Indian J. Hort. 65(1), March 2008: 102-105

Short communication

Effect of foliar spray of micronutrients in banana under high soil pH condition

K.J. Jeyabaskaran* and S.D. Pandey

National Research Centre for Banana, Thogamalai Road, Thayanur Post, Tiruchirapalli 620 102

Among the micronutrients required by banana, iron, zinc and boron are found to be major yield limiting factors in India. Nearly, 5.9, 4.7 and 1.27 kg of Fe, Zn and B, respectively are absorbed per hectare for optimum production of banana based on the total uptake of these micronutrients (Lahav, 5). Generally, the micronutrients are given to banana through either soil or foliar application. In soil, where pH is greater than 8.5, the availability of micronutrients to banana crop is not at sufficient level, even though the soil is rich or applied with sufficient quantities of micronutrients. Turner *et al.* (10) found that zinc deficiency was more common in high pH soils or on excessively limed soils because Zn ions in the chelated complex can be replaced by calcium ions. They also found that banana yield declined from more than 60 t/ha at soil pH 4.5 to about 30 t/ha at pH 8.7. This was thought to be associated with changing supply of Zn to the plants and leaf analysis data supported this interpretation. Under such conditions, micronutrients can be given to banana through foliar sprays. In contrast, Hernandez and Lugo Lopez (3) found that foliar spray of trace elements gave a markedly lower response than soil applied mixtures. Absence of Fe and Zn depressed performance to the level of NPK only. Das and Mohan (2) proved that application of 6g B, 9g Zn, 6g Cu and 6g Mn per plant significantly increased bunch length, number of hands and fingers in banana cultivars, Jahaji (AAA), Brajahaji (AAA) and Chenichampa (AAB). Studies on soil and foliar applications of micronutrients in banana, and its evaluation and comparison in high pH soil are meagre. Hence, an attempt was made in the present study to compare the soil and foliar applications of micronutrients in banana in high pH soil.

A field experiment was conducted during 2003-05 with Karpuravalli (ABB) banana (plant crop and ratoon crop) in 3^3 factorial randomized block design with three levels namely, 0, 1 and 2. The level 0 indicates control (no micronutrient application). The level 1 indicates soil application of 5 g of $FeSO_4$ or $ZnSO_4$ or borax per plant at 3 months after planting (MAP). The level 2 indicates foliar application of 0.5% $FeSO_4$ or 0.5% $ZnSO_4$ or 10 ppm boric acid of each of three factors (micronutrients), Fe, Zn and B at 3 MAP, 5 MAP and 7 MAP. Using above three factors (micronutrients - Fe, Zn and B) of three levels each (control, soil application and foliar application), twenty-seven treatment combinations (3^3) were made. They were (0,0,0), (0,0,1), (0,0,2), (0,1,0), (0,1,1), (0,1,2), (0,2,0), (0,2,1), (0,2,2), (1,0,0), (1,0,1), (1,0,2), (1,1,0), (1,1,1), (1,1,2), (1,2,0), (1,2,1), (1,2,2,), (2,0,0), (2,0,1), (2,0,2), (2,1,0), (2,1,1), (2,1,2), (2,2,0), (2,2,1) and (2,2,2). In each treatment combination, the levels of micronutrients were given in the order of Fe, Zn and B respectively. Common N, P_2O_5 and K_2O doses of 200, 50 and 400 g plant^{-1}, respectively were given to all the plants. The soil of experimental field was of pH-8.7, EC-0.2 dS m^{-1}, OC-0.23%, $CaCO_3$-5.2%, CEC-11.5 cmol (P^+) kg^{-1}, N-230 kg ha^{-1}, P_2O_5-8.5 kg ha^{-1}, K_2O-150 kg ha^{-1}, Fe-2 ppm, Zn-1.8 ppm, B-0.4 ppm, Cu-0.3 ppm and Mn-1.5 ppm, silty clay loam texture, *Typic Ustropept,* mixed, hyperthermic. The treatment combinations were replicated thrice. Eight banana plants per treatment were maintained in every replication. The soil applications of above micronutrients were given at 3 months after planting. The foliar applications of above micronutrients were given at 3, 5 and 7 MAP. The leaf samples were collected (Martin-Prevel, 6) at flowering stage from all the treatment combinations for nutrient analysis. The oven dried leaf samples were finely ground and analysed for nitrogen by Kjeldahl method (Piper, 7). Finely ground, oven dried leaf samples were digested in tri-acid mixture and, phosphorus was estimated by vanadomolybdo-phosphoric yellow colour colorimetric method, potassium by flame photometric method (Chapman and Pratt, 1) and micronutrients by atomic absorption spectrometer (Varian Spectr AA-200). Data on bunch weight (kg) were recorded at the time of harvest. The correlation coefficients of the growth and yield parameters, and leaf nutrient concentrations with the bunch weight were worked out. The correlation coefficients of leaf micronutrient concentrations under different mode of applications with bunch weight were worked out to study the effects of different modes of application of micronutrients on the bunch weights. The fruit quality parameters like total soluble solids (TSS in °Brix) and acidity (%) were estimated and TSS/acid ratios were also worked out.

