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Effect of Foliar Application of Macro and Micronutrients on Quality Seedlings Production in Small Cardamom (*Elettaria cardamomum* Maton.)

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ABSTRACT

An experiment was carried out to assess the effect of foliar nutrition with macro and micronutrients on quality seedlings production in small cardamom seedlings in the secondary nursery at ZAHRS, Mudigere with seven treatments and three replications in Completely Randomized Design during the year 2020-21. The results of study revealed that, among the different treatments studied, combined application of macro and micro nutrients (19:19:19 @ 0.50%+ $MgSO_4$ @ 0.25%+ $ZnSO_4$ @ 0.25 %+ Borax @ 0.25 %) thrice at monthly intervals after 30 days of transplanting in the secondary nursery recorded significantly maximum pseudostem height (56.07 cm), number of leaves (7.26), leaf area (646.90 cm^2), leaf area index (5.24), total chlorophyll content (1.68), number of primary (13.66) and secondary roots (76.85), root length (41.40), root thickness (1.58), root volume (17.88 cc), total dry matter production (5.61 g), tillering percentage (25.43), Dickson quality index (1.56) and volume index (259.87) at 120 days after treatment. The nutrient status of the nursery media revealed that, the available nitrogen (318.00 kg/ha), phosphorus (27.50 kg/ha) and potash (230.00 kg/ha). The analysis of plant nutrients at 120 days after treatment revealed that, the higher nitrogen (2.72 %), phosphorus (0.20 %) and potassium (3.90 %) were also recorded maximum with combined spray with macro and micronutrients. Hence, combined application of foliar nutrients proved to be the best application than either single spray or combination of two and uninoculated for raising quality seedlings in cardamom.

Keywords Foliar nutrients, Nitrogen, Phosphorus, Potassium, Quality seedlings.

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INTRODUCTION

Small cardamom (*Elettaria cardamomum* L. Maton) is popularly known as "Queen of spices" is an export oriented spice cum medicinal crop of India. However, India being the second largest producer of cardamom, the production and productivity is declining year after year mainly due to inadequate production and

supply of quality planting materials in large quantities to establish sustainable commercial plantation. To achieve success in cardamom cultivation, uses of quality planting materials and subsequent establishment of seedlings are the important phases because propagation through seed is commercially preferred. The demand for quality seedlings is increasing from the growers of South Indian states. Foliar application of macro and micronutrients, favors greater absorption by plants, compared to soil application of nutrients. Foliar nutrition besides better absorption, also stimulates the root system to absorb nutrients from the soil solution. Another advantage over soil application of fertilizer is that there is no dependence on soil moisture and pH, as well as other chemical and physical properties for nutrient absorption. At the same time, foliar application contributes to reducing soil chemical contamination.

MATERIALS AND METHODS

Seedlings used for the study were raised from fully matured bold capsules of high yielding and disease free mother clumps of Mudigere 2 variety during September month. The seeds are extracted by gently pressing the capsules and washed 3-4 times in cold water to remove the mucilage adhering to the seeds. Then acid scarification with 25% nitric acid for 10 minutes was carried out to ensure the higher and uniform germination. After seed treatment, the seeds were shade dried, later thinly broadcasted on the raised beds and covered lightly with cocopeat under low cost poly house. After sowing, beds were mulched with paddy straw to maintain soil temperature and moisture. Germination commenced in about 20-25 days and allowed to grow for a month in the primary nursery. The seedlings at three to four leaf stage in the primary nursery were transplanted in polybags (6 × 6 inches) containing 0.75 kg of potting mixture consists of Forest soil: Sand: FYM @ 3:1:1.

