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Effect of planting density and nutrients levels on solar energy interception and growth characters in cardamom (*Elettaria cardamomum*)

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Abstract

A field investigation was undertaken to study the influence of varying levels of NPK fertilizers and planting densities on the solar energy interception and growth performance of perennial psciophytic cardamom. It was found that light penetration into the canopy enhanced with increased nutrient levels, whereas it was reduced with increased planting density. All the growth characters (plant height, number of tillers and leafiness i.e. number of leaves) showed improvement with increased nutrient levels whereas they showed negative trend with increased plant densities.

Key words : Cardamom, light interception, leafiness, tillering, plant height.

Introduction

The main constraint responsible for the low productivity of cardamom in India is the lack of application of adequate quantity of external source of nutrients. Leaching and run-off losses of nutrients are also very common in the cardamom growing areas due to heavy rain and undulated topography. The crop being perennial in nature, continuous cultivation on the same piece of land leads to depletion of nutrients [2]. Cardamom keeps on producing suckers throughout the year. A steady absorption and utilization of plant nutrients take place throughout the life cycle of cardamom and hence a balanced fertilizer schedule should be followed for better fertilizer use efficiency and crop productivity [4].

In a perennial, psciophytic, tillering cardamom, appropriate planting density and geometry are the most important non-cash inputs for optimum productivity and longevity of the plantation [3]. Although cardamom is a psciophyte, it requres adequate amount of filtered sun light for optimum tillering and productivity. If the lower leaves in a plant are not properly illuminated, they do not actively participate in the phytosynthesis but their share of respiration continues [6], thus acting as a drain on sink. Proper illumination of greener parts of pseudostem and young green capsules is also essential for the higher productivity of cardamom. The inputs like nutrition and planting density indirectly influence the light interception in the cardamom canopy through their effect on tillering and other growth parameters. Hence, a study was undertaken to investigate the effect of above inputs on solar light interception and growth characters of cardamom.

Material and methods

The study was carried out at Indian Institute of Spices Research, Cardamom Research Centre, Appangala, Madikeri, Kodagu, Karnataka situated in heavy rainfall region (2679 mm) and at an elevation of 1006 m above MSL. The soil is predominantly kaolinitic having a pH of 5.3. The organic matter content in top layer is high (3.86%), but the soil is generally low in available phosphorus and potassium. The experiment was laid out in a split plot design with three levels of nutrient combinations in main plots (50:25:100, 100:50:200 and 150:75:300 kg NPK/ha) and five planting densities in subplots (2x 2 m = 2500 plants/ha, 2 x 1.5 m = 3333 plants/ha, 2 x 1 m = 5000 plants/ha, 2 x 0.75 m = 6666 plants/ha and 2 x 0.5 m 10,000 plants/ha) with two replications. The seedlings of cardamom were planted at the end of September, 1983. The experimental plot had a gentle slope of 5-8 per cent in north-south direction. Besides imposing fertilizer treatments as per the schedule, other cultural operations and plant protection measures

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Table-1. Tillering and leafiness in cardamom as influenced by NPK levels and planting density

Treatments	Plant height (cm) at 22 MAP	Number of tillers per clump at 22 MAP	Number of tillers per clump at 45 MAP	Number of green leaves per clump at 45 MAP
Fertilizer levels (NPK, kg ha^{-1})				
50:25:100	171.20	13.83	19.35	147.30
100:50:200	195.90	19.95	23.58	161.20
150:75:300	216.50	24.96	27.18	199.40
Spacing (m)				
2 x 2	157.57	27.83	33.32	256.83
2 x 1.5	181.83	24.83	25.30	196.67
2 x 1	204.83	19.75	23.60	150.50
2 x 0.75	212.17	14.77	18.67	144.50
2 x 0.5	216.17	10.71	15.97	98.00
For comparing means of				
Fertilizer levels (FL)				
SE m ±	6.60	0.59	0.36	5.61
LSD (P = 0.05)	28.41	2.52	1.55	24.16
Plant population (PP)				
SE m ±	4.52	1.03	1.47	20.04
LSD (p = 0.05)	9.87	2.25	3.02	43.67

MAP : Months after planting
NS : Not significant

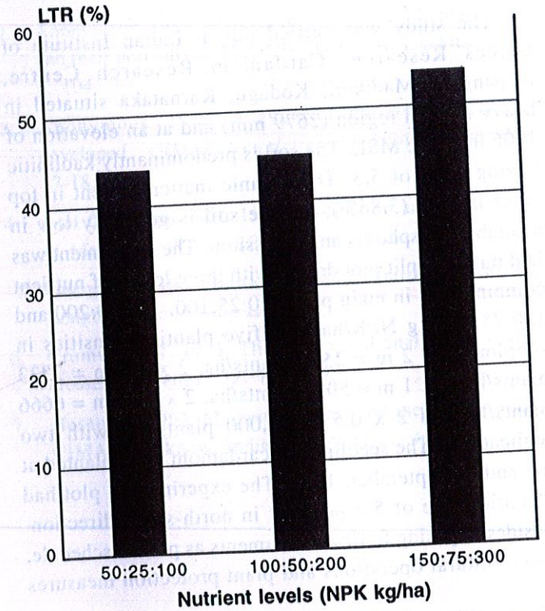

Figure-1 Solar energy interception in cardamom as affected by nutrients

were taken as per the requirement. Light transmission at the base and top of the canopy of cardamom was measured at 22nd month of growth using LUX meter and the light transmission ration (LTR) was calculated using the following formulae.