Micronutrients like Fe, Zn and B, both as soil and foliage application, influenced the plant growth and yield parameters significantly (Table 1). The treatment,

*Corresponding author's E-mail: jeyabaskaran_kj@yahoo.com

Table 1. Effect of micronutrients on growth and yield parameters, leaf nutrient concentrations and quality of Karpuravalli banana.

Respective levels of (Fe,Zn,B)	Pseudostem height (cm)	Pseudostem girth (cm)	Total No. of leaves	Total leaf area (m^2)	Total No. of fingers	Total No. of hands	Bunch weight (kg)	TSS (°Brix)	Acidity (%)	TSS : acid ratio	Leaf K (%)	Leaf Mg (%)	Leaf Fe (ppm)	Leaf Zn (ppm)	Leaf B (ppm)	Leaf Cu (ppm)	Leaf Mn (ppm)
0,0,0	182	79	20	10.8	146	10	10.4	28.0	0.23	122	2.9	0.24	102	10	8	25	112
0,0,1	242	71	19	11.3	102	11	10.3	29.1	0.27	108	3.0	0.31	113	7	10	22	126
0,0,2	218	76	30	10.7	145	11	10.4	30.4	0.21	145	2.7	0.29	120	12	14	24	98
0,1,0	227	72	31	11.2	163	9	10.1	28.1	0.23	122	2.8	0.28	109	13	7	30	142
0,1,1	258	90	33	12.2	124	10	10.3	29.1	0.2	146	3.1	0.30	116	12	9	18	120
0,1,2	277	91	33	12.4	195	11	10.9	29.3	0.22	133	3.2	0.29	120	10	15	34	114
0,2,0	272	90	33	12.0	242	14	12.8	28.1	0.26	108	3.2	0.25	123	15	9	20	108
0,2,1	287	93	33	13.1	237	15	14.6	28.6	0.26	110	3.3	0.31	118	17	10	27	136
0,2,2	298	99	36	12.9	184	13	12.4	27.6	0.25	110	3.3	0.30	112	16	13	38	120
1,0,0	302	97	32	13.0	193	12	11.6	29.4	0.25	118	2.9	0.39	140	10	10	30	127
1,0,1	320	96	33	12.8	220	13	10.3	28.8	0.31	93	3.0	0.30	128	9	11	12	115
1,0,2	321	99	32	12.4	168	11	11.2	29.5	0.26	113	2.7	0.41	130	10	15	19	123
1,1,0	318	99	32	11.7	205	12	11.3	28.4	0.32	89	2.9	0.40	142	10	10	37	110
1,1,1	320	99	34	13.0	209	13	13.9	29.3	0.2	147	3.0	0.56	154	12	12	30	143
1,1,2	319	98	33	13.2	195	12	15.0	28.6	0.29	99	3.4	0.50	158	14	17	21	139
1,2,0	321	99	35	13.6	211	13	14.9	28.8	0.26	111	3.2	0.45	149	16	7	19	126
1,2,1	313	98	32	14.0	210	13	15.6	28.9	0.27	107	3.3	0.43	154	14	11	36	129
1,2,2	328	101	35	14.6	218	14	16.3	30.4	0.20	152	3.8	0.58	186	19	15	34	147
2,0,0	288	96	32	12.9	232	14	13.6	30.2	0.27	112	2.8	0.59	148	11	6	28	150
2,0,1	244	92	31	12.8	216	13	12.8	29.2	0.32	91	3.1	0.40	159	14	13	20	98
2,0,2	296	97	29	13.6	192	13	13.7	29.3	0.26	113	2.9	0.50	160	12	16	19	143
2,1,0	315	100	31	12.7	203	12	14.8	28	0.2	147	2.7	0.51	204	14	7	26	136
2,1,1	298	99	33	12.0	179	13	13.4	28.9	0.27	107	3.6	0.58	197	11	14	27	97
2,1,2	282	99	31	12.6	185	13	12.8	28.3	0.24	118	3.0	0.52	214	13	19	31	104
2,2,0	309	98	35	12.0	188	12	12.2	28.7	0.24	120	3.0	0.53	250	15	8	34	131
2,2,1	307	100	34	12.7	202	13	12.1	29.2	0.23	127	3.2	0.48	196	17	13	28	120
2,2,2	301	98	34	14.2	210	14	14.6	28.5	0.20	143	3.5	0.42	264	15	13	36	119
CD (P = 0.05)	92.1	12.8	9.8	2.21	93.5	4.3	3.87	2.01	0.10	47.3	0.83	0.211	86.3	5.3	7.9	17.0	20.3
r (n = 27)	0.58	0.62	0.42	0.80	0.62	0.71	1.00	-	-	-	0.56	0.64	0.49	0.65	0.18	0.23	0.42

