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Soil amendments and molybdenum on yield and quality of black pepper (*Piper nigrum*)

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ABSTRACT

A study was conducted during 1996–99 at Calicut under green house and field in Mo deficient acidic soils to study the effect of soil amendments (lime, farmyard manure) and Mo on soil availability, plant uptake, yield and quality of black pepper (*Piper nigrum* L.). Under the greenhouse condition, soil application of Mo @ 0.25 mg/kg of soil enhanced the yield and quality of black pepper. Among the amendments farmyard manure @ 100 g/pot enhanced the yield while lime @ 20 g/pot increased the piperine content by 4.2%. Under field condition, lime application (0.5 tonne/ha) gave significantly highest yield and benefit : cost ratio (4.58). The Mo availability in the soil was highest for soil application of lime (0.5 tonne/ha) followed by Mo @ 0.5 kg/ha.

Key words: Amendments, Farmyard manure, lime, Mo, Yield, Quality, Black pepper

Black pepper (*Piper nigrum* L.) is cultivated mainly in the warm humid and high rainfall regions on the slopes of western ghats of south India where the soils are acidic, poor in Mo and high in Cu. The high Cu status of these soils is owing to constant application of Bordeaux mixture to arrest fungal diseases and this has further aggravated Mo deficiency due to the antagonistic interaction between Cu and Mo (Sadanandan 2000). The acid soils are apt to be more deficient in Mo (Misra 2004). Information is lacking on the effect of Mo in conjunction with soil amendments on the yield and quality of black pepper. The present investigation was therefore undertaken to study the effect of amendments and Mo on yield, quality and economics of black pepper production.

MATERIALS AND METHODS

Greenhouse experiment

A pot culture experiment was conducted in the green-house of IISR, Calicut during 1996–1999. The Mo deficient (0.16 mg/kg) black pepper growing soil from Pulpally, Wayanad (Kerala) having *p*H 5.9, lime requirement 3 tonnes/ha, organic carbon 1.1%, Bray P 11 mg/kg, exchangeable K, Ca and Mg 110, 792 and 140 mg/kg respectively, available S 21 mg/kg DTPA extractable Fe, Mn, Zn and Cu 46, 33, 1.4, 2.6 mg/kg respectively with available Mo, 0.16 mg/kg was used. The soil was sieved, weighed (10 kg) and filled in earthen pots of 15 cm lined with polythene sheet. Three-month-old 'Karimunda' bush black pepper was planted and a uniform dose of NPK @ 1, 0.5, 2 g/pot was applied at bimonthly intervals for the establishment of the saplings (Sadanandan and Hamza 1998). After 3 months of establishment, the following treatments were super imposed, (i) check (without amendments), (ii) 100 g farmyard manure/pot, (iii) 0.25 mg Mo/kg of soil, (iv) 0.5 mg Mo/kg, (v) 20 g lime/pot, (vi) 0.25 mg Mo/kg of soil + 20 g lime/pot, (vii) 0.1% foliar spray of sodium molybdate and (viii) 0.2% foliar spray of sodium molybdate. The experiment was laid in complete randomized design with 4 replications. Soil nutrient availability, leaf and berry content of Mo, morphological characters and yield were recorded.

Field experiment

The field experiment was conducted during 1996–99 at Boikeri, Kodagu district of Karnataka. The soil characteristics of fields were: lime requirement 3 tonnes/ha, *p*H 5.35, organic C 2.3%, Bray P 3 mg/kg, exchangeable K, Ca and Mg 212, 996 and 156 mg/kg respectively, available S 66 mg/kg DTPA extractable Fe, Mn, Zn and Cu 28, 29, 0.88 and 5.8 mg/kg respectively and available Mo 0.21 mg/kg. Five-year-old 'Panniyur 1' black pepper vines having uniform growth trailed on *Erythrina indica* support (called as standard) were selected at random for the experiment. Six vines were used per treatment in a randomized block design with 3 replications. A uniform dose of NPK @ 100, 40, 140 g/vine/year was applied (Sadanandan 2000). The following treatments were imposed, (i) check (no amendment), (ii) 10 tonnes farmyard manure/ha, (iii) 0.5 kg Mo/ha, (iv) 0.5 tonnes lime/ha, (v) 0.25 kg Mo + 0.5 tonnes lime/ha, (vi) 0.5 kg Mo + 0.5 tonnes lime/ha, (vii) 0.1% foliar spray of sodium molybdate and (viii) 0.2% foliar spray of sodium molybdate.

