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Research Article

Influence of organic and inorganic nutrients on large cardamom (*Amomum subulatum* Roxb.) under Darjeeling sub-Himalayan region of West Bengal

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ABSTRACT

A field experiment with 7 treatments was carried out during 2012-13 and 2013-14 at Sub-Himalayan region of Darjeeling district of West Bengal to find out the most appropriate nutrient management option for large cardamom (*Amomum subulatum* Roxb). Significantly maximum plant height (2.47 m), number of tillers/clump (12.4), number of spikes/clump (33.2), average spike length (63.6 cm) and number of capsules/clump (494.9) were found with application of 50% recommended dose of fertilizers + farmyard manure7.5 tonnes/ha + vermicompost 2.5 tonnes/ha + *Azospirillum*(10 g/clump) + phosphorus solubilising bacteria(10 g/clump). This treatment (T_6) also recorded significantly highest dry capsules yield (425.8

kg/ha) followed by T_4, T_3 and T_2 treatments, whereas, lowest yield was found in farmers' practice (213.5 kg/ha). Comparatively, superior treatment i.e. application of 50% recommended dose of fertilizers + farmyard manure7.5 tonnes/ha + vermicompost 2.5 tonnes/ha + *Azospirillum*(10 g/clump) + phosphorus solubilising bacteria(10 g/clump)recorded about 99.4 percent and 37.6 percent higher dry capsule yield as compared to farmers' practice and recommended dose of fertilizers (T_2), respectively. In economic point of view, this treatment combination (T_6) registered B:C ratio of 4.95, which owing to higher input cost of vermicompost and farmyard manure, was 2.71 percent lower than recommended dose of fertilizers (5.09). Application of vermicompost and farmyard manure as well as bio-fertilizers had favorable impact on various soil properties viz. bulk density, organic carbon, available N and available P status of surface soil.

Key words: Organic and inorganic nutrients, large cardamom yield, economics, soil properties

INTRODUCTION

Large cardamom (*Amomum subulatum* Roxb.) is one of the oldest spices known to mankind. It is a perennial cash crop traditionally growing up to 1.0-3.0 meter in height. Stem is a pseudo-stem which is called tiller. Inflorescence is spike. Flowers are yellow, bisexual, zygomorphic and pollinated by bumble bees. Cardamom is one of the oldest spices used in Ayurvedic preparations as described in Sashruta. It is the most important cash crop of Sikkim and Darjeeling district of West Bengal spread over about 26,437 hectares of land. Sikkim covers the largest percentage of area under cultivation (90.1%) and production (74.4%) followed by Darjeeling District of West Bengal (9.9% and 25.6%). It is a shade loving plant and requires high moisture and is usually cultivated in areas where mean annual rainfall varies between 1500 to 3000 mm. The crop is predominantly cultivated between 600 to 2000 m MSL that covers the subtropical to the cool temperate zones. Farmers take care to grow the crop on steeper and marginal and fragile lands so as to minimize the soil erosion and landslides [1]. The practices of using nitrogen fixing Himalayan alder (*Alnus nepalensis*) as shade trees has been adopted by the indigenous communities to maintain the soil fertility and increasing the productivity [2]. It is indigenous to moist, deciduous and evergreen forest of sub-Himalayan tracts. Its cultivation is affected by various biotic and abiotic stresses at altitudes and these factors are mainly responsible for poor plant health and production in certain regions. Large cardamom is a low input crop; organic manures, fertilizers and pesticides are seldom used. Its productivity is low because of inherently low

soil fertility in this region. Washing of nutrient rich top soil due to erosion and poor crop management practices have depleted the soil further. Recommending the use of chemical fertilizers alone in degraded soil conditions of the risk prone tribal region will be a deliberate mistake. Whereas, conjunctive use of organic manures and chemical fertilizers will augments the efficiency of both the substances to maintain a high level of soil productivity [3]. Vermicompost has been advocated as good organic manure for use in integrated nutrient management practices [4]. Bio-fertilizers are another potential alternate source of nutrient. Farmyard manure as source of plant nutrients has been used since ancient times. The present investigation was therefore, carried out to find out the most appropriate nutrient management option for large cardamom, the most important cash crop grown in this hilly region.

