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RESEARCH ARTICLE

IMPACT OF *BT* COTTON CULTIVATION ON ZINC CONTENT AND PH OF SOIL IN NORTHERN REGION OF MAHARASHTRA

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ABSTRACT

Plants need the right and appropriate combination of nutrients to live, grow and reproduce. Soil fertility depends on the availability of all essential macro and micronutrients and uptake by the crops grown on it. Genetically modified crop varieties have various advantages over traditional crop varieties. Area under cultivation of such genetically modified crop is increasing worldwide including India. In India genetically modified BT Cotton is grown since 2002. Maharashtra is an important state for cotton cultivation and production. It is contended by researchers that continued cultivation of genetically modified BT cotton crop may create harm to the soil fertility and availability of nutrient. Present study deal with the comparison of Zinc micronutrient and potential of hydrogen ion (pH) concentration of soil, on which BT Cotton and non BT Cotton cultivated soils of farmers belonging to Nandurbar, Dhule and Jalgoan District of North Maharashtra. Standard procedures were followed for collection of soil samples, quantitative analysis of zinc and pH of the soils.

INTRODUCTION

The physical and chemical properties of a soil enable it to provide essential chemical elements (nutrients) in quantities and proportions for the growth of specified plants (Brady and Weil, 1999). Nutrients are obtained from the soil and its availability is dependent on various factors including physic-chemical and biological characteristics of the soil. Soil fertility of the soil can be maintained by biological and chemical methods.

The amount of nutrients present in the soil depends upon various factors including parent rocks from which the soil is formed, presence of organic matter, micro-organisms, of nutrients to the soils artificially, uptake of nutrients by the crops grown on the soil etc. and its availability to the plant also depends upon various physico-chemical factors. Plants roots require certain condition to obtain these nutrients from the soil. The most important condition is the moisture in the soil. Secondly, the pH of the soil must be within a certain range for nutrients to be absorbed. Also the temperature of the soil must fall within a certain range for nutrients uptake to occur (Shanyn Hosier, 1999).

Different crops take up different quantities of macro- and micro nutrients from the soil depending upon the requirements of the crops and the physico-chemical properties of the soil. Generally hybrid-high yielding varieties take up more nutrients than the other varieties. Of late along with hybrid and high yielding varieties genetically modified crop varieties are also grown in India. The most popular amongst the genetically modified crops is the Bt-Cotton. BT-Cotton is transgenic plant developed by introducing cry^{++} genes in the genome of native cotton plant. It is reported that such transgenic plants take up even higher amounts of nutrients from the soil depleting it of particular nutrient. Deficiency of a particular nutrient in the soil adversely affects the production of a particular crop. Supply of such nutrient in appropriate quantities may restore the crop production.

During the recent period the area under cultivation of BT-Cotton is increasing. States like Gujarat, Rajasthan, Andhra Pradesh and Maharashtra are major areas of BT cotton cultivation.

In Maharashtra cotton is cultivated in 27 districts that can be classified into four regions viz: Vidarbha; the Marathwada; the Deccan; and Khandesh (North Maharashtra). The North Maharashtra region consists of Jalgoan, Dhule and Nandurbar districts. The area under BT-Cotton cultivation, during the cropping years 2007-08 to 2010-11 in these districts is given in Table-1. Despite the claims of high productivity and greater income return from cultivation of BT-Cotton, in this region of Maharashtra there was reduction in the area under BT-cotton cultivation in 2010-11 as compared to 2007- 08 cropping season owing to unprofitability in Bt cotton cultivation. Marathe and Somani (2010) reported that along with reduction in the area under cultivation there was reduction in the

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productivity of BT- cotton in the study area. Marathe and Somani (2011, 2012) also reported that there was reduction in soil micro- organism where genetically modified BT-cotton was cultivated for a long time in north Maharashtra.

The reduction in the number of soil microorganism has indirect impact on the soil fertility. Continuous cultivation of cotton crop without crop rotation may lead to depletion of certain micronutrients and macronutrients from the soil and may also alter the physiochemical properties of the soil that finally culminates in lesser yield of crop (Marathe and Somani, 2012).

Zinc plays a major role in the growth and reproduction of cotton crop. Deficiency of zinc results in dwarfism and reduction in the size of the leaves along with reddening of the first true leaves with chlorosis. Such symptoms finally lead to reduction in the productivity of the crop. Widespread deficiency of zinc is commonly observed in the intensive cropping zones of irrigated regions (Singh and Blaise, 2000).The p^H of the soil plays an important role in the availability of zinc from the soil (McKenzie, 2011). During our field visits in the BT and non-BT cotton fields in the study area we have observed dwarf BT plants and the farmers narrated us other symptoms like reddening of leaves etc. This prompted us to believe that such BT plants were suffering from zinc deficiency. The farmers to whose fields we had visited have been growing BT varieties and non-BT varieties of cotton for more than five years. Most of them have one or the other facilities for irrigation.

