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Growth of bush pepper (*Piper nigrum* L.) plants as influenced by light and nutrients

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Abstract

Experiments conducted at Sadanandapuram (Kerala, India) to study the influence of nutrients under different light intensities on growth of bush pepper (*Piper nigrum*) plants indicated that better expression of growth characters was observed at 50% light intensity in plants given 37.5 g each of nitrogen and phosphorus and 50.0 g of potassium per year.

Key words : bush pepper, growth, light, nutrients, *Piper nigrum.*

Introduction

Though India is a leading producer of black pepper (*Piper nigrum* L.) in the world, the productivity of the crop is considerably low. One of the important suggestions to bridge the gap between demand and supply of black pepper in India is to grow bush pepper, which is advantageous for urban areas since the trailing nature of the crop limits its cultivation to rural areas only. Studies conducted at IISR (1992) indicated that bimonthly application of NPK @ 1.0, 0.5, 2.0 g plant^{-1} (in 10 kg soil) was optimum. Since bush pepper is recommended for urban areas also, its nutrient requirement in the open as well as shaded conditions needs investigation.

Materials and methods

The experiment was conducted under pot culture at the Farming Systems Research Station, Sadanandapuram (Kerala, India) to study the influence of NPK fertilizers under different light intensities on growth of bush pepper. One year old bush pepper cuttings of var. Karimunda were planted in pots of 30 cm x 35 cm size filled with potting mixture prepared from soil, sand and farm yard manure taken in equal proportion. The treatments consisted of three levels of light (100, 75 and 50%) and three levels each of nitrogen and phosphorus (25.0, 37.5 and 50.0 g bush^{-1}) and potassium (50, 75 and 100 g bush^{-1}). The experiment was laid out in split plot design with 3 replications, assigning light levels to the main plots and nutrient levels to the sub plots. Black high-density polyethylene films fabricated for 50 and 75% light intensity were used for the experiments. Nitrogen, phosphorus and potassium were supplied in the form of urea, mussoriphos and muriate of potash respectively, at monthly intervals in 12 equal splits.

Observations on growth parameters were recorded at monthly intervals. The number and length of primary and secondary branches, number of leaves and total leaf area (Mohankumar & Prabhakaran 1980) were recorded.

Results and discussion

Effect of light

Varying light intensities had significant influence on all growth characters of bush pepper plants including length and number of primary and secondary branches, number of leaves and total leaf area (Table 1). The length of primary and secondary branches increased with decrease in light intensity from 100 to 50%. Maximum length of primary branches (28.43 cm) and secondary branches (29.28 cm) was attained in 50% light. The increased length obtained under shaded condition may be due to lesser photosynthetically active radiation obtained under the situation

Table 1. Effect of light and nutrient levels on growth parameters of bush pepper plants

Treatment	No. of branches		Length of branches (cm)		No. of leaves	Total leaf area (cm^2)
	Primary	Secondary	Primary	Secondary		
Light $level_1$	1.74	6.14	16.21	16.00	30.72	1795.17
Light $level_2$	3.09	8.47	21.70	23.05	60.41	3314.17
Light $level_3$	3.28	10.89	24.83	29.28	94.68	5013.24
F test	S	S	S	S	S	S
SE±m	0.26	0.28	1.29	0.74	6.31	256.52
CD (P<0.05)	0.89	0.96	4.47	2.58	21.85	887.69
Nutrient level						
N_1	2.04	8.21	22.90	22.73	60.91	3250.39
N_2	3.37	9.14	24.60	22.47	59.93	3152.27
N_3	2.36	8.15	18.83	22.61	64.96	3719.91
F test	S	S	S	S	S	S
P_1	3.26	8.32	21.36	23.02	65.90	3676.28
P_2	2.75	8.84	23.48	21.74	53.31	2983.11
P_3	2.10	8.33	21.49	24.04	66.59	3463.19
F test	S	S	S	S	S	S
K_1	2.51	8.57	22.90	24.66	64.24	3669.85
K_2	3.03	8.28	21.30	22.61	66.31	3442.11
K_3	2.58	8.63	22.13	21.54	55.26	3010.62
F test	S	NS	NS	S	S	S
SE±m	0.10	0.13	0.70	0.22	1.37	76.47
CD (P<0.05)	0.29	0.36	1.93	0.60	3.79	211.95

S = Significant; NS = Non significant
L_1 = 100%; L_2 = 75%; L_3 = 50%
N_1 - N_3 and P_1 - P_3 = 25.0, 37.5 & 50.0 g $bush^{-1}$; K_1 - K_3 = 50, 75 & 100 g $bush^{-1}$

(Attridge 1990). High irradiance results in high rates of transpiration which are likely to result in internal deficiencies of water and a consequent retardation of cell division or cell elongation. This may be the possible reason for the reduced length of branches under open condition. Similar results were reported in black pepper vines by Senanayake & Kirthisinghe (1983).

