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RESPONSE OF BLACK PEPPER TO FOLIAR APPLICATION OF MAGNESIUM AND BORON

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ABSTRACT

A green house experiment was conducted at College of Agriculture, Padannakkad, Kerala to study the response of black pepper to foliar application of magnesium and boron. The experiment was laid out in completely randomized design replicated thrice with nine treatments using Panniyur-1 as the test variety. The results revealed that the foliar application of 1% $MgSO_4$ + 0.5% borax increased B and Mg content in pepper leaves.In general B and Mg content in leaves increased up to 6 MAP followed by a reduction at 9 MAP irrespective to various treatments. The maximum leaves vine^{-1} (48.6), leaf area (95.10cm^{-2}) and branches vine^{-1} (11.00) were recorded with 1% Mg SO_4 + 0.5% borax foliar application. The lowest values of these growth characters were recorded under control. The spikes vine^{-1} (38.33), berries spike^{-1} (102.0), 100 berry weight (6.61g) and berry yield (122.0 g) were recorded by foliar application of 1% $MgSO_4$ + 1.0% borax. The highest oleoresin (11.73%) and piperine (5.87%) content were obtained with foliar application of 1% $MgSO_4$ + 1% borax. Foliar application of 1% Mg SO_4 + 0.5% borax proved next best treatment in improving these parameters.

Key words: Magnesium, boron, black pepper, oleoresin, piperine

INTRODUCTION

Black pepper (*Piper nigrum*L.), the king of spices is mainly cultivated in warm, humid and high rainfall regions. It is an economically important and widely used spice crop indigenous to the Western ghats of Kerala. The dried berry obtained from the vines has a commercial value as an important spice condiment used all over the world. It is also valued for its oleoresin and medicinal properties. The low productivity of black pepper in India is due to poor genetic potential of the vines, high population of senile and unproductive vines, losses caused by pests, diseases and soil constraints. Among these, soil related stress like acidity and nutrient deficiencies are major ones. Pepper requires a porous friable soil, having good drainage, adequate water holding capacity, rich in humus and essential plant nutrients. In Kerala, pepper is cultivated in laterite soils, which is acidic, generally low in plant nutrients, low in cation exchange capacity with weak retention capacity of bases applied as fertilizers. So the secondary and micronutrient deficiencies are frequent in these soils. Magnesium is an important element required for the growth of pepper plant. It plays an important role in photosynthesis. It also plays an important role in the cell energy balance, interacting with the pyrophosphate structure of nucleotide tri and di-phosphates (Igamberdiev and Kleczkowski, 2003). Magnesium deficiency in plants often results in ultra structural changes especially in chloroplast, well before visible foliage symptoms are obvious. This is accompanied by impairment of photosynthesis (Sun and Payn, 1999). The total magnesium reserves in Kerala soils are poor and thus magnesium can be considered as a critical element in the acid soils of Kerala. Magnesium application is required for crops grown in soils with magnesium content below the critical limit of 120 mg kg^{-1}. Boron is an important essential micronutrient required for plant growth and reproduction (Siddiky*et al.,* 2007). Boron has a primary role in cell wall biosynthesis, cell division, lignification of cell wall, membrane function, RNA metabolism, indole acetic acid (IAA) production, phenol metabolism, carbohydrate metabolism, sugar transport, nucleotide synthesis, respiration (Sims and Jhonson, 2003). Boron deficiency symptoms in black pepper are yellowing starting from the centre to the extremities in younger leaves. Malformed terminal buds show reduced development and development of dark spots between veins and leaf margins. Some younger leaves are curved downside with a rosette appearance (Velso*et al.,* 1998). These symptoms are widespread in the pepper growing

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areas of Kerala. Application of B is essential for crops grown in soils with available B below critical limit of 0.5 mg kg^{-1}. The present investigation was therefore, undertaken to study the response of black pepper to foliar application of magnesium and boron.

MATERIALS AND METHODS

A green house experiment was conducted at College of Agriculture, Padannakkad during 2012-14. Three months old black pepper var. Panniyur-1 (bush) plants were planted into the earthen pots filled with twenty kilograms of laterite soil. The experimental soil was sandy clay loam belonging to order Inceptisol, having pH 5.81, EC 0.18 dSm^{-1}, organic carbon 17 g kg^{-1}, available nitrogen 460.5 kg ha^{-1}, available P_2O_5 10.8 kg ha^{-1}, available K_2O 98.7 kg ha^{-1}, available Mg 14.80 mg kg^{-1} and available B 0.30 mg kg^{-1}. The experiment was laid out in completely randomized design replicated thrice with nine treatments using Panniyur-1 as the test variety. There were 9 treatments *viz.,* T_1- 0.5% $MgSO_4$, T_2- 0.5% $MgSO_4$ + 0.5% borax, T_3- 0.5% $MgSO_4$ + 1% borax, T_4-1% $MgSO_4$, T_5- 1% $MgSO_4$ + 0.5% borax , T_6-1% $MgSO_4$ + 1% borax, T_7- 0.5% borax, T_8-1% borax and T_9- control. Nitrogen, P and K fertilizers were applied as per package of practices recommendations. Magnesium as magnesium sulphate and boron as borax solutions (0, 0.5 and 1%) were sprayed at now flushing and spike initiation stage. Leaf samples were collected at 3, 6 and 9 months after planting and analyzed for boron and magnesium content. Magnesium was determined in di acid (HNO_3 and $HClO_4$) mixture with the help of flame photometer. Boron was analysed by azomethen-H colorimetric method (Bingam, 1982). The oleoresin content of dried berries was estimated using the Soxhlet method of extraction as per Horwitz (1980). The piperine content in dried berries of pepper was determined by uv-spectrophotometric method described by Kolhe *et al.* (2011). Observations *viz.,* leaves $vine^{-1}$, branches $vine^{-1}$, leaf area, yield and yield attributes, and quality parameters were recorded. The results obtained were statistically analyzed using statistical analysis software (SAS).