MATERIALS AND METHODS

The present experiment was conducted during 2012-13 and 2013-14 at farmer's field at Jaldhaka under Kalimpong Sub-Division in Darjeeling District of West Bengal. The experimental field was medium, sandy loam in texture, acidic in nature and low fertility status. The popular cultivar, Sawney was selected for the present study. The experiment was done in new plantations during both the seasons with a plot size 5 m x 5 m. Planting was done in the main field during June – July when the seedlings attain a growth of 45-60 cm in height with 2-3 tillers and there was enough moisture in the soil. The land selected for planting is cleared of all undergrowth, weeds, etc. for new planting. Pits of size 30 x 30 x 30 cm^3were prepared on the contour of the hill at a spacing of 1.5 m x 1.5 m after the onset of monsoon showers. When the seedlings attained 3 to 4 leaf stages they were transferred to the secondary nursery. Fertilization was done during April- May every year in the main field. Earthing up was carried out after each fertilizer application and hand weeding was undertaken once in every 20-25 days. The plantation was done under Himalayan alder (*Alnus nepalensis*) which is a nitrogen fixing tree. Flowering of cardamom commences in the third year after planting. Flower appears during April and May and the capsules mature in September and October. The experiments was comprised of 7 treatments viz. T_1, Farmers' practice (2.5 tonnes farmyard manure/ha); T_2, recommended dose of fertilizers (NPK-125:125:250 kg/ha); T_3, 50% recommended dose of fertilizers + farmyard manure 15 tonnes/ha; T_4, 50% recommended dose of fertilizers + vermicompost 5 tonnes/ha; T_5, 50% recommended dose of fertilizers + *Azospirillum* (10 g/clump) + phosphorus solubilising bacteria (10 g/clump); T_6, 50% recommended dose of fertilizers + farmyard manure 7.5 tonnes/ha + vermicompost 2.5 tonnes/ha + *Azospirillum*(10 g/clump) + phosphorus solubilising bacteria (10 g/clump) and T_7, 50% recommended dose of

fertilizers + farmyard manure 7.5 tonnes/ha + *Azospirillum* (10 g/clump) + phosphorus solubilising bacteria (10 g/clump). The statistical analysis of data was done as per method suggested by Anonymous [5] .The experiment was conducted in randomized block design with three replications. Farmyard manure, vermicompost and bio-fertilizers were incorporated as per the treatment and thoroughly mixed with the soil during pit making 15 days before transplanting of large cardamom seedlings. Pits were left open for weathering for a fortnight and then filled with topsoil mixed with farmyard manure and vermicompost. Pit making and filling operation completed in the third week of May before the onset of pre-monsoon showers. Chemical fertilizers were applied in several splits doses. Irrigation of plantation was done with limited water derived from adjoining *jhora* as per need of the crop. Other cultural operations were done as and when required. Soil of the experimental site was sandy loam in texture. The organic carbon content was found very high about 2.05% [6]. The EC of the soils was 0.48 dsm^{-1}. The available N, P_2O_5 and K_2O content of the experimental soils were 320.27 kg ha^{-1}, 41.59 kg ha^{-1} and 334.99 kg ha^{-1} respectively [7, 8, 9]. Data on growth parameter viz. plant height and yield attributing parameters viz. number of bearing tillers/clump, number of spikes/clump, spike length, number of capsules/clump and capsule yield were recorded at first harvesting stage i.e. 3rd year of planting. Analysis of soil properties viz. bulk density, organic carbon content, available N, P and K were also carried out after harvesting of crops. The cost of production and gross return estimated on the basis of price fixed by Government of West Bengal to work out the economics of cardamom cultivation in hilly region of West Bengal.

RESULTS AND DISCUSSION

a) Growth, yield attributes and yield:

Growth characteristics like plant height, number of tillers/clump, number of spikes/clump, spike length (cm) and capsules/clump were significantly influenced by various organic and inorganic sources (Table 1). Application of 50% recommended dose of fertilizers + farmyard manure 7.5 tonnes/ha + vermicompost 2.5 tonnes/ha + *Azospirillum* (10 g/clump) + phosphorus solubilising bacteria (10 g/clump) (T_6) gave taller plants (2.47 m) than other treatments except 50% recommended dose of fertilizers + vermicompost 5 tonnes/ha (T_4). The plant height in 50% recommended dose of fertilizers + farmyard manure 15 tonnes/ha (T_3) was statistically at par with recommended dose of fertilizers (T_2). Formation of number of tillers/clump was significantly highest (12.4) with 50% recommended dose of fertilizers + farmyard manure 7.5 tonnes/ha + vermicompost 2.5 tonnes/ha + *Azospirillum* (10 g/clump) + phosphorus solubilising bacteria (10 g/clump)