$$LTR = \frac{\text{Light received at the base of plant}}{\text{Light received at the top of canopy}} \times 100$$

Observation on number of tillers at 22 months after planting (MAP) and 45 MAP were also recorded. Average number of green leaves per clump were counted at 45 MAP stage. The plant height was also recorded at 22 MAP.

Results and discussion

Effect of NPK levels on light interception and growth

There was no significant effect of nutrients levels on the extent of light received above the canopy as well as on LTR. However, the nutrient levels significantly affected the intensity of light received at the base of the clumps (Figure-1). Highest nutrient level (150:75:300

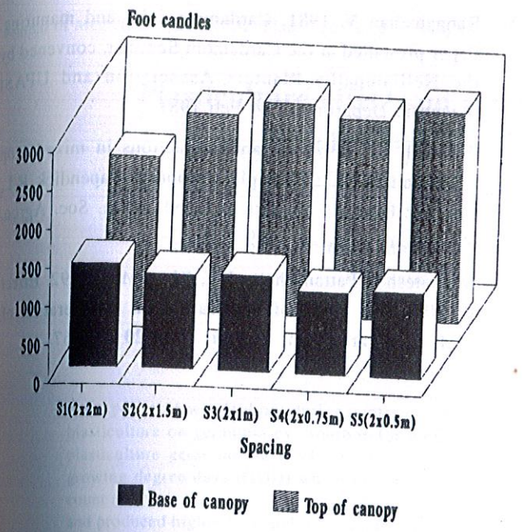

Figure-2. Solar radiation intercepted at the top and base of cardamom at different plant population density

kg NPK/ha) resulted in significantly higher intensity of light received at the base of the clump (54%). This was mainly due to increased plant height which enabled a better distribution (spread) of leaves in the canopy (Table-1). As a result, light transmission ratio was also higher at this level. Number of tillers per clump at 22 MAP and 45 MAP and number of green leaves per clump at 45 MAP showed significant improvement with increased nutrient levels (Table-1). Light transmission ratio improved significantly in taller canopies (44 to 54%). Increased plant height was mainly due to increased supply of nitrogen and other two essential macro-nutrients (P and K). There exists an important relationship between nitrogen and naturally occurring phytohormones. The activity of auxin decreases when nitrogen is deficient, leading to the retardation of plant elongation. Synthesis of new protoplasm depends on nitrogen availability to a great extent. Increased re-piration is expected during new tissue formation, because respiration is the source of energy to support protein synthesis, cell division and expansion, etc. Increase in the respiration rate increases the demand for photosynthates, which may be accomplished through increase in number of leaves, leaf area, number of tillers etc. This chain of reactions result in improvement in growth and yield.

Phosphorus plays an important role in photosynthesis because of its involvement in energy transfer system. The available phosphorus and potassium content of cardamom growing areas is intrinsically low and there is no buffering capacity of the soils to replenish the K removed either by crop or by leaching [1,5]. In this investigation also, growth and leafiness (number of leaves) showed substantial improvements upon the application of increased levels of nutrients. Earlier studies did indicate the similar response elsewhere [7].

Effect of plant densities on light interception and growth

With regards to planting density treatments, although the results were statistically not significant, increased planting density resulted in lesser penetration of light through the cardamom canopy (Figure-2). Plant height increased and number of tillers and green leaves reduced with increased plant density (Table-1). This could be due to over crowding of plants which resulted in competition for growth factors, particularly light. The extent of light interception increased due to over crowding. Under such circumstances, self-shading phenomenon sets in thereby resulting in the shading of lower leaves which get under illuminated thus reducing the photosynthetic efficiency. As plant density increases the growth rate per plant falls below that obtained from plants grown in isolation without interference. Close proximity of neighbours causes sub-optimum absorption of nutrients and utilization of growth factors and so there is sub-optimum distribution of growth resources in the plants. The resulting reduction in growth per plant and yield is compensated for by the overall total production from a large number of plants growing in an unit area. Hence, at the optimum plant density of sole crops, the production per unit area is optimal [6].

It can be concluded that for a satisfactory growth of cardamom, application of NPK @ 150:75:300 per ha and planting at a spacing of 2x1 m (5000 plants/ha) is essential.

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