IJPS INTERNATIONAL JOURNAL OF PLANT SCIENCES
ISSN-0973-1547 Volume **14** | Issue 1 | January, 2019 | 10-13
DOI: 10.15740/HAS/IJPS/14.1/10-13
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RESEARCH ARTICLE

Yield maximization in okra through nutrient interventions in typic ustipsamments of Kerala, India

■ **V. Mini and Usha Mathew**

SUMMARY

A study was conducted in the typic ustipsamments of Kerala in India to assess the available micronutrient status of the region to develop a multi micronutrient mixture for balanced crop nutrition and to evaluate the effect of multi micronutrient mixture on growth and yield of okra. Chemical analysis of 200 georeferenced soil samples from the region revealed deficiencies of boron (77%), zinc (66%) and copper (53%). A customized micronutrient mixture with a composition of Zn (9.5%) + B (2.6%) +Cu (1.2%) +Mg (2.4%) +N (0.46%) @ 20kg ha^{-1} was developed based on the available micronutrient status of the region and crop requirement. Effect of micronutrient mixture was assessed in field experiments using okra variety Varsha Uphar as the test crop with nine treatments in three replications. Growth, yield and quality of okra increased significantly due to multi micronutrient mixture. Application of soil test based NPK and secondary nutrients + foliar application of 0.5 per cent solution of computed dose of micronutrient mixture @ 5 kg ha^{-1} in two splits at 15 DAS and 30DAS (T_7) yielded significantly higher (11.3 t ha^{-1}) with a B: C ratio of 3.02. Application of micronutrient mixtures customized for soil and crop ensures increased yield and sustain soil health.

Key Words : Typic ustipsamments, Micronutrients, Customized mixture, Okra

How to cite this article : Mini, V. and Mathew, Usha (2019). Yield maximization in okra through nutrient interventions in typic ustipsamments of Kerala, India. *Internat. J. Plant Sci.*, **14** (1): 10-13, **DOI: 10.15740/HAS/IJPS/14.1/10-13,** Copyright@ 2019: Hind Agri-Horticultural Society.

Article chronicle : Received : 03.09.2018; **Revised :** 03.12.2018; **Accepted :** 11.12.2018

The sandy plain region of Kerala in India, belongs to typic ustipsamments and the soils are coarse textured with low nutrient and water retention capacity. The agroecological unit is designated as Onattukara sandy plain (AEU 3) and covers an area of 40,495 ha. In older days this region was in agricultural prosperity, but now it has become an area of low productivity with many constraints limiting production (Premachandran,1998). There is yield gap due to inadequate and imbalanced supply of nutrients for crops in the Onattukara region. Now problems due to micronutrient deficiencies have been reported from many parts of this region (KSPB,2013). The supplementation of micronutrients under such situation becomes more

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important to provide balanced nutrition to crops. Supplementation of micronutrients helps in correction of hidden hunger and better utilization of major nutrients resulting in better crop growth and yield (Mathew,2007). Zn, Cu and B deficiency are the most frequently observed micronutrient deficiencies in these soils. Micronutrient deficiencies cause remarkable yield loss and their deficiencies warrants the need for research on Zn, Cu and B especially on their usage in mixtures as foliar/soil application. Hence, the present investigation was undertaken to develop and use customized micronutrient mixture for management of micronutrient efficiencies in this sandy plain using okra as the test crop.

MATERIAL AND METHODS

To characterize the soil fertility status of the Onattukara region, 200 georeferenced soil samples were collected from twenty soil series of the region and analysed using standard analytical procedures (Jackson,1973).