RESULTS AND DISCUSSION

The boron content of leaves increased from 3 MAP to 6 MAP. At 6 MAP, treatment T_6 (1% $MgSO_4$ + 1% borax) recorded highest boron content of 57.34 mg kg^{-1} (Table 1). At nine months after planting, there was a decline in boron content in all treatments compared to previous stage. There was significant difference among treatments with respect to boron content in leaves. At 9 MAP, highest value was obtained in T_6 (51.83 mg kg^{-1}) and minimum in control (Table 1). The higher dose of foliar B application increased the B status in leaves, indicating that B is absorbed by leaves and is redistributed to developing sinks (Akram *et al.* 2006). Foliar application of 1% Mg SO_4+ 0.5% borax, being at par with 1% Mg SO_4 + 1% borax , also increased the boron content in leaves at all the stages of growth over other treatments. Foliar application of Mg did not affect the B content in leaves significantly over control at all the stages of growth. The leaves of plants grown under control treatment had minimum values of boron content at all the stages of growth.

Table 1: Effect of foliar application on boron and magnesium content in pepper leaves at different stages

Treatments	Boron (mg kg^{-1})			Magnesium (%)		
	3 MAP	6 MAP	9 MAP	3 MAP	6 MAP	9 MAP
T_1 – 0.5% $MgSO_4$	31.82	27.83	21.83	0.30	0.53	0.31
T_2 – 0.5% $MgSO_4$ + 0.5% borax	36.65	45.00	36.65	0.28	0.52	0.31
T_3 – 0.5% $MgSO_4$ + 1% borax	36.66	45.00	40.00	0.27	0.53	0.33
T_4 – 1% $MgSO_4$	32.33	27.66	23.83	0.28	0.60	0.39
T_5 – 1% $MgSO_4$ + 0.5% borax	34.16	54.16	49.65	0.30	0.66	0.41
T_6 – 1% $MgSO_4$ + 1% borax	38.00	57.34	51.83	0.28	0.66	0.38
T_7 – 0.5% borax	35.83	50.33	48.00	0.27	0.24	0.19
T_8 – 1% borax	37.50	52.19	49.82	0.28	0.24	0.17
T_9 – control	30.00	26.50	21.66	0.29	0.21	0.14
CD (5%)	NS	6.22	6.62	0.01	0.03	0.02

After three months of planting the highest content of magnesium in leaves was noticed in T_1 (0.30%) and T_5 (0.30%) which were significantly higher than other treatments. At six months after planting the highest magnesium content in leaves was recorded in T_5 (0.66%) (Table 1). At nine months after planting, the highest value was recorded in T_5 (0.41%), which was significantly higher than other treatments. Application of higher doses of Mg SO_4 helped in the better absorption and translocation of Mg to pepper leaves. Treatments T_5 and T_6 were almost equally effective in improving the magnesium content in leaves at all the stages of growth. This clearly indicates positive influence of treatments on magnesium nutrition of pepper.Foliar application of boron did not influence the Mg content in leaves markedly at all the stages of growth..The lower values of Mg content in leaves at all the stages of growth were recorded under control. The treatment T_6 (1% $MgSO_4$ + 1.0% borax) recorded maximum leaves vine^{-1} (48.6), leaf area (95.10 cm^2) followed by T_5 treatment. The maximum branches vine^{-1} (10.00) was recorded in T_6 (Table 2) and minimum under control.

