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Soil Fertility status of Bt cotton Cultivated fields and other Soils of Khammam region in relation with available macro, micro nutrients and Microbial count.

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Abstract: *Soil fertility evaluation of an area or region is an important aspect in context of sustainable agricultural production. The macro and micro nutrients govern the fertility of the soil and control the yields of crops. Microbial population indicates the soil health with positive correlation with available nutrients. Khammam region was selected for the present study.Ten represented villages were chosen and two soil samples for two variants (Bt and NBt) were collected from each village. All the 20 available samples were analysed for N,P,K,S,B,Zn and microbial count. Results revealed that soil samples were found slightly alkaline, medium Organic carbon, phosphorus, sulphur, Boron and Zinc but low in Nitrogen. The two variants are differing in Nutrient index values and microbial count.*
Key Words: *Macronutrients, Microbial count, Nutrient index, Bt cotton, Soil health.*

I. Introduction

Soil is the critical component of the earth system functioning not only for the production of the food, fodder and fibre but also in the maintenance of local regional and global environmental quality.Soil characterization in relation to evaluation of fertility status of soils of an area or region is an important aspect in context of sustainable agricultural production. Nitrogen, phosphorus, potassium, sulphur, boron and zinc are important soil elements that control it's fertility and yields of the crops.

The structure of the soil microbial community is an important component of soil quality and health. Soil microbiological properties could be early and sensitive indicators of anthropogenic effects on soil ecology in both natural and agricultural ecosystems[1].Total number of microbes in a given soil indicates the soil fertility as they are actively involved in conversion of organic matter into available nutrients in the soil[2]. In other words viable count of microbial population in a given soil sample is an indicator of soil fertility.Variation in a nutrient supply is a natural phenomenon, and some of them may be sufficient where others deficient. Because of imbalanced and inadequate fertilizer use coupled with low efficiency of agriculture practices reduced the efficiency of chemical fertilizer under intensive agriculture. Productivity of crop can be boosted by judicious use of macro and micro nutrient fertilizers and focus on improving the soil physicochemical nature or soil health[3]. Farming practices have under gone various changes from time to time with new technologies. For higher productivity, heavy doses of fertilizers and other agrochemicals are applied,these practices even though increased the yield,make the microbial and plant systems more vulnerable to various stress besides deleterious effect on the environment[4].

A transgenic approach to crop protection was realized in the mid-1990s with the commercial introduction of genetically modified insect-resistant crops. According to the International Service for the Acquisition of Agri-Biotech Applications (ISAAA) worldwide production of genetically modified crops has increased 67-fold, from 1.7 million hactor in 1996 to114.3 million hactor in 2007, and is predicted to increase even more in the future. However, the large-scale commercial release of Bt crops is a public concern, becauseof the danger to natural and agricultural ecosystems[5-9]. Inevitably, Bt toxin will be introduced to soil in rootexudates throughout the growth of the transgenic plant[10-16] through pollen deposition during tasseling, e.g., maize[17] and by incorporation of plant residues after harvest [9,18,19]. Some studies have shown that repeated and large-scale use of transgenic Bt crops could lead to the accumulation and persistence of Bt proteins in soil [8,9,19,20]. Saxena and Stotzky (2002) showed that the toxin released in root exudates and from the bio-mass of Bt corn rapidly binds to surface-active particles in soil and remains larvicidal activity for at least 180 days[19,20,21]. The present study focused on the fertility status of Bt cotton soils compared with other crop cultivated soils in the region of Khammam, Andhra Pradesh, India.

