

USE OF MICRONUTRIENTS AS FERTILIZERS

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## USE OF MICRONUTRIENTS AS FERTILIZERS

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The recent discoveries about the importance of small amounts of copper, zinc, boron and manganese in the physiology of higher plants have added interest to the studies on the role of these elements in a number of soil plant problems. These elements or micronutrients are now recognized to be essential plant nutrients and a shortage of one or more of these is known to adversely affect the metabolism and growth of plants. Severe insufficiency of a micronutrient in the soil often gives rise to a disease of plants grown in it showing symptoms which are typical of the particular deficiency. However, where several deficiencies exist together the symptoms may be complicated, and therefore difficult to distinguish them as those of any known deficiency of a particular trace element. Further it has been noted by previous investigations that sometimes, plants suffering from a deficiency of micronutrients may not show any symptoms of the deficiency at all, except that their growth is stunted or that they display the symptoms only for a short period in the growing season. It has also been observed that on many soils plants suffer from a deficiency of a number of micronutrients simultaneously, though they may only show symptoms of one or even of none of them. Micronutrient deficiencies are also often known to occur in soils which contain adequate quantities of the micronutrient, but in a form unavailable to the plant. It may, therefore, be realised that the deficiency or requirements of soils for the different micronutrients for a normal and vigorous growth of plant cannot be easily determined. In these circumstances empirical trials wherein these elements are used as supplementary fertilizers will help a great deal in knowing the micronutrients requirement of soils. Such experiments in foreign countries with micronutrient fertilizers have shown that large acreages of cultivated land in different parts of Europe, Australia, U.S.A. are deficient in one or the other of micronutrient. So far as we know, there has not been any definite knowledge of the deficiency of micronutrients in large tracts of the cultivated soils of India. Daji<sup>1</sup> observed that the cause of the "band" disease of areca palm is manganese toxicity. We<sup>2</sup> have, however, shown that application of copper sulphate or zinc sulphate separately to the soil, leads to an improvement and cure of the diseased areca palms. Basu and Rege<sup>3</sup> have analysed the highly eroded soils of the Bombay State for their content of B, Zn and Mn and have studied the responses of crops to the application of these micronutrients to the soil. In conclusion these authors have observed that "in the scarcity zones of the Bombay State, advantage of increasing the food crops by the application of secondary elements (or micronutrients), can be easily taken up."

The present paper gives data of our pot culture experiments and field trials wherein we have used copper, zinc and boron as fertilizers in some poor soils of the Maharashtra and Konkan regions of the Bombay State.

## EXPERIMENTAL AND DISCUSSION OF RESULTS

In the pot culture experiment, a large quantity of soil from the surface 9" layer from the poor crop yielding field was collected. The different treatments given to the soil filled in pots were (1) control, (2) copper, (3) organic manure, (4) copper plus phosphate manure, (5) phosphate and (6) copper plus organic manure.

Copper was supplied at the rate of 5 milligrams Cu, per hundred grams of air-dry soil. The copper salt used in the present experiment was cupric oxide (CuO). Organic manure was added in the form of oil-free groundnut cake, on the basis of 15 milligrams nitrogen per hundred grams air-dry soil. Calcium monophosphate was used at the rate of 30 milligrams P<sub>2</sub>O<sub>5</sub> per hundred grams air-dry soil.

The results of crop yields obtained with the different treatments are given in the table 1.

TABLE No. 1

Yield of wheat plants in grams per pot with different treatments of soil

Pot No.	Treatment					
	Control (gms)	Cu (gms)	Org. M (gms)	P (gms)	P+Cu (gms)	O.M+Cu (gms)
1	8.35	8.18	7.88	12.48	8.30	15.84
2	5.57	8.65	7.75	10.61	8.48	13.70
3	4.20	7.85	7.60	11.31	10.36	13.30
4	6.75	9.13	7.45	10.45	90.80	11.50
Total	24.87	33.81	30.68	44.85	36.22	54.34
% Increase of crop over control		35.8	23.30	80.00	45.60	118.34

It is seen from figures of crop yields with different treatments that copper alone has given an increase of 35.8 % over the control ; phosphate treatment has given 80 % increase but the addition of organic manure alone has resulted in an increase of only 23.3 % over the control. The yield of crop with the treatment (O M +Cu) is the highest among the yields obtained with the different treatments of the soil and it is 118.3 % more than the yield from the control or untreated pots.

The data of yields were statistically analysed. "F" for treatment variance was found to be significant at zero percent level.

The sum of squares for "between treatments" was further split into components for detecting the significance of response to the different main factors and their interaction. In the table 2 responses have been so tested for their significance.

TABLE 2

Analysis of variance for main responses and interactions

Source of variation	D.F.	S.S.	M.S.	F
Main response to O.M.	1	43.3622	43.3622	31.16**
„ „ „ Cu	1	35.7305	35.7305	25.67**
„ „ „ P	1	31.3320	31.3320	22.57**
Interaction of P and Cu	1	19.2941	19.2941	13.86**
„ „ „ O.M. and Cu	1	13.5424	13.5424	9.73**
Within treatments	18	25.0513	1.3917	...