The experiment was laid out in Completely Randomized Design (CRD) with seven treatments and three replications. The treatment details are T_1- Control (Water spray), T_2- 9:19:19 @ 0.25%, T_3 -19:19:19 @ 0.50%, T_4- 19:19:19 @ 0.25 % + $MgSO_4$ @ 0.10 %+ $ZnSO_4$ @ 0.10%+ Borax @ 0.10%, T_5 -19:19:19 @ 0.25%+ $MgSO_4$ @ 0.25% + $ZnSO_4$ @ 0.25% + Borax 0.25%, T_6 -19:19:19 @ 0.50 %+ $MgSO_4$ @ 0.10 %+ $ZnSO_4$ @ 0.10% + Borax @ 0.10 % and T_7- 19:19:19 @ 0.50%+ $MgSO_4$ @ 0.25%+ $ZnSO_4$ @ 0.25%+ Borax @ 0.25%. The required quantity of nutrients as per the treatments were weighed using electronic balance and dissolved in small quantity of water and then volume made up according to concentration. The prepared nutrients solution was sprayed using hand sprayer at monthly intervals during the period of experimentation i.e. 30, 60, and 90 days after transplanting (total three sprays) in the secondary nursery. First foliar spray was taken up at 30 days after transplanting in the secondary nursery when the seedlings better established. The observations were recorded on growth parameters, root parameters, seedling quality and nutrient status of the nursery media and plant nutrient status.

RESULTS AND DISCUSSION

The data recorded on growth parameters of cardamom seedlings treated with foliar nutrition consisting of macro and micronutrients are presented in Table 1. The seedlings treated with 19:19:19 @ 0.50%+ $MgSO_4$ @ 0.25%+ $ZnSO_4$ @ 0.25%+ Borax @ 0.25% (T_7) recorded highest pseudostem height (56.07 cm), number of leaves (7.26), leaf area (646.90 cm^2), leaf area index (3.02) per plant over control- water spray (45.83 cm, 6.53, 418.50 cm^2 and 5.04 respectively). This might be due to supply of balanced nutrition of macro and micronutrients coupled with better fertilizer use efficiency which enhanced the photosynthetic rate and other metabolic processes that lead to increase in various plant metabolites responsible for cell multiplication and enlargement and also synthesis of phytohormone (auxin) as zinc is main component of tryptophan which is a precursor of Indole acetic acid (IAA), when auxin concentration is more, the pseudo stems are able to absorb and translocate more nutrients to the apical bud, which resulted in better vegetative growth. Similar results were obtained by Hnamte *et al.* (2018) in turmeric; Singh and Dwivedi (2007) in ginger.

The total chlorophyll content was recorded maximum (1.68 mg/g) in (19:19:19 @ 0.50%+ $MgSO_4$ @ 0.25 %+ $ZnSO_4$ @ 0.25 % + Borax @ 0.25%). While, the lowest total chlorophyll content was detected

Table 1. Effect of foliar nutrition on growth parameters in cardamom seedlings at secondary nursery conditions.

Treatment	Pseudostem height (cm)		Pseudostem girth (cm)		Number of leaves		Leaf area per plant (cm^2)		Leaf area index		Total chlorophyll (mg/g)	
	60 DAT	120 DAT	60 DAT	120 DAT	60 DAT	120 DAT	60 DAT	120 DAT	60 DAT	120 DAT	60 DAT	120 DAT
T_1	31.72	45.83	3.03	3.83	5.33	6.53	268.83	418.50	2.24	3.48	0.82	1.14
T_2	29.23	48.48	3.02	3.92	5.86	6.60	314.58	462.46	2.62	3.85	0.88	1.23
T_3	30.83	54.51	3.12	3.84	5.80	6.93	299.05	587.73	2.54	4.87	0.87	1.52
T_4	31.23	55.53	3.02	4.02	6.13	6.80	322.90	573.58	2.71	5.04	1.21	1.52
T_5	30.30	53.96	3.06	3.86	5.93	7.00	307.64	598.50	2.56	4.98	0.96	1.55
T_6	29.70	54.53	3.06	3.98	6.13	7.06	326.15	628.39	2.52	5.13	1.29	1.61
T_7	32.06	56.07	3.06	4.28	5.86	7.26	347.56	646.90	3.02	5.24	1.37	1.68
SEm ±	1.20	2.81	0.04	0.21	0.20	0.45	4.48	6.51	0.16	0.36	0.15	0.16
CD @ 5%	NS	8.43	NS	NS	0.59	1.33	13.32	19.35	0.48	1.07	0.44	0.48

in control (1.14 mg/g). The increase in chlorophyll content might be due to optimum supply of macro and micronutrients which enhanced the chloroplast organelle synthesis. The results of the present study are in agreement with Jirali *et al.* (2007) in turmeric; Khadeeja (2017) in arecanut and Assem *et al.* (2016) in gladiolus.