II. Materials And Methods

The study area covers khammam region A.P.,India.Ten villages namely Ballepalli(K1) Daredu(K2),Sathanugudem(K3),Suryathanda(K4),Polisettivarigudem(K5),Wyara(K6),Nelakondapalli(K7),Kusumanchi(K8),Penuballi(K9),Thallada(K10)were selected for study.Two samples one from Bt cotton field second from other than Bt cottonfields were collected from each village.Soil samples were analysed as per standard methods[22]. P^H, OrganicCarbon, available nitrogen(0.32% alkaline $KMnO_4$),Phosphorus (0.5M $NaHCO_3$), Potassium(1Nneutral ammonium acetate extractible), Sulphur(turbidomeric method), Boron(hot water)and Zinc(DTPA extraction) were determined following the methods described by Methods manual, soil testing in India,Department of Agriculture and cooperation, ministry of Agriculture, Govt. of India, New Delhi 2011. Soil samples were generally classified into three categories low, mediumand high(Table.III)based on the soil test values (Table I &II) for different nutrients using these fertility classes nutrient index was calculated as per the following equation.

$$\text{Nutrient Index}=(N_L X1+N_M X2+N_H X3)/N_T$$

Where N_L,N_M,&N_H are number of samples falling in low,medium and high classes of nutrient status respectively and N_T is total number of samples analysed for a given area[23]. Total cfu(colony forming units) of Bacteria, Fungi and Actinomycetes were determined as per the standard methods.Bacteria cultivated on nutrient agar,fungi on rose bengal agar and Actinomycetes on starch casein agar by dilution plate method.1gm of soil for each sample was taken and serially diluted to get dilutions of 10^{-1}to10^{-6}. 1ml of inoculum from 10^{-6},$10^{-4}$and 10^{-5} dilatations for bacteria, fungi and Actinomycetes were taken respectively. Triplicates for each dilution were maintained and incubated for 24-48 Hrs, 5-7 days,and 7-14 days at 30°C, 24°C and 24°C temperature for bacteria, fungi and Actinomycetes respectively [24]. After incubation number of colonies per dilution was counted and determined cfu pergram soil by the formula.

Viable count (cfu/gm soil)=Average no. of colonies per plate X dilution factor/Weight of the soil.

Viable count of bacteria, fungi and Actinomycetes were determined from all the soil samples and meanvalues of each variant (Bt soil and non Bt soil) were tabulated (table IV). By analysing the soil fertility index(table.V) and microbial populations, data compared in between Bt cotton and non Bt cotton soils.

III. Results and Discussion

3.1 Soil P^H :

Data presented in tables I&II shows that Bt soil P^H varied from 7.5-7.9 with an average of 7.69 and non Bt soil P^H varied from 7.3-7.6 with an average of 7.5. According to classification of soil reactions suggested by Brady(1985) most of the samples i.e 9 from Bt soils and 9 from NBt soils were mildly alkaline (P^H 7.4-7.8). One sample ($K7_{Bt}$)is moderately alkaline with P^H 7.9 and one sample ($K8_{NBt}$) is near neutrality with P^H 7.3.The average P^H values for Bt and Non Bt soils shown a difference, but both fall in the range of mildly alkaline.The alkaline P^H may be attributed to the reaction of basic cations on the exchangeable complex of the soil [3].

3.2 Organic carbon:

The organic carbon content in Bt soils ranged from 0.45 to 1% with an average of 0.65% and Non Bt soil ranged from0.5 -1% with an average of 0.72%. Eight samples from Bt and seven samples from nonBt soils were found to be medium(0.5-0.75) even the mean values of both variants also fall under medium range. But the Non Bt soils contain a bit higher value than the Bt soils.

3.3 Nitrogen fertility status:

Nitrogen status available in Bt soils varied from 124-281 Kg/ha with an average of 224Kg/ha. On the basis of the ratings suggested by subbiah and Asija, methods manual [25] 90% of the samples were found to be low (<280Kg/ha), one sample($K8_{Bt}$) was medium. In case of NonBt soils the range fall in between 141-300, with an average of 236.9 Kg/ha. Six samples(60%) were found to be low and four samples (40%) were medium(280-560 Kg/ha). The nitrogen fertility index was 1.1 in case of Bt cotton soils and 1.3 in case of Non Bt cotton soils [26] (table. V) indicates the nitrogen fertility status is better in NBt soils than Bt soils.