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Table 1 Effect of amendments and Mo on soil, leaf and berry content of Mo, yield and quality of black pepper (mean of 3 years) under field condition

Treatment	Soil Mo (mg/kg)	Leaf Mo (mg/kg)	Berry Mo (mg/kg)	Dry yield (kg/vine)	Oleoresin (%)	Piperine (%)	Benefit : cost ratio
Check	0.21	3.0	0.89	1.27	8.03	5.76	4.06
FYM (10 tonnes/ha)	0.33	3.4	0.90	1.38	8.25	5.91	4.02
Mo (0.5 kg/ha)	0.35	4.0	0.93	1.45	8.52	6.19	4.57
Lime @ 0.5 tonnes/ha	0.35	3.4	0.87	1.47	8.29	6.09	4.58
Mo (0.25 kg) + lime (0.5 tonnes/ha)	0.39	3.5	0.91	1.43	8.31	5.76	4.41
Mo (0.5 kg) + lime (0.5 tonnes/ha)	0.47	4.0	0.97	1.45	8.40	5.92	4.43
Mo (0.1%) foliar	0.32	4.8	1.02	1.40	8.05	5.93	4.31
Mo (0.2%) foliar	0.33	5.3	1.11	1.33	8.36	5.75	3.98
CD ($P = 0.05$)	0.02	0.14	0.10	0.09	0.16	0.19	

FYM, Farmyard manure; Mo, molybdenum

Table 2 Effect of amendments and Mo on soil, leaf and berry Mo content, production of spikes, yield and quality (oleoresin and piperine content) of bush pepper under greenhouse condition.

Treatment	Soil Mo (mg/kg)	Leaf Mo (mg/kg)	Berry Mo (mg/kg)	No. of spike	Dry yield (g/pot)	Oleo-resin)%)	Piperine (%)	Benefit : cost ratio
Control	0.16	2.6	0.8	20	84	9.10	7.09	1.3
FYM (100 g/pot)	0.42	3.1	0.9	27	102	9.13	7.07	1.6
Mo (0.25 mg/kg soil)	0.38	2.8	0.9	23	103	9. 84	7.17	1.6
Mo (0.5 mg/kg soil)	0.46	3.1	1.0	23	98	9. 49	7.20	1.6
Lime (20 g/pot)	0.38	2.8	1.3	16	92	9.34	7.39	1.5
Mo (0.25 mg/kg) + lime	0.45	3.0	1.4	21	96	9.65	7.30	1.5
Sodium molybdate (0.1%) as foliar spray	0.18	3.6	1.4	23	99	9.73	7.21	1.6
Sodium molybdate (0.2%) as foliar spray	0.24	4.5	1.4	23	79	9.93	7.36	1.3
CD ($P = 0.05$)	0.03	0.16	0. 20	1.4	6	0.30	0.13	

FYM, Farmyard manure; Mo, molybdenum

Foliar spray was given twice/year during June and September. Liming was done during May and all other treatments during June every year. Soil, leaf and berry samples were collected during March just before the harvest of crop and analyzed for different nutrients including Mo in soil, leaf and berry (Black 1965). Crop quality with respect of oleoresin and piperine were also analyzed (ASTA 1968).