Branching was maximum under 50% light. The reduction in photosynthetically active radiation received may be the reason for the increased vegetative growth under partially shaded condition (Attridge 1990). Similar results were obtained in black pepper vines by Senanayake & Kirthisinghe (1983) and Mathai & Sasthry (1988).

Maximum number of leaves were produced under 50% light followed by 75% light. Under shade, the production as well as retention of leaves was higher. Under shaded condition, reduced radiation may prevent scorching or wilting of leaves caused by marked increase in temperature within the leaf tissue from strong sunlight (Aasha 1986) and thereby increase the leaf life under shade resulting in maximum retention of leaves. Senanayake & Kirthisinghe (1983) reported the same in black pepper vines. In the open condition, the number of leaves was minimum. This may be due to scorching and wilting of leaves under high light intensity (Aasha 1986).

The total leaf area of plants followed the same

pattern as the number of leaves, increasing from 100 to 50% light intensity. The tendency of plants to increase the leaf area from no shading to moderate shading as observed in the present investigation may perhaps be a plant adaptation to expose larger photosynthetic surface under limited illumination (Attridge 1990).

Effect of nutrients

Nitrogen application influenced the length and number of primary and secondary branches, number of leaves and total leaf area of bush pepper plants significantly (Table 1). The importance of nitrogen on vegetative growth of black pepper has been reported by Waard (1969), Nybe & Nair (1987) and Geetha & Aravindakshan (1992).

Phosphorus application had a significant effect on length and number of primary and secondary branches, number of leaves and total leaf area. The increase in length and number of branches may be due to higher metabolic activity coupled with rapid cell division brought about by increased phosphorus levels (Bear 1965). Since phosphorus is a constituent of cell nucleus, it is closely associated with cell division and meristematic activity and hence results in better branching. The increased root growth and activity resulting from application of phosphorus would have encouraged extensive exploitation of both soil nutrients and moisture resulting in higher number of functional leaves. Similar results were reported by Geetha & Aravindakshan (1992) in bush pepper.

Potassium application had a significant effect on the length of secondary branches, number of primary branches, number of leaves and total leaf area. The importance of potassium on vegetative growth of plants has been reported by Tisdale *et al.* (1995). Potassium activates the enzymes present in the meristematic tissue where cell division and cell elongation take place rapidly. Significant increase in the length of branches due to application of potassium has been reported earlier by Waard (1969) and Nybe & Nair (1987) in black pepper vines. Potassium absorbed during the vegetative period of plant growth would have helped the production of maximum number of branches (Mengel & Kirbky 1980).

Interaction of light and nutrients

Significant interaction between light and nutrients was noted with respect to all growth characters studied namely, number and length of primary and secondary branches, number of leaves and total leaf area (Table 2).

In the open condition, better expression of all growth characters was observed from low to medium level of nitrogen and phosphorus (25.0 to 37.5 g bush^{-1}). The plants also responded to the lowest level of potassium (50 g bush^{-1}) in the open condition. Compared to plants under 75% and 50% light, the vegetative growth of plants in the open condition was poor. Here, transpiration rates are high, so even when a plant is well watered, water stress may develop due to the heat of the day if water absorption by roots fails to keep pace with transpiration (Noggle & Fritz 1992). The poor soil moisture status and high soil temperature prevailing under direct sun might have limited the capacity of plants to utilize higher doses of nutrients.