Table 2: Effect of foliar application of Mg and B on growth parameters of black pepper

Treatment	Leaves vine^{-1}	Total Leaf area (cm^2)	Branches vine^{-1}
T_1 – 0.5% $MgSO_4$	43.66	85.93	7.33
T_2 – 0.5% $MgSO_4$ + 0.5% borax	45.00	87.92	7.65
T_3 – 0.5% $MgSO_4$ + 1% borax	47.66	88.12	8.33
T_4 – 1% $MgSO_4$	45.66	88.07	8.00
T_5 – 1% $MgSO_4$ + 0.5% borax	47.00	94.00.	9.33
T_6 – 1% $MgSO_4$ + 1% borax	48.60	95.10	10.00
T_7 – 0.5% borax	41.33	87.04	7.60
T_8 – 1% borax	45.33	89.93	8.33
T_9 – control	40.00	81.15	6.33
CD (5%)	12.25	8.24	0.83

The foliar application of magnesium increased the chlorophyll content and photosynthetic rate of the plants which is translated into higher dry matter production. This coupled with the influence of boron on the enzyme system and metabolism of the plant resulted in more number of leaves, leaf area and branches. The role of Mg and B in cell differentiation and development, translocation of photosynthates and growth regulators from source to sink also contributed to the above parameters. Similar results were reported by Mostafa *et al.* (2007).

Table 3: Effect of foliar application of B and Mg on yield and yield attributes of black pepper

Treatment	Spikes vine^{-1}	Spike length (cm)	Spike yield (fresh) (g vine^{-1})	Berries spike^{-1}	100 berry weight (g)	Spike dry yield (g vine^{-1})	Dry berry Yield (g)
T_1 – 0.5% $MgSO_4$	33.00	10.55	311.9	89.00	5.75	117.3	108.6
T_2 – 0.5% $MgSO_4$ + 0.5% borax	35.66	11.56	324.2	89.86	5.94	121.4	110.0
T_3 – 0.5% $MgSO_4$ + 1% borax	36.66	11.66	326.4	95.40	5.88	122.8	113.5
T_4 – 1% $MgSO_4$	34.33	11.88	325.9	94.92	6.00	120.3	113.3
T_5 – 1% $MgSO_4$ + 0.5% borax	36.00	12.22	340.0	100.60	6.37	126.0	120.7
T_6 – 1% $MgSO_4$+1% borax	38.33	13.66	335.7	102.00	6.61	128.0	122.0
T_7 – 0.5% borax	32.00	10.22	308.0	88.20	6.39	116.6	101.6
T_8 – 1% borax	35.66	10.24	310.7	90.93	6.41	123.9	111.6
T_9 – control	30.66	9.22	300.4	84.73	4.36	100.1	90.43
CD (5%)	4.26	1.05	12.43	5.19	1.09	10.81	12.01

Yield and yield attributes

Foliar application of 1% $MgSO_4$ + 1% borax recorded minimum number of spikes per vine (38.33), berries per spike (102.0), 100 berry weight (6.61 g) and berry yield (120.0 g). The maximum spike length was measured in T_6 (11.56 cm). The highest spike yield (385.7 g vine^{-1}) and spike yield (dry) (128.0 g vine^{-1}) was recorded in T_6 treatment (Table 3) which may be due to higher requirement of boron for reproductive growth than vegetative growth. Boron increases flower production and retention, pollen tube germination and seed and fruit setting (Oosterhuis, 2001). More number of spikes and higher 100 berry weight due to application of Mg and B might be due to involvement of B in reproductive growth as B improves the spike fertility.The higher amounts of B and Mg used in spraying proved superior to lower levels of these elements in respect of yield attributes and yield. The minimum values of yield attributes and yield were recorded under control.

Quality parameters

The contents of oleoresin and piperine contents in black pepper ranged from 11.14 to 11.73% and from 5.06 to 5.87%, respectively. The foliar application of 1% $MgSO_4$ + 1% borax (T_6) recorded highest oleoresin content of 11.73% which was on par with T_5 (11.51%) (Table 4). The highest content of piperine was recorded in T_6 (5.87%) (Table 4). The minimum values of oleoresin and pipperine content in black pepper were recorded under control.Boron is required for many enzymatic processes, which might have contributed to the improved quality parameters of black pepper as reported by Villarias*et al.,* 2000. This might also be attributed to the fact that magnesium act as an activator or co-factor of many enzymes in plants and in various metabolic process as reported by Cowan, (2002).

Table 4: Effect of foliar application of Mg and B on quality parameters of black pepper

Treatments	Oleoresin (%)	Piperine (%)
T_1–0.5% $MgSO_4$	11.32	5.51
T_2–0.5% $MgSO_4$ + 0.5% borax	11.34	5.61
T_3–0.5% $MgSO_4$ + 1% borax	11.42	5.80
T_4 – 1% $MgSO_4$	11.26	5.89
T_5 – 1% $MgSO_4$ + 0.5% borax	11.51	5.80
T_6 – 1% $MgSO_4$ + 1% borax	11.73	5.87
T_7 – 0.5% borax	11.34	5.25
T_8 – 1% borax	11.45	5.36
T_9 – control	11.14	5.06
CD (5%)	0.26	0.33

It may be concluded from the study that foliar application of Mg and B (1% Mg SO_4 + 0.5% borex) proved superior in respect of leaf nutrient content,yield parameters and berry yield, oleoresin and piperine content in black pepper. Foliar application of Mg and B may be recommended for the successful cultivation of black pepper in the area.

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