3.4 Phosphorus fertility status:

The available phosphorus in Bt soils varied from 8.9 – 20 Kg/ha with an average of 15.6 Kg/ha. In NBt soils available Phosphorus ranges from 9-20.5 Kg/ha with an average of 15.9 kg/ha.On the basis of soil fertility ratings as shown in table III, Two samples from Bt and two samples from NBt were found to be low(<10 Kg/ha) and 8 samples from each variant were found to be medium (10-24.5 Kg/ha). The phosphorus fertility index was same (1.8) for both the variants[26](table. V).

3.5 Potassium fertility status:

Status of available potassium in Bt soils ranged from 85-189 Kg/ha with an average of 148.5 Kg/ha. In case of NBt soils it was ranged from 88-195 with an average of 151.2 Kg/ha. According to the table III, two samples from eachvariant were found tobe low(<108 kg/ha) and rest of the samples from both variants were medium(108-280kg/ha). Potassium nutrient index for Bt and NonBt soils was found to be medium(1.672.33)[26] and same i.e 1.8 (table. V).

3.6 Sulphur fertility status:

The availableSulphur inBt soils ranged from 4.5-14.2 ppm with an average of 9.3 ppm. In NBt soils it was ranged from 5-15.3ppm, with an average of 9.7 ppm. Five samples from Bt soils and five from NBt were found to be low (<10ppm) and 5 from Bt and 5 from NBt were found to be medium(10-20ppm)category as per the categorization given by Hariram and Dwivedi(1994).The sulphur nutrient index value in both Bt and NBt soils was medium(1.63-2.33). For Bt soils it was 1.9 and for NBt it was 2.0(table V)Small difference was found in between Bt and NBt soils.

3.7 Boron fertility status:

The available Boron in Bt soils ranged from 0.3-1.6 ppm with an average 0.9ppm.In NBt soils it was ranged from 0.4-1.7 with an average of 1.05ppm. On the basis of soil fertility ratings table, two samples from Bt soils and two from Non Bt soils were found to be low (<0.5) 3 from Bt soils and six from NBt soils were found to be high (.1ppm).The boron nutrient index was found to be medium(1.67-2.33)i.e 2.3(table. V). In Bt soils, where as in NBt soils it was high 2.4 (>2.33) .

3.8 Zinc fertility status:

Zinc in Bt soils was ranged from 0.3-1.1 ppm with an average of 0.6ppm.In NBt soils it was ranged from 0.35-1.1 with an average of 0.62ppm. On the basis of table III, $K9_{Bt}$ and $K4_{NBt}$ were found to be low (<0.4ppm), six samples from Bt soils and six from NBt soils were medium (0.4-0.6 ppm)and three from Bt three from NBt soils were high(>0.6ppm). Zinc nutrient index of Bt soils with 2.0 and Non Bt soils with 2.3 were found to be medium.The Zn nutrient index value showed some difference.

3.9 Microbial populations:

Average number of each dilution was counted and cfu /gm soil calculated for fungi, bacteria and actinomycetes. InBt soils cfu/gm soil is about $16x10^{-4}$,$26X10^{-6}$,$12X10^{-5}$ for fungi, bacteria and actinomycetesrespectively. Inthe NBt soils cfu/gm soil were $20X10^{-4}$,$35X10^{-6}$& $15X10^{-5}$fungi ,bacteria and actinomycetes. The cfu of fungi and bacteria and Actinomycetes is relatively low[table. 4]. There is a significant difference in the Number of microbial populations in both Bt and NBt soils, which can be explained the little high value in nutrient index of NBt soils when compared with Bt soils.