Under 75% light, better expression of all growth characters was at medium level of nitrogen (37.5 g bush^{-1}) except number of leaves and leaf area, where 25 g was found optimum. This may be due to the reason that the number of leaves produced and leaf area developed by the application of 25 g nitrogen may be sufficient for intercepting 75% of light. With respect to phosphorus, better experssion of all growth characters except length of primary branches was noted at the lowest level of phosphorus (25 g bush^{-1}). Phosphorus is an element which is involved in early establishment of plants (Tisdale *et al.*1995). So higher doses of phosphorus might have not been utilized for vegetative growth. The uptake of phosphorus was also less at this level. This may be due to less moisture in the soil due to which absorption was restricted (Noggle & Fritz 1992). All the growth characters studied responded up to 75 g potassium under this light intensity.

Under 50% light, response to nitrogen levels was not consistent for different growth parameters. Being a perennial crop, black pepper vines will take at least 2 years for full expression of all growth characters due to various treatments. This may be the reason for the inconsistent response of growth parameters to applied nitrogen.

Length of primary and secondary branches were maximum at the lowest level of nitrogen (25 g bush^{-1}). Under shaded condition, plants in general show a tendency to elongate (Attridge 1990). So the role played by nutrients to effect increase in

Table 2. Effect of interaction of light with nitrogen, phosphorus and potassium on growth parameters in bush pepper plants

Light/ NPK level	No. of branches		Length of branches		No. of leaves	Total leaf area(cm^2)
	Primary	Secondary	Primary	Secondary		
L_1N_1	10.41	6.11	15.36	16.96	30.07	1408.70
L_1N_2	2.15	6.59	20.21	16.04	29.78	2018.29
L_1N_3	1.67	5.70	13.06	15.00	32.30	1958.52
L_2N_1	2.39	8.19	23.17	23.74	71.70	3827.48
L_2N_2	3.89	9.00	23.85	22.78	57.07	2823.33
L_2N_3	3.00	8.22	18.08	24.04	52.44	3291.70
L_3N_1	3.37	10.33	30.17	30.48	80.96	4515.00
L_3N_2	4.07	11.82	29.76	28.59	92.93	4615.19
L_3N_3	2.41	10.52	25.35	28.77	110.14	5909.52
F test	S	S	S	S	S	S
L_1P_1	2.26	5.67	16.46	16.42	37.44	2052.67
L_1P_2	1.59	6.44	15.72	13.35	23.59	1341.85
L_1P_3	1.37	6.30	16.44	18.23	31.11	1991.00
L_2P_1	3.74	8.33	19.51	24.25	69.84	3980.56
L_2P_2	3.37	8.74	24.63	23.63	53.41	3173.07
L_2P_3	2.15	8.33	20.96	22.67	57.96	2788.89
L_3P_1	3.78	10.96	28.11	28.38	90.41	4995.63
L_3P_2	3.30	11.33	30.10	28.24	42.93	4434.41
L_3P_3	2.78	10.37	27.08	31.22	110.7	5609.67
F test	S	S	S	S	S	S
L_1K_1	1.85	6.15	16.84	16.60	39.07	2078.41
L_1K_2	1.93	5.63	15.97	16.40	27.82	1730.74
L_1K_3	1.44	6.63	15.80	15.00	25.26	1576.37
L_2K_1	2.78	8.67	22.35	25.40	57.85	3482.59
L_2K_2	3.48	8.26	21.45	22.01	68.41	3561.29
L_2K_3	3.00	8.48	21.29	23.15	54.96	2898.63
L_3K_1	2.89	10.89	29.54	31.99	95.78	5448.55
L_3K_2	3.67	10.89	26.46	29.41	102.70	5034.29
L_3K_3	3.30	10.89	29.28	26.45	85.56	4556.85
F test	S	S	S	S	S	S
SE±m	0.18	0.28	1.21	0.38	2.37	132.44
CD ($P<0.05$)	0.49	0.63	3.34	1.05	6.56	357.12

S = Significant; NS = Non significant

L_1=100%; L_2=75%; L_3=50%.

N_1-N_3 and P_1-P_3 = 25.0, 37.5 & 50.0 g $bush^{-1}$; K_1-K_3 = 50, 75 & 100 g $bush^{-1}$

length is less marked compared to shade. This may be reason for the increased length of primary and secondary branches at the lowest dose of nitrogen.

The number of leaves and hence leaf area increased with nitrogen and phosphorus doses. This may be due to better soil moisture status and moderate light intensity available to the plants, which favoured increased uptake of nutrients. The plants showed positive response to phosphorus and potassium levels for medium to highest levels in terms of all growth characters. This may be due to increased uptake of these nutrients under 100% light.

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