(T_6) and closely followed by T_4, T_3 and T_2treatments. The last two treatments i.e. T_3 and T_2 were statistically at par with each other with respect to number of tillers/clump. The number of spikes/clump and spike length were found significantly maximum (33.2/clump and 63.6 cm, respectively) with application of 50% recommended dose of fertilizers + farmyard manure 7.5 tonnes/ha + vermicompost 2.5 tonnes/ha + *Azospirillum* (10 g/clump) + phosphorus solubilising bacteria (10 g/clump) (T_6) as compared to other remaining treatments. The number of spikes/clump which is one of the most important yields attributing character was 118.4 percent and 34.4 percent higher in T_6 treatment as compared to farmers' practice (T_1) and recommended dose of fertilizer (T_2), respectively. It was found in Table 1 that number of capsules/clump of large cardamom was recorded significantly highest (494.9/clump) with application of 50% recommended dose of fertilizers + farmyard manure 7.5 tonnes/ha + vermicompost 2.5 tonnes/ha + *Azospirillum* (10 g/clump) + phosphorus solubilising bacteria (10 g/clump) (T_6) closely followed by T_4, T_3 and T_2 treatments, whereas, farmers' practice (T_1) recorded the lowest value of capsules/clump (241.5). Table 1 indicated that T_6 treatment recorded about 104.9 percent and 24.5 percent higher capsules/clump as compared to farmers' practice (T_1) and recommended dose of fertilizer (T_2), respectively. Better growth characteristics resulted significant improvement in yield attributes, like number of spikes/clump and number of capsules/clump in T_6 over rest of the treatments. It is evident from the Table 1 that superior growth and yield attributes were reflected in highest capsule yield in T_6 (425.8 kg/ha), closely followed by T_4 (402.2 kg/ha) and T_3 (391.4 kg/ha). Treatment T_4 gave statistically at par yield with T_3 treatment. The latter two treatments were also superior to remaining treatments. Vermicompost (in T_4 and T_6) containing higher available N, P and K content and rich population of microbes might have degraded and mobilized the occluded soil nutrients to available form. Further several enzymes and hormones present in vermicompost might have stimulated the growth and development of large cardamom plants. Thus, effect of farmyard manure and vermicompost in the root zone resulted in increased availability and uptake of nutrients by the plants. That was responsible for better growth and yield attributes in vermicompost and farmyard manure applied plots (T_3, T_4, T_6 and T_7). Similar findings have also been reported by Anonymous [10] in small cardamom.

b) Economics:

Though T_6 followed by T_4 recorded significantly highest capsule yield, B:C ratio was significantly higher in T_2 (Table 2). This is because of higher cost of vermicompost and farmyard manure used in T_6, $T_4$and T_3 treatments. However, T_6 treatment recorded significantly highest net returns (Rs. 180084/ha) than all

other treatments. Farmers' practice (T_1) gave significantly lowest net returns of Rs. 79452/ha and B:C ratio (3.91).

c) Soil properties

Application of vermicompost and farmyard manure had favorable impact on various soil properties viz. bulk density, organic carbon, available N and available P status of soil surface (Table 2). After two years of experimentation, all the treatments were superior to T_1 (farmers' practice) in terms of bulk density. Lowest bulk density was recorded under T_6 which was statistically at par with T_4. Treatment T_3 was also statistically at par with T_4. It was observed that in treatments receiving farmyard manure or vermicompost, the bulk density was relatively lower as compared to other treatments. For soil organic matter, T_6 recorded the maximum value (2.53%) was statistically at par with T_4 treatment, whereas, organic carbon was significantly lowest in T_1 (Farmers' practice). Improvement in organic matter content in treatments receiving farmyard manure or vermicompost or both in addition to inorganic fertilizers might be due to direct addition of organic matter through farmyard manure and vermicompost and recycling of organic materials in form of crop residues. Addition of all the organic nutrient sources along with 50% recommended dose of fertilizers i.e. T_6, T_4, T_3 and T_7 significantly improved the available N status of soil over T_1, T_2 and T_5 treatments. Similar trend was observed for P content of surface soil. Higher P content of soil was also observed in T_5 than T_2 which might be due to application of phosphorus solubilising bacteria along with 50% recommended dose of fertilizer which might have solubilized inherent and applied P. The overall increase in available N and P status due to organic materials could be ascribed to direct addition of N and P through organics to the available pool of the soil and greater multiplication of microbes which convert organically bound N and P to inorganic form.