The effect of foliar nutrition on root parameters (Table 2). The maximum primary roots (13.66), secondary roots (76.85), length of longest primary root (41.40 cm), root thickness (1.58 mm) and root volume (17.88 cc) recorded in (19:19:19 @ 0.50 %+ $MgSO_4$ @ 0.25 %+ $ZnSO_4$ @ 0.25 % + Borax @ 0.25%). While, the lowest values were noticed in control- water spray (9.10, 58.26, 32.33 cm ,0.99 mm and 10.99 cc, respectively). Might be the enhanced hydrolysis of stored carbohydrates which promoted better rooting. Krishnamurthy (1981) had an opinion that auxins would bring about various physiological changes along with stored food and nutrient content present seedlings.

The highest tillering percentage (25.43), Dickson quality index of 1.56 and volume index (259.87) was observed in the seedlings sprayed with 19:19:19 @ 0.50%+ $MgSO_4$ @ 0.25%+ $ZnSO_4$ @ 0.25% + Borax @ 0.25% (Table 3). The lowest tillering percentage was noticed in T_1 (control- water spray) with value of 11.70%, 0.91 and 168.46 respectively. This might be due to the fact that, the combined application of macronutrients and micronutrients promotes vigour of seedlings through cell division and shoot differentiation. The conclusions drawn by Gudade *et al.* (2016) in large cardamom; Hnamte *et al.* (2018) in turmeric are similar to the results of the present study.

Table 2. Effect of foliar nutrition on root parameters ant plant biomass at 150 days after treatment in cardamom seedlings at secondary nursery conditions.

Treatment	Root parameters					Plant biomass				
	Number of primary roots	Number of secondary roots	Root length of longest primary root (cm)	Root thickness (mm)	Root volume (cc)	Fresh weight (g)		Dry weight (g)		Total dry matter production (g)
						Shoot	Root	Shoot	Root	
T_1	9.10	58.26	32.33	0.99	10.99	14.55	11.10	1.44	1.55	3.00
T_2	11.22	65.37	33.33	1.17	11.66	18.77	14.10	2.33	1.55	3.89
T_3	11.33	64.81	33.77	1.39	14.66	21.77	12.55	3.11	1.78	4.89
T_4	10.53	70.44	38.66	1.26	14.22	21.55	14.44	2.44	2.67	5.11
T_5	10.11	73.85	37.60	1.44	10.44	14.77	12.55	2.33	2.11	4.44
T_6	10.44	75.33	39.77	1.49	15.44	23.66	15.33	2.55	2.44	5.00
T_7	13.66	76.85	41.40	1.58	17.88	29.55	17.55	2.88	2.72	5.61
SEm ±	0.75	7.42	3.50	0.10	2.09	3.34	1.68	0.33	0.32	0.10
CD @ 5%	2.23	22.06	10.40	0.29	6.21	9.93	4.98	0.98	0.96	0.31

Table 3. Effect of foliar nutrition on seedling quality at 120 days after treatment in cardamom seedlings at secondary nursery conditions.