RESULTS AND DISCUSSION

Greenhouse experiment

Soil availability of Mo was significantly increased (0.46 mg/kg) due to Mo application @ 0.5 mg/kg but was on par with the treatment 0.25 mg Mo/kg+ lime (Table 1). Leaf and berry Mo were significantly increased due to 0.2% foliar Mo application. Number of spikes and yield were significantly higher in farmyard manure treatment. Oleoresin content of berry was increased owing to 0.2% foliar Mo treatment. Piperine content was enhanced due to lime treatment and Mo treatments. With regards to benefit: cost ratio, application of FTM (100 g/pot), Mo (0.25 or 0.5 mg/kg) or lime (20 g/pot) were on par.

Field experiment

Application of Mo @ 0.5 kg/ha (followed after lime application @ 0.5 tonnes/ha) recorded significantly highest soil availability of Mo. Significantly higher leaf and berry Mo were recorded due to 0.2% foliar Mo. The yield was maximum (1.47 kg/vine) in the lime treatment (0.5 tonne/ha) but was on par with all other amendments except 0.2% foliar Mo. The oleoresin and piperine contents were significantly enhanced owing to application of 0.5 kg Mo/ha. The economic analysis (B : C ratio) showed that the application of lime @ 0.5 tonne/ha was superior followed by Mo @ 0.5 kg/ ha (Table 2). The contribution of Mo to pepper may be either due to application of Mo @ 0.5 kg or due to increased availability of Mo by liming. Even though Mo requirement of the vines are at low level, application of Mo at 0.5 kg/ha and/ or liming have contributed to the Mo pool in the soil solution and hence increased yield of crop.

Organic manures like farmyard manure also contribute to the availability of Mo in the soil. Mo is required for N metabolism in plants and availability of Mo could lead to

increased N metabolism resulting in increased proteins, amino acids and oil production in black pepper. This could be one of the reasons for increase in oil, oleoresin and piperine contents contributed by increased Mo availability. The increase in Mo availability in acid soils by liming is due to exchange of MoO_4^{2-} and $HMoO_4^-$ anion for OH group of clay. Mishra (2002) also reported the response of crops to liming without Mo application while Pattanayak *et al.* (2005) found significant increase in yield of crops due to application of lime and farmyard manure and Hamza and Sadanandan (2005) due to Mo. It was reported that strongly acid soils may be managed with lime, but moderately acid soils be managed with sufficient quantity of organic amendments (Misra 2004).

It may be concluded that in Mo deficient acidic soils applying lime @ 0.5 tonne/ha and/ or Mo @ 0.5 kg/ha enhances the Mo availability in the soil and concentration in the leaves, maximizes the economic yield of black pepper and quality of the produce. Foliar spray of 0.1% sodium molybdate also contributes to the economic yield of black pepper.

REFERENCES

ASTA. 1968. *Official Analytical Methods*, p 38, 2nd edn. American Spice Trade Association, New York.

Black C A. 1965. *Method of Soil Analysis*, 1 572 p. Part 2. American Society of Agronomy Inc., Madison, Wisconsin, USA.

Hamza S and Sadanandan A K. 2005. Response of black pepper to molybdenum nutrition. *Indian Journal of Agricultural Sciences* **75**(5) : 294–5.

Mishra M. 2002. 'Response of crops to graded doses of lime amended with or without FYM'. Ph D thesis, Orissa University of Agriculture & Technology, Bhubaneswar, Orissa.

Misra U K. 2004. Acid soils and its management. *Journal of Indian Society of Soil Science* **52**(4) : 332–43.

Pattanayak S K, Mohanty R K and Sethy A K. 2001. Response of okra to *Azotobacter* and *Azospirillum* inoculation grown in acid soil amended with lime and FYM. Paper presented at the North East Regional conference on biofertilizers, AAU Jorhat, Assam, pp 35.

Sadanandan A K. 2000. Agronomy and nutrition of black pepper. (*in*) *Black Pepper*, pp 163–223. Ravindran P N (Ed). Harwood Academic Publishers, New Delhi.

Sadanandan A K and Hamza S 1998. Studies on nutrient requirement of bush pepper for yield and quality. (*in*) *Development in Plantation Crop Research* pp 223–7. Mathew M and Kuruvila Jacob (Eds). Allied Publishers & RRII, Kottayam.