CONCLUSION

Considering all the parameters, it becomes clear that inorganic fertilizers, vermin-compost and farmyard manure in an appropriate proportion have pronounced favorable impact on growth, yield attributes, yield and also soil properties which ultimately increase the capsule yield of large cardamom as compared to single application. Keeping in view the acreage and potential for growing this cash crop, it is necessary to popularize the use as well as production of vermin-compost along with different inorganic nutrient sources by farmers for its higher production and benefits.

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LIST OF TABLES

Table no. 1: Effect of different organic and inorganic nutrients on growth, yield and yield attributing characters of large cardamom (mean of two years data)

Treatment	Plant height (m)	No. of tillers/ Clump	No. of spikes/ clump	Spike length (cm)	No. of capsules/ clump	Yield (kg/ha)
T_1	1.19	8.1	15.2	47.3	241.5	213.5
T_2	2.18	10.2	24.7	53.1	397.6	309.5
T_3	2.26	10.7	27.6	56.5	452.6	391.4
T_4	2.37	11.5	29.8	59.2	471.7	402.2
T_5	1.78	8.6	21.1	48.7	314.2	263.3
T_6	2.47	12.4	33.2	63.6	494.9	425.8
T_7	1.98	9.3	22.5	51.2	365.4	295.4
S. Em±	0.03	0.2	0.7	0.7	5.1	6.7
C.D. at 5%	0.11	0.6	2.3	2.4	15.9	21.2

T_1, Farmers' practice (2.5 tonnes FYM/ha); T_2, RDF (NPK- 125:125:250 kg /ha); T_3, 50% RDF + FYM 15 t/ha; T_4, 50% RDF + vermicompost 5 t/ha; T_5, 50% RDF + *Azospirillum*(10 g/clump) + PSB (10 g/clump); T_6, 50% RDF + FYM 7.5 t/ha + vermicompost 2.5 t/ha + *Azospirillum* (10 g/clump) + PSB (10 g/clump) and T_7, 50% RDF + FYM 7.5 t/ha + *Azospirillum* (10 g/clump) + PSB (10 g/clump).

Table no. 2: Effect of different organic and inorganic nutrients on economics and soil properties (0-15 cm) of large cardamom field after 2 years of experimentation

Treatment	Gross cost (Rs.)	Gross return (Rs.)	Net return (Rs.)	BCR	Bulk density (g/cc)	Organic carbon (%)	Available N (kg/ha)	Available P_2O_5 (kg/ha)
T_1	27298	106750	79452	3.91	1.33	2.09	322.3	42.4
T_2	32105	164035	131930	5.09	1.30	2.21	327.3	45.2
T_3	47410	207442	160032	4.38	1.22	2.45	365.0	50.8
T_4	47150	213166	166016	4.52	1.23	2.50	368.0	51.2

T_5	34325	139549	105224	4.07	1.31	2.31	332.7	46.4
T_6	45590	225674	180084	4.95	1.20	2.53	385.7	54.0
T_7	36790	156562	119772	4.26	1.24	2.36	341.3	48.2
S. Em±	165.7	1900.8	1282.8	0.04	0.01	0.01	1.34	0.35
C.D. at 5%	519.8	5963.7	4024.9	0.15	0.02	0.03	4.22	1.08

Prevailing market price of dry capsules @ Rs. 530.00/ kg. T_1, Farmers' practice (2.5 tonnes FYM/ha); T_2, RDF (NPK- 125:125:250 kg /ha); T_3, 50% RDF + FYM 15 t/ha; T_4, 50% RDF + vermicompost 5 t/ha; T_5, 50% RDF + *Azospirillum*(10 g/clump) + PSB (10 g/clump); T_6, 50% RDF + FYM 7.5 t/ha + vermicompost 2.5 t/ha + *Azospirillum* (10 g/clump) + PSB (10 g/clump) and T_7, 50% RDF + FYM 7.5 t/ha + *Azospirillum* (10 g/clump) + PSB (10 g/clump).