Treatment	Seedling quality				
	Tillering percentage	Root/shoot ratio	Dickson quality index	Sturdiness quotient	Volume index
T_1	11.70	1.11	0.91	2.41	168.46
T_2	15.63	0.73	0.98	2.47	186.94
T_3	19.57	0.57	1.07	2.83	201.94
T_4	13.67	1.11	1.38	2.79	223.94
T_5	19.53	1.01	1.09	2.81	200.03
T_6	21.53	1.05	1.31	2.81	214.72
T_7	25.43	0.94	1.56	2.64	259.87
SEm ±	1.39	0.20	0.18	0.23	17.62
CD @ 5%	4.12	NS	0.54	NS	52.37

The effect of foliar nutrition on biomass like the fresh weight of shoot (29.55 g), root (17.55 g), dry weight of shoot (2.88 g) and root (2.72 g) recorded highest in (19:19:19 @ 0.50%+ $MgSO_4$ @ 0.25%+ $ZnSO_4$ @ 0.25% + Borax @ 0.25%) and lowest recorded in control- water spray (14.55, 11.10, 1.44 and 1.55 g respectively) and the total dry matter production (5.61 g) over control (3.0 g). This might be due to the better accumulation of photo assimilates like nitrogen, being an important constituent of chlorophyll, proteins and amino acids, which promoted the better photosynthetic efficiency when balanced nutrition applied in sufficient quantities. Shanwaz *et al.* (2018) recorded the fresh weight of stem with the foliar applications of micronutrients mixture in potato, and also due to the foliar application of macro and micro nutrients in balanced form enhanced the accumulation of more dry matter in the roots as compared to other plant parts at different growth stages. Santos *et al.* (2019) observed similar variations in grafted cashew.

Effect of foliar nutrition on the nutrient status of nursey media (Table 4). The available N (318.00 kg ha^{-1}), P (27.50 kg ha^{-1}) and K (230.00 kg ha^{-1}) was recorded high in (19:19:19 @ 0.50% + $MgSO_4$ @ 0.25% + $ZnSO_4$ @ 0.25% + Borax @ 0.25%) as foliar spray. The availability of higher nutrients in the nursery media might be due to better mineralization of nutrients in the media and uptake of more nutrients which resulted in production of more number of tillers and leaves which absorbs more nutrients during photosynthesis and other metabolic processes. These results are in conformity with findings of Gudade *et al.* (2016) with boron spray in cardamom.

Table 4. Effect of foliar nutrition on nutrient status of the nursery media and plant nutrient status at 120 days after treatment in cardamom seedlings at secondary nursery conditions. Note: Initial chemical properties and nutrient status of the nursery media: Soil pH 5.84, EC (0.054 dSm^{-1}), organic carbon (0.68 %), available nitrogen (298.00 kg ha^{-1}), phosphorus (22.00 kg ha^{-1}) and potassium (128.93 kg ha^{-1}).

Treatment	Nutrient status of the nursery media			Plant nutrient status		
	Available nitrogen (kg/ha)	Available phosphorus (kg/ha)	Available potassium (kg/ha)	Total nitrogen (%)	Total phosphorus (%)	Total potassium (%)
T_1	282.00	19.10	145.00	1.80	0.10	3.10
T_2	298.00	24.20	180.00	2.00	0.11	3.30
T_3	265.00	24.80	175.00	2.30	0.10	3.40
T_4	296.00	19.80	198.00	2.20	0.16	3.30
T_5	305.00	20.40	180.00	2.30	0.13	3.60
T_6	310.00	22.10	230.00	2.40	0.16	3.80
T_7	318.00	27.50	230.00	2.72	0.20	3.90
SEm ±	6.57	0.49	4.05	0.258	0.004	0.254
CD @ 5%	20.14	1.51	12.42	0.156	0.010	0.239

Effect of foliar nutrition on plant nutrient status recorded maximum nitrogen (2.72%), phosphorus (0.20%) and potassium (3.90%) and minimum was recorded in control – water spray (1.80%, 0.10% and 3.10% respectively) in cardamom seedlings. This might be due to better absorption of nitrogen, phosphorus element and assimilation of potassium element through foliar spray of macronutrients. Gudade *et al.* (2016) in large cardamom were recorded the similar results.

CONCLUSION

The results of present investigation indicated that the cardamom seedlings treated with combined application of macro and micronutrients 19:19:19 @ 0.50% + $MgSO_4$ @ 0.25% + $ZnSO_4$ @ 0.25% + Borax @ 0.25% resulted in better performance with respect to growth parameters, root parameters, seedling quality, nutrient status of nursey media and plant nutrient status.

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