The soil was very strongly acidic with high level of phosphorus, low oxidisable organic carbon and available potassium and wide spread deficiencies of calcium, magnesium, boron and zinc. The soil analysis results revealed deficiency of B (77%), Zn (66%) and Cu (53%) in the region. Majority of the area in the Onattukara sandy plain recorded low status for all these micro nutrients (29672.14 ha) (Fig. A). To address the multiple micronutrient deficiencies, a multi micronutrient mixture is more economical than individual applications. Hence, a customized multi micro nutrient mixture having a composition of Zn (9.5%) + B (2.6%) +Cu (1.2%) +Mg (2.4%) +N (0.46%) @ 20kg ha^{-1} was developed based on the soil status and crop requirement of the test crop okra (cv. VARSHA UPHAR). Along with the deficient micronutrients, magnesium was added to ensure balanced nutrition and nitrogen was added to improve the efficiency of foliar absorption. Two field experiments were conducted in the Onattukara region during 2013-2014 for studying the effect of customized multi micronutrient mixture in improving crop production using okra (cv. VARSHA UPHAR) as the test crop. The treatments consisted of T_1 (Absolute control), T_2 [Package of practices (POP)], T_3 (Soil test based POP and secondary nutrients), T_4 (Treatment 3 + computed dose of micronutrients mixture), T_5 (Treatment 3 + 25% less of computed dose of micronutrients mixture), T_6 (Treatment 3+ 25% more of computed dose of micronutrients mixture), T_7 (Treatment 3+ foliar application of 0.5% solution of computed dose of micronutrients mixture), T_8 (Treatment 3+ foliar application of 0.5% solution of 25% less of computed dose of micronutrients mixture) and T_9 (Treatment 3 + foliar application of 0.5% solution of 25% more of computed dose of micronutrients mixture). Mode of application of T_4, T_5 and T_6 was soil application @ 20kg

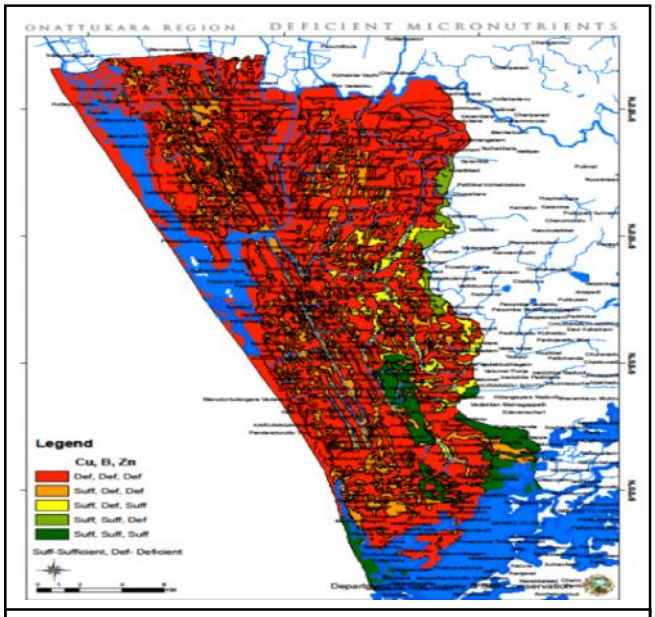

Fig. A : Spatial distibution of deficient micronutrients

Table A: Physico- chemical properties of soil at experiment site

Parameter	Value
pH(1:2.5)	4.99
EC(d S m^{-1})	0.04
Texture	Loamy sand
Bulk density	1.58 Mg m^{-3}
Particle density	2.43 Mg m^{-3}
Organic carbon %	0.58
Available nitrogen (kg ha^{-1})	138.2
Available phosphorus (kg ha^{-1})	29.92
Available potassium (kg ha^{-1})	104.5
Available calcium (mg kg^{-1})	209.15
Available magnesium (mg kg^{-1})	48.16
Available sulphur (mg kg^{-1})	5.07
Available iron (mg kg^{-1})	12.05
Available manganese (mg kg^{-1})	7.62
Available zinc (mg kg^{-1})	0.27
Available copper (mg kg^{-1})	0.21
Available boron (mg kg^{-1})	0.17

ha^{-1} and T_7, T_8 and T_9 were applied as 0.5 per cent foliar spray at 15 DAS and 30 DAS. The treatments were replicated thrice in Randomized Block Design. The initial physico chemical properties of the experimental site are given in Table A.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Growth and yield:

Data on growth, yield and quality of okra Var. Varsha Uphar raised in the farmer's field of Onattukara region in the first and second season are presented in Table 1 and 2.