In the light of the above facts it was decided to make quantitative analysis of zinc and recording p^H of the soils on which BT cotton was cultivated for more than five years and compare it with control soils where non-BT cotton was cultivated in selected farms of Nandurbar, Dhule and Jalgoan district of North Maharashtra.

MATERIALS AND METHODS

Table 1 Area under BT-Cotton in North Maharashtra (2007-08 to 2010-11).

Sr. No	Year	Area (Hector)		
		Jalgoan	Dhule	Nandurbar
1	2007-08	548570	117886	53694
2	2008-09	522843	109854	54609
3	2009-10	458290	102312	46196
4	2010-11	412294	106960	48540

Source: District Agriculture Department (2012)

The study was conducted during the Kharif 2008 to 2011. The area selected for the present study includes farms of farmer from three districts of North Maharashtra Region viz. Nandurbar, Dhule and Jalgaon, where BT-Cotton and Non-BT-Cotton is cultivated simultaneously. For the purpose of present study from each district two talukas were selected. From each taluka four villages were selected randomly. From each village, randomly selected ten farmers cultivating BT-Cotton varieties and two to three farmers who were cultivating Non-BT-Cotton varieties represented the sample.

Thus a total of 290 farmer respondents were selected to obtain Details about cotton cultivation practices followed by them. Of these 290 farmers 230 were cultivating BT- and 60 farmers were cultivating non-BT cotton. A structured questionnaire was prepared to record information regarding the soil type, use of chemical fertilizer, year of cultivation, irrigation source, method of irrigation etc. From these selected farmers a total of 124 farmers (83 cultivating BT and 41 cultivating non-BT cotton) were randomly selected from whose fields soil was collected for the analysis of zinc and recording p^H.

Soil sample were collected from fields of each of the farmers by digging out soil around rhizosphere area of the BT-Cotton and the Non-BT-Cotton plants up to 20 cm. from the plant to a dimension of 15 cm. height X 7 cm. diameters from five spots and pooled and mixed together into a single sample. Quantitative analysis of zinc and pH was conducted as per standard analytical procedures followed by Somawanshi *et.al.* (1999).

RESULTS AND DISCUSSION

The result obtained from the soil analysis is presented here with. The following table (No.2) details the quantity of zinc present in soil and pH of the soil on which BT- and non- BT cotton was cultivated by selected farmers of Nandurbar, Dhule and Jalgaon district of North Maharashtra. It is clear from the table that the soils on which non BT-cotton was cultivated had more average zinc quantity as compared to soils on which BT cotton was cultivated. Normally 0.60 ppm zinc and slightly neutral range pH value of soil is to be required for crops for its better performance.

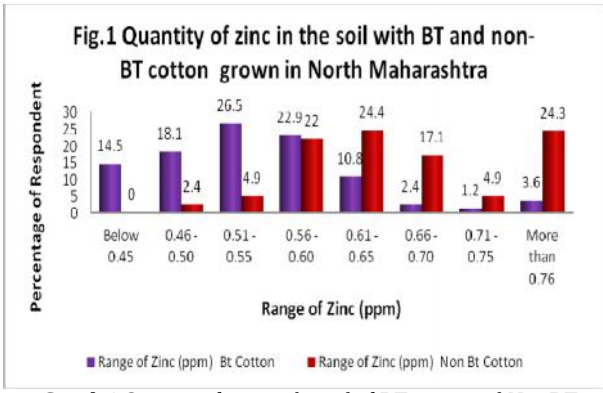
It can be seen from table 2 that in all three district under study the minimum, maximum and average quantity of zinc present in the soils where BT cotton was cultivated was found to be less than the respective quantities found in the soils where non-BT cotton was cultivated. Thus the quantity of zinc present in the soil seems to have reduced in soils due to continuous cultivation of BT cotton.

However, in the case of soil pH value no significant difference was recorded from the soils on which BT and non-BT cotton was grown.

Further analyses of the data on the quantity of zinc present in the soils of selected respondents cultivating BT and non-BT cotton following results were obtained. As can be seen from Fig. 1, the soils on which BT cotton was cultivated showed more deficient samples (less than 0.6 ppm) that the soil samples on which non-BT cotton was cultivated. Also in BT- farm soil samples very less samples (15.4 %) had more than optimum quantity of zinc. On the other hand 46.6 % of the samples of soils on which non-BT cotton was cultivated had more than optimum amount of zinc. Also soil samples from BT farm lagged behind non-BT in each category of zinc level found. Optimum level of zinc in soil at vegetative stage is 20-
30 ppm.

Table 2 Quantity of zinc and pH of the soils of selected respondents of Nandurbar, Dhule and Jalgaon districts of Maharashtra.

