary root (9.50 cm) were recorded with T_1 (without nitrogen) on the last date of observation. Maximum chlorophyll a (0.953 mg/g fresh weight), chlorophyll b (0.650 mg/g fresh weight) and total chlorophyll content (1.814 mg/g fresh weight) were recorded with T_5 as compared to minimum values of chlorophyll a (0. 377 mg/g fresh weight), chlorophyll b (0.082 mg/g fresh weight) and total chlorophyll content (0.452 mg/g fresh weight) were recorded with T_1 treatment (without nitrogen) (Table 1) after 90 days of observation. Since nitrogen is a highly mobile element with the plant system, a stage reached where the plant felt a scarcity in nitrogen supply, nitrogen from older leaves translocated to the more active growing regions of the plant where nitrogen required for growth processes. Nitrogen

Table 1. Effect of variable nitrogen supply on growth attributes of Bael seedling.

Treatment	Height of seedling (cm)	Number of leaves	Length of leaf (cm)	Breadth of leaf (cm)	Fresh weight of leaves (g)	Dry weight of leaves (g)	Leaf area (cm²)	Stem girth (cm)	Length of primary root (cm)	Chlorophyll a (mg/g of fresh weight of leaves)	Chlorophyll b (mg/g of fresh weight of leaves)	Total chlorophyll (mg/g fresh weight of leaves)
T_1	9.90	9.00	4.63	1.96	0.900	0.293	66.33	0.191	9.50	0.377	0.082	0.452
T_2	11.40	10.00	4.73	2.00	1.006	0.336	68.00	0.219	12.43	0.638	0.145	1.596
T_3	12.40	12.00	7.53	2.06	1.066	0.340	60.33	0.227	16.63	0.675	0.273	1.598
T_4	12.40	13.00	7.56	2.33	1.088	0.433	78.00	1.275	18.03	0.701	0.279	1.601
T_5	13.76	15.00	11.20	3.23	1.100	0.483	85.00	1.398	19.96	0.951	0.599	1.814
T_6	13.50	14.00	10.60	2.70	1.009	0.420	81.00	1.308	19.26	0.951	0.630	1.914
T_7	13.23	13.66	10.56	2.53	1.004	0.400	79.00	1.281	18.03	0.951	0.650	1.812
T_8	12.56	12.00	8.36	2.40	1.000	0388	72.00	1.268	17.13	0.952	0.648	1.810
T_9	12.53	12.00	7.63	2.40	1.000	0.383	70.00	0.752	16.53	0.953	0.648	1.676
S.Em.±	0.411	0.577	0.137	0.933	0.069	0.145	1.936	0.129	0.313	0.007	0.003	0.026
CD (P = 0.05)	1.231	1.650	0.409	0.396	0.206	0.136	3.781	0.383	0.931	0.021	0.011	0.077

Table 2. Effect of variable nitrogen supply on uptake of nutrients in Bael seedling.

Treatment	Nitrogen content of leaf (%)	Phosphorus content of leaf (%)	Potassium content of leaf (%)	Calcium content of leaf (%)	Magnesium content of leaf (%)	Copper content of leaf (ppm)	Iron content of leaf (ppm)	Manganese content of leaf (ppm)	Zinc content of leaf (ppm)
T_1	0.24	0.31	0.98	1.28	0.70	41.11	42.33	82.00	76.66
T_2	0.65	0.32	0.99	1.28	0.70	41.00	41.66	81.00	76.33
T_3	0.65	0.32	1.00	1.28	0.70	41.66	41.66	81.00	76.00
T_4	0.66	0.32	1.00	1.29	0.70	41.66	40.66	83.00	76.33
T_5	1.36	0.33	1.04	1.30	0.71	41.33	40.33	85.00	76.66
T_6	1.37	0.32	1.02	1.31	0.70	41.33	41.66	85.00	76.66
T_7	1.40	0.32	1.01	1.30	0.70	41.00	41.00	85.00	76.33
T_8	1.41	0.32	1.00	1.30	0.70	41.00	41.00	85.00	76.00
T_9	1.45	0.32	1.01	1.30	0.70	41.00	40.66	85.00	76.00
S.Em ±	0.010	0.008	0.012	0.011	0.007	0.430	1.110	1.36	0.683
CD ($P=0.05$)	0.035	NS	NS	NS	NS	NS	NS	NS	NS

influenced the growth of plant. As the levels of nitrogen reduced in the nutrient solution, there was corresponding decrease in growth attributes and up to a certain limit increase in the height of seedling. This is primarily due to the role of nitrogen in the growth process reported by Bhattacharya *et al.*, (1972).

The lowest nitrogen content of leaves (0.24%) with T_1, while maximum value of leaf nitrogen content (1.45%) was found with T_9 (maximum concentration of nitrogen) on the last date of sampling (Table 2). Motiramani (1968) reported that increasing nitrogen availability over a period of time increased the nitrogen uptake, thereby resulting into corresponding increase in plant nitrogen content. Other nutrients i.e. phosphorous, potassium, calcium, magnesium, copper, iron, manganese and zinc showed non-significant difference after 90 days of observation. The present results are, however, in line with the finding of Malik and Singh (1960). The critical level of leaf nitrogen was considered as 0.65 per cent on dry weight basis.

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