*Levels 0 - control, 1 - soil application and 2 - foliar application.

r - Correlation coefficient between bunch weights vs. respective parameters.

(1,2,2) recorded the highest pseudostem height, girth, total leaf area and bunch weight. Total number of leaves was the highest in the treatment (0, 2, 2) and was 80 percent more than that of the control. The highest number of fingers per bunch was recorded in the treatment (0, 2, 0). Application of Fe alone in soil increased the bunch weight slightly by 11.5 percent over control, while foliar spray of Fe alone increased the bunch weight significantly by 30.8 percent over control. Thus, foliar application of Fe alone was found to be better than soil application in high pH soil. Soil application of Zn alone had not increased the bunch weight but foliar spray of Zn alone increased the bunch weight significantly by 23.1 percent over control. Since Zn is fixed under alkaline conditions, it is easy to correct its deficiency with a foliar spray of 0.5 percent $ZnSO_4$ (Jordine, 4) rather than soil application. Thus, foliar spraying of Zn alone was found to be better than the soil application in high pH soil. Neither soil application nor foliar application of B alone influenced the bunch weight significantly. However, either mode of B application along with foliar spray of Zn influenced the bunch weight significantly and similar trend was also observed with foliar spray of Fe on bunch weight. These observations indicated the synergistic effects of foliar applied Fe and Zn on the uptake of B applied in either mode and are in agreement with Srivastava (8).