The results of statistical analysis clearly show that the main responses to all the three factors organic matter, copper and phosphate are highly significant. Similarly it can be seen that the interaction between copper and organic manure is highly significant indicating thereby that the combined effect of copper and organic manure added together to the soil is greater than the sum of the effects on the yield of crop obtained by the separate addition to the soil of each of these two fertilizers, copper and organic manure. A highly significant interaction is also evident when copper and phosphate are added together to the soil, but in this case the application of the two manures together is not found to be favourable for the crop yield. Copper appears to partially counteract the beneficial effect of phosphate addition on the crop resulting in a lesser yield of crop with the simultaneous addition of copper and phosphate than what is obtained with the addition of phosphate alone.

In the field experiments carried out under our supervision in some cultivators' fields, copper sulphate was used as a supplementary fertilizer for paddy crop. Following results were obtained :—

TABLE 3

Yield of paddy grain in Bengali maunds per acre

Place	District	Treatment of seed-bed	Yield in maunds		
			Control	Copper sulphate	increase %
Alibag	Kolaba	Rabbed	19.75	27.0	36.7
Murdi	Ratnagiri	Rabbed	12.00	22.0	83.3
Palghar	Thana	Manured with 20-80 cake and super-phosphate	20.80	31.6	52.0

In another pot culture experiment of a factorial design, we tried the application of the following different trace elements for the soil filled in pots. The treatments were as follows :—

- (1) Control, no treatment,
- (2) Organic manure,
- (3) Boric acid,
- (4) Zinc sulphate,
- (5) Organic manure plus boric acid,
- (6) Organic manure plus zinc sulphate,
- (7) Boric acid plus zinc sulphate and
- (8) Organic manure plus boric acid plus zinc sulphate.

Wheat was grown in pots. The dose of the micronutrients added to the soil in pots was 5 mgm, of the element per 100 gms air-dry soil. Oil free groundnut cake was used as the organic manure on the basis of 15 mgm per 100 gms soil. The results of crop yields are given in the table below :—

TABLE 4  
Yield of wheat plants (grain straw) in pots receiving different treatments

Pot No.	Treatments							
	Control	Org. M	B	Zn	Org. M + B	B + Zn	Org. M + Zn	Org. M + B + Zn
1.	6.5	9.7	8.3	7.7	11.3	6.0	10.1	11.5
2.	7.0	10.3	9.6	8.7	14.7	6.7	13.5	13.0
3.	7.3	9.3	8.8	7.9	12.0	5.7	11.0	12.3
4.	7.7	10.5	8.4	8.0	14.1	6.2	12.3	11.2
5.	7.5	8.7	8.5	6.8	13.3	5.9	11.2	10.5
6.	7.9	8.6	8.3	6.0	10.6	5.2	10.5	9.4
Total	43.9	57.3	51.9	45.1	76.0	35.7	68.6	67.9
Grain	27.4	38.0	33.0	28.1	53.2	22.5	46.8	43.1
Straw	16.5	19.3	18.9	17.0	22.8	13.2	21.8	24.8
% increase over control		32.0	18.0	2.7	73.0	19.0	56.0	54.0

It may be observed from the results in the table given above, that the increase in crop due to the addition of zinc salt, alone to the soil was only 2.7 % while that due to boric acid alone was 18 %. The increase due to the addition of organic manure was 32 % over the control. The combination of zinc salt and organic manure gave an increase of nearly 56 % over the control, while boric acid and organic manure when added together gave an increase of 73 %. The combination of zinc sulphate and boric acid, however, decreased the yield by about 19 % below the control.

Statistical analysis of the data showed that "F" for treatment variance is significant at one per cent level. Analysis of variance for significance of main responses of individual factors and their interactions, revealed that the main response due to organic manure is highly significant while the main responses due to boron and the three interactions between (1) organic manure and zinc, (2) organic manure and boron, and (3) zinc and boron; are all statistically significant.

#### SUMMARY AND CONCLUSION

(1) Application of copper salt alone or in combination with organic manure to the soils in Maharashtra and Konkan regions of the Bombay State gives a significantly large increase in the crop, from the soils studied by us.

(2) Application of boric acid alone gives a significant increase in crop.

(3) Addition of zinc sulphate alone to the soils in Maharashtra and Konkan regions is not found to be beneficial.

(4) Application of micronutrients copper, zinc or boron in the form of their salts to the soil singly, without the addition of organic manure is not so much beneficial for crop as the simultaneous addition of the micronutrient and the organic manure.

(5) The two factor interactions between micronutrient as one part and organic manure as the other, are found to be statistically significant.

(6) The main effects of the micronutrients Cu and boron singly are found to be significant while that of zinc singly is not significant.

(7) From these results it may be safely concluded that micronutrients should be generally applied along with organic manures.

(8) Combinations of two micronutrients Zn and B is found to be harmful for plants, so also simultaneous addition of copper salt and phosphate.

(9) These results indicate that before combining the nutrients into a fertilizer mixture for application to any soil, the different possibilities about the nature of interactions between the constituents requires to be thoroughly investigated.

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