Properties	Crop	Nandurbar			Dhule			Jalgaon		
		Mini.	Max.	Ave.	Mini.	Max.	Ave.	Mini.	Max.	Ave.
Zinc (ppm)	BT Cotton	0.47	0.66	0.55	0.33	0.73	0.52	0.34	1.40	0.56
	Non BT Cotton	0.51	0.71	0.61	0.55	0.78	0.64	0.48	1.17	0.76
pH	BT Cotton	6.91	8.30	7.74	6.66	8.02	7.63	6.72	8.16	7.66
	Non BT Cotton	7.30	8.12	7.83	6.60	8.00	7.46	6.90	8.16	7.75



Graph 1 Quantity of zinc in the soil of BT cotton and Non BT Cotton grower respondents (farmers) in North Maharashtra.

samples were having pH range 7.71 to 8.0. This range of pH has no impact on the availability of zinc present in the soil. Katyayan (2008) has reported that a pH between 6.0 and 6.5 is best for production of most field crops.

District wise analysis of soil pH is presented below (Table 4). The result shows that there was no significant difference in the pH groups in the district under study. In Nandurbar district 56.5 % soils samples on which Bt cotton was grown had pH between 7.71 – 7.9 the corresponding figures for soil samples showing this range of pH in non Bt cultivating farmers was 50 %. On the other hand of the total soil samples collected from farmers cultivating Bt cotton in Nandurbar district 8.7 % soil samples showed pH range of 7.91 – 8.1 whereas it was 25 % for farmers cultivating non Bt cotton.

Table 3 Zinc Percentage of Respondent soil District and Crop Wise

Zinc (ppm) Group	Percentage of soil samples					
	Nandurbar		Dhule		Jalgaon	
	BT Cotton	Non BT Cotton	BT Cotton	Non BT Cotton	BT Cotton	Non BT Cotton
Below 0.45	0.0	0.0	15.6	0.0	24.9	0.0
0.46 - 0.50	21.7	0.0	18.8	0.0	14.3	5.6
0.51 - 0.55	39.2	12.5	21.9	6.7	21.4	0.0
0.56 - 0.60	17.4	37.5	37.5	20.0	10.7	16.7
0.61 - 0.65	17.4.	25.0	3.1	33.3	14.3	16.7
0.66 - 0.70	4.3	12.5	0.0	26.7	3.6	11.0
More than 0.71	0.0	12.5	3.1	13.3	10.8	50.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Table 4 pH Percentage of Respondent soil district and Crop Wise

pH Group	Percentage					
	Nandurbar		Dhule		Jalgaon	
	BT Cotton	Non BT Cotton	BT Cotton	Non BT Cotton	BT Cotton	Non BT Cotton
Below 7.70	26.2	12.5	31.3	60.0	35.7	33.3
7.71 - 7.80	21.7	12.5	28.1	20.0	10.7	11.1
7.81 - 7.90	34.8	37.5	12.5	6.7	10.7	11.1
7.91 - 8.00	8.7	25.0	25.0	13.3	25.0	22.2
8.01 - 8.10	4.3	0.0	3.1	0.0	14.3	5.6
More than 8.11	4.3	12.5	0.0	0.0	3.6	16.7
Total	100.0	100.0	100.0	100.0	100.0	100.0

The district wise quantity of zinc in the soils (Table 3) where BT and non-BT cotton was cultivated is given. The optimum level of zinc required for better performance of cotton crop is reported be 0.60 ppm and above. Of the selected farmers growing BT cotton in Nandurbar district, only 21.7 % farmers had zinc quantities more than 0.60 ppm in their soils. The corresponding figure for non-BT farmers was 37.5 %, indicating that the amount of zinc present in the soils on which BT cotton is cultivated is lesser than the soils on which non-BT cotton was cultivated. Similarly more farmers cultivating BT- cotton (78.2 %) had sub-optimal levels of zinc than that cultivating non-BT cotton (50 %).

Similarly in Dhule districts the percentage of farmers cultivating BT cotton and having sub-optimal levels of zinc was more (78.2 %) than their non Bt cultivating counterparts (26.7 %). In Jalgoan district, however, the percentage of farmers cultivating Bt and having sub-optimal levels of zinc in their farms was quite less (46.04 %) as compared to farmers cultivating non Bt cotton (22.3 %). The results indicates that in Jalgaon district the soils on which Bt cotton was cultivated is comparatively less deficient in zinc than in Nandurbar and Dhule region. One of the reasons for such result was the fact that the farmers of Jalgaon used more compost manure for Bt cotton crop than the farmers of other two districts.

Analysis of the pH range of soil samples where BT and non BT cotton crop was grown revealed that maximum soil

The results of the present study clearly indicate that the soils on which Bt cotton was cultivated was more deficient in zinc than the soils on which non Bt cotton was cultivated. The deficiency of zinc due to continuous cultivation of Bt cotton in the study area may be one of the reasons for lesser production of Bt cotton than that was claimed by the Seed producing companies.

CONCLUSIONS

Continuous cultivation of Bt cotton tends to deplete the zinc content of the soil. Also it results in increased pH of the soil. These trends in reduction in zinc and increase in pH of the soil have negative effect on the productivity of the soil. If such trend continues without appropriate additions of micronutrients or soil addendum that has micronutrients including zinc and also reduces soil pH would result in decreased production of Bt cotton.

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