Growth, yield and quality of okra increased significantly due to multi nutrient mixture. Yield of okra

Table 1: Effect of multi nutrient mixture on growth and yield

Treatments	Plant height(cm)		Yield (t ha^{-1})		
	Crop I	Crop II	Crop I	Crop II	Pooled
T_1	68.5	70.2	2.29	2.17	2.23
T_2	97.4	99.1	4.76	5.47	5.12
T_3	109.8	111.4	6.00	6.57	6.29
T_4	135.7	137.3	9.32	9.82	9.57
T_5	117.7	119.3	7.34	8.10	7.72
T_6	138.6	140.3	9.72	10.16	9.94
T_7	142.7	144.3	11.08	11.52	11.30
T_8	122.8	124.4	8.06	8.67	8.36
T_9	117.8	119.3	7.40	8.24	7.82
C.D.(P=0.05)	0.96	1.913	1.128	0.692	0.592

Table 2 : Effect of multi nutrient mixture on fruit quality

Treatments	Protein (%)		Keeping quality (days)		B: C ratio
	Crop I	Crop II	Crop I	Crop II	
T_1	1.00	0.98	5.33	5.33	1.08
T_2	1.10	1.13	7.33	7.33	1.56
T_3	1.07	1.26	7.33	7.00	1.87
T_4	1.53	1.51	8.33	8.33	2.68
T_5	1.19	1.16	8.33	8.00	2.22
T_6	1.56	1.54	9.00	9.00	2.70
T_7	1.63	1.63	9.00	9.00	3.02
T_8	1.38	1.35	9.00	8.67	2.25
T_9	1.19	1.26	9.00	9.00	2.08
C.D. (P=0.05)	0.225	0.278	0.527	0.666	0.166

Table 3: Available Zn, Cu and B in soil after the harvest of the second crop

Treatments	Zn (mg kg^{-1})	Cu (mg kg^{-1})	B (mg kg^{-1})
T_1	0.18	0.15	0.10
T_2	0.31	0.25	0.17
T_3	0.36	0.23	0.19
T_4	1.51	0.88	0.30
T_5	1.41	0.85	0.21
T_6	1.58	0.95	0.31
T_7	0.64	0.99	0.25
T_8	0.63	0.74	0.20
T_9	0.62	0.81	0.19
C.D. (P=0.05)	0.095	0.160	0.041

in the soil test based NPK fertilizers and secondary nutrients alone (T_3) ranged from 6.0 to 6.57 t ha^{-1} and in the treatments of soil test based NPK fertilizers and secondary nutrients+ 0.5% foliar application of multi nutrient mixture @ 5kg ha^{-1} (T_7), yield ranged from 11.08 to 11.52 t ha^{-1} in two seasons. T_7 recorded 80 per cent more yield than T_3, which was the soil test based package of practices (POP) and secondary nutrients. Soil application of this mixture @20kg ha^{-1} (T_4) was also significantly superior to the POP recommendations. The hidden deficiencies of micronutrients are overcome due to their supplementation during the growth period, which results in better crop growth and thereby yield. The inherent status of secondary and micronutrients in the experimental site was very low as presented in Table A. Hence, balanced application of secondary and micronutrients through the multi nutrient mixture had a beneficial effect on plant growth and yield. In severe deficiency condition the yield increase could reach over 100 per cent due to balanced use of fertilizers of major and micronutrients (Malakouti, 2007). Application of micronutrient mixture was found beneficial in increasing okra yield due to increase in number of flowers, number of inflorescence/plant, number of fruits per plant and fruit size of okra as a result of boron and copper application (Hazra *et al*., 1987). All the treatments involving the application of multinutrient mixture recorded higher benefit: cost ratio compared to those treatments without the mixture. The highest B: C ratio of 3.02 was obtained due to the foliar application of computed dose of nutrient mixture (T_7).

Soil status:

Soil status of micronutrients in the experiment site before the experiment was Zn (0.27 mg kg^{-1}), Cu (0.21 mg kg^{-1}) and B (0.17 mg kg^{-1}). After two consecutive application of multi nutrient mixture, the soil status of Zn, Cu and B were in the range of 0.62 to 1.58 mg kg^{-1}, 0.74 to 0.99 mg kg^{-1} and 0.19 to 0.31 mg kg^{-1}, respectively (Table 3).

Even after continuous application of multi nutrient mixture for two seasons there was no toxicity of these micronutrients, but the soil status was improved from the initial status. So application of multi micronutrient mixtures customized for soils and crops ensures increased yield and sustain soil health.

Conclusion:

The study revealed that there is a scope for the use of customized mixture of multi micronutrients to overcome the multiple micronutrient deficiencies in Typic Ustipsamments of Kerala. Foliar application of micronutrient mixture @5kg ha^{-1} in two splits at 15 DAS and 30 DAS was superior to soil application in respect of yield, quality and B: C ratio in okra. Micronutrient deficiency is one of the yield barriers which can be broken down by including micronutrient fertilizers in the nutrient schedule of okra.

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