No significant effects of these soil or leaf applied micronutrients on leaf concentrations of N and Ca were observed. Though soil or foliar application of Fe alone had not influenced the leaf K concentration significantly, Fe along with Zn and B increased the leaf K concentration significantly. The treatment combination (1,2,2) recorded the highest leaf K concentration. Soil application of Zn reduced the P concentrations in the leaf significantly by 21 to 42 percent as compared to control, while foliar application of Zn recorded leaf P on par with that of control (Fig. 1). This indicated the antagonistic effect of soil applied Zn on P uptake by banana. This may be due to the formation of less soluble zinc phosphate in the soil (Tisdale *et al.,* 9) leading to reduction in phosphorus uptake in banana. Thus, these observations suggested that foliar application was better than soil application of Zn. The leaf micronutrient concentrations were significantly influenced by soil and leaf applications of micronutrients under high pH soil condition (Table 1). Soil application of Fe increased leaf Fe concentration by 37.3 percent and foliar application of Fe increased leaf Fe concentration by 45.1 percent, when compared to control. Soil application of Zn increased the leaf Zn concentration by 30 percent and foliar application of Zn increased the leaf Zn concentration by 50 percent when compared to control. The treatment of 1, 2, 2 recorded the highest leaf Zn concentration. Soil applied B increased the leaf B concentration by 25 percent and the foliar applied B increased leaf B concentration by 75 percent, when compared to control. The highest leaf B concentration was recorded in treatment 2, 1, 2. Higher leaf Cu and Mn concentrations were observed with foliar application of micronutrients as compared to soil applications. The correlation coefficients of the growth and yield parameters with the bunch weight were highly significant at 1% probability. The correlation coefficients of leaf nutrient concentrations, except of boron and copper, with the bunch weight were highly significant at 1% probability (Table 1). The correlation coefficients between the leaf nutrient concentrations

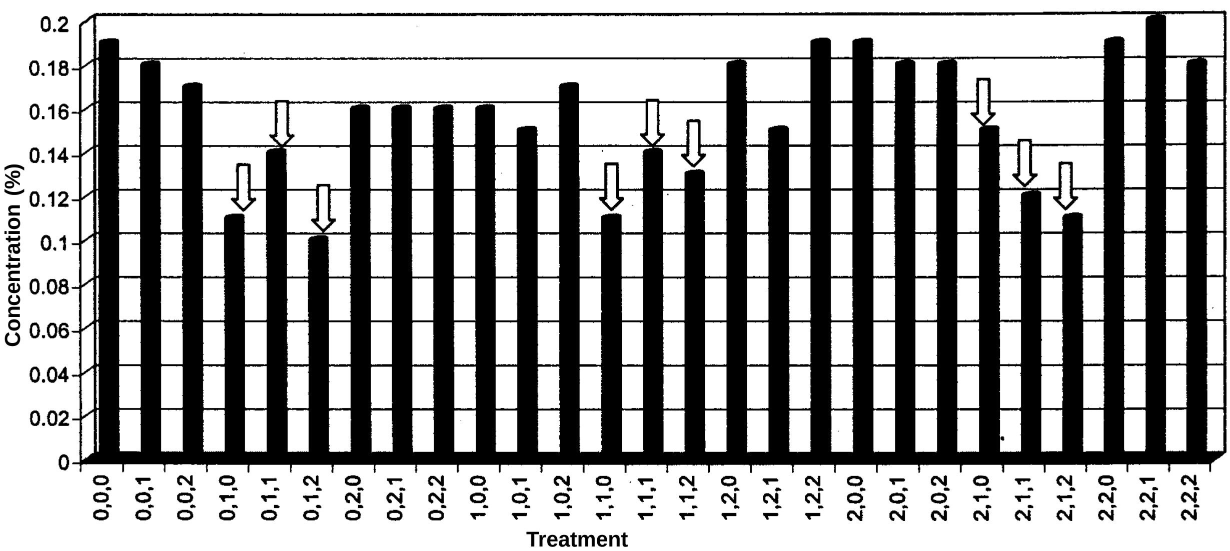

Fig. 1. Effect of soil and foliar applications of micronutrients on phosphorus concentration in leaf of Karpuravalli.

Note: Soil application of zinc reduced the leaf phosphorus concentration (Indicated by downward arrow)

Table 2. Correlation Coefficients between the leaf nutrient concentrations under different modes of application and corresponding bunch weights (n = 27).

Nutrient	Control	Soil application	Foliar application
Iron	0.068***	0.871**	0.393*
Zinc	0.252***	0.521**	0.605**
Boron	0.101***	0.143***	0.394*

under different modes of application of micronutrients and corresponding bunch weights are given in the Table 2. The leaf Fe concentrations due to soil applied Fe influenced the bunch weight more than those due to foliar sprayed Fe. But, in cases of Zn and B, the trend was reverse. The foliar sprayed Zn or B was more effective in increasing bunch weights than soil applied Zn or B.

The fruit quality parameters like total soluble solids, acidity and TSS/acid ratio were significantly influenced by the soil or foliar application of micronutrients. The highest TSS, lowest acid and the highest TSS/acidity ratio were recorded in the treatment 1, 2, 2. Thus, keeping over all performance and correlations coefficients, the treatment 1, 2, 2 was found to be superior to other treatment combinations, based on its influence on plant growth, yield, and nutritional status in the leaf tissues and fruit quality. In conclusion, soil application of Fe (5 g $FeSO_4$ per plant at 3 MAP), foliar applications of Zn (0.5 percent $ZnSO_4$ each at 3, 5 and 7 MAP) and B (10 ppm boric acid each at 3, 5 and 7 MAP) with recommended dose of NPK (N : P_20_5 : K_2O - 200 : 50 : 400 g plant^{-1}), produced the highest bunch weight and best quality fruits.

ACKNOWLEDGEMENTS

The authors express their gratitude to Dr M.M. Mustaffa, Director, National Research Centre for Banana, Trichy for his constant encouragement. The help rendered by Mrs. T. Anitha Sree, Technical Assistant during the experiment is gratefully acknowledged.

REFERENCES

1. Chapman, H.D. and Pratt, P.F. 1961. *Methods of Analysis for Soils, Plants and Water.* University of California, USA.
2. Das, P.K. and Mohan, N.K. 1991. Influence of micronutrients on bunch characters of banana cvs. Jahaji (AAA), Barajahaji (AAA) and Chenichampa (AAB). *Banana Newsletter,* Australia, **14**: 29-30.
3. Hernandez, M.E. and Lugo Lopez, M.A. 1969. Effect of minor nutrient elements and magnesium upon the growth, development and yields of plantains. *J. Agric. Univ. Puerto Rico.* **53**: 33-40.
4. Jordine, C.G. 1962. Metal deficiencies in banana. *Nature,* **194**: 1160-63.
5. Lahav, E. 1995. Banana nutrition. **In**: *Bananas and Plantains* (Ed., Gowen, S.). Chapman and Hall, London, UK. pp. 258-315.
6. Martin-Prevel, P. 1977. Echantillonnage du bananier pour l'analyse foliar, consequences des differences de techniques. *Fruits,* **32**: 151-66.
7. Piper, C.S. 1966. *Soil and Plant Analysis.* Hans Publisher, Mumbai.
8. Srivastava, R.P. 1964. Effect of micro-elements Cu, Zn, Mo, B and Mn on the growth characteristics of banana. *Sci. Cult.* **30**: 352-55.
9. Tisdale, S.L., Nelson, W.L., Beaton, J.D. and Havlin, J.L. 1997. *Soil Fertility and fertilizers.* 5th Edn., Prentice-Hall of India Pvt. Ltd., New Delhi. pp. 304-63.
10. Turner, D.W., Korawis, C. and Robson, A.D. 1989. Soil analysis and its relationship with leaf analysis and banana yield with special reference to a study at Carnarvon, Western Australia. *Fruits,* **44**: 193-203.

(Received: January, 2007; Revised: June, 2007; Accepted: October, 2007)