IV. Conclusions:

The fertility status in the Bt cotton cultivated fields and other crop cultivated soils fall in to the same category that is low to medium, but the fertility index values varies, where Bt soils has lesser values than NBt soils.All the samples P^Hwere slightly alkaline and Organic Carbon percentage is medium. Nitrogen nutrient index for Bt soils was low even though the **OC%** is moderate.The difference between Bt and NBt is also observed[27]. Other nutrients like **'P,K,S,B&Zn'** did not show much difference[figure. 1]. Microbial populations like fungi, bacteria and actinomycetes were low and has observable difference(cfu/gm)in between Bt and NBt soils[28][figure. 2]. Continuous cultivation of Bt cotton may change the physicochemical nature of the soil, because of large accumulations or continuous exposure of microbes to Bt toxin. The test area has less nutrient index in spite of moderate Organic Carbon content, this may be attributed to less microbial activity [29]. Further research is required to determine the factors affecting the soil fertility.

References

[1] Suzanne Visser[a1] and Dennis Parkinson[a]: 30 October 2009 American Journal of Alternative Agriculture / Volume 7 / Special Issue 1-2 / June 1992, pp 33-37

[2] Kate M. Scow and Matthew R. Wern :soil ecology chapter 5 ,pp 67-78.

[3] R. P. Singh and S. K. Mishra (2012) Available Macro nutrients(N, P, K and S) in the Soils Of Chiraigon Block Of District Varanasi (U.P.) In Relation to Soil Characteristics. Indian J.Sci.Res.3(1) : 97-100, 2012

[4] Bibhuti B. Das and M.S. DkharRhizosphere Microbial Populations and Physico Chemical Properties as Affected by Organic and Inorganic Farming Practices. American-Eurasian J. Agric. & Environ. Sci., 10 (2): 140-150, 2011

[5]. Williamson E (1992) Environmental risks from the release of geneticallymodified organisms (GMOS)—the need for molecular ecology.MolEcol 1:3–8. doi:10.1111/j.1365-294X.1992.tb00149.

[6] Hails RS (2000) Genetically modified plants-the debate continues.TrendsEcolEvol 15:14–18. doi:10.1016/S0169-5347(99)01751-7

[7] . Stotzky G (2000) Persistence and biological activity in soil ofinsecticidal proteins from Bacillus thuringiensis and of bacterialDNA bound on clays and humic acids. J Environ Qual 29:691–705

[8] Stotzky G (2002) Release, persistence, and biological activity in soilof insecticidal proteins from Bacillus thuringiensis . In: Letourneau DK, Burrows BE (eds) Genetically engineered organisms:assessing environmental and human health effects. CRC Press,Boca Raton, FL, pp 187–222

[9] Stotzky G (2005) Persistence and biological activity in soil of theinsecticidal proteins from Bacillus thuringiensis , especially fromtransgenic plants. Plant Soil 266:77–89. doi: 10.1007/s11104-005-5945-6

[10] . Saxena D, Stotzky G (2000) Insecticidal toxin from Bacillusthuringiensis is released from roots of transgenic Bt corn in vitroand in situ. FEMS MicrobiolEcol 33:35–39. doi: 10.1111/j.1574-6941.2000.tb00724.x

[11] Saxena D, Stotzky G (2001) Bacillus thuringiensis (Bt) toxin releasedfrom root exudates and biomass of Bt corn has no apparent effecton earthworms, nematodes, protozoa, bacteria, and fungi in soil.SoilBiolBiochem 33:1225–1230. doi:10.1016/S0038-0717(01)00027-X

[12] Saxena D, Stotzky G (2002) Bt toxin is not taken up from soil orhydroponic culture by corn, carrot, radish, or turnip. Plant Soil239:165–172. doi:10.1023/A:1015057509357

[13] Saxena D, Flores S, Stotzky G (1999) Insecticidal toxin in rootexudates from Bt corn. Nature 402:480

[14] Saxena D, Flores S, Stotzky G (2002a) Vertical movement in soilof insecticidal Cry1Ab protein from Bacillus thuringiensis.SoilBiolBiochem 34:111–120. doi:10.1016/S0038-0717(01)00193-6

[15] Saxena D, Flores S, Stotzky G (2002b) Bt toxin is released in rootexudates from 12 transgenic corn hybrids representing threetransformation events. Soil BiolBiochem 34:133–137. doi:

[16] Icoz I, Stotzky G (2007) Cry3Bb1 protein from Bacillus thuringiensisin root exudates and biomass of transgenic corn does not persistin soil. Transgenic Res. doi: 10.1007/s11248-007-9133-8

[17] Hansen Jesse LC, Obrycki JJ (2000) Field deposition of Bttransgeniccorn pollen: lethal effects on the monarch butterfly. Oecologia125:241–248. doi:10.1007/s004420000502

[18] Zwahlen C, Hilbeck A, Gugerli P, Nentwig W (2003) Degradation ofthe Cry1Ab protein within transgenic Bacillus thuringiensiscorntissue in the field. MolEcol 12:765–775. doi: 10.1046/j.1365-294X.2003.01767.x

[19] Namita Rani Das*, Anita Chaudhary, R. Choudhary and H.C. Joshi (2009) ..Journal of Environmental Research And Development Vol. 3 No. 3, January-March 2009

[20] Tapp H, Stotzky G (1998) Persistence of insecticidal toxin fromBacillusthuringiensis subsp. Kurstaki in soil. Soil Biol Biochem30:471–476. doi: 10.1016/S0038-0717(97)00148-X

[21] Hai-Yan HuÆ Xiao-Xia Liu Æ Zhang-Wu ZhaoÆJian-GuangSunÆ Qing-Wen Zhang ÆXing-Zhong Liu Æ Yong Yu(2009) World J MicrobiolBiotechnol (2009) 25:357–366DOI 10.1007/s11274-008-9899-8

[22] Chopra S.L. and Kanwar, J.S,2005. Analytical Agricultural Chemistry.Kalyani Publishers, New Delhi.

[23] H PATHAK (2010)Trend of fertility status of Indian soils , Current Advances in Agricultural Sciences 2(1): 10-12 (June 2010)

[24] Johnson, L.F. and A.E. Curl, 1972. Method for the research on ecology of soil borne plant pathogens.Burgess publishing company.Pp. 247, Minneapolis.

[25] Methods manual Department of agrculture&cooperation ,Ministry of Agriculture, Govt of India, New Delhi,2011,

[26] Meena H.B., Sharma R.P. and Rawat U.S., 2006.Status of macro and micro nutrients in some soils of Tonk district of Rajasthan. J. Indian Soc. Soil Sci., 54: 508-512.

[27] B. Sarkar.,A. K. Patra, & T. J. PurakayasthaJ. Agronomy & Crop Science (2008) ISSN 0931-225 Transgenic Bt-Cotton Affects Enzyme Activity and NutrientAvailability in a Sub-Tropical Inceptisol.

[28.] DeepakSaxena*,, SmrutiPushalkarand Guenther StotzkyThe Open Toxinology Journal, 2010, 3, 151-171 151Open Access-Fate and Effects in Soil of Cry Proteins from Bacillus thuringiensis:Influence of Physicochemical and Biological Characteristics of Soil

[29]. Masto, R. E., P. K. Chhonkar, D. Singh, and A. K. Patra, 2006:Changes in soil biological and biochemical characteristics ina long-term field trial on a sub-tropical inceptisol. Soil Biol.Biochem. 38, 1577–1582.

TABLES:

Table 1: Nutrient status of Bt soils under study.

Table 2:Nutrient status of non Bt soils under study.

Table 3:Soil fertility ratings based on soil test values.

Table 4:Microbialpopulation(CFU/gm of soil) in sample varients.

Table 5: Nutrient index of sample varients.

Table1:

s.no	*site*	*P^H*	*o.c(%)*	*Available N (Kg/ha)*	*Available P (Kg/ha)*	*Available K (Kg/ha)*	*Available S (ppm)*	*Available B (ppm)*	*Available Zn (ppm)*
1.	$K1_{Bt}$	7.7	0.5	250	15.2	162	7.5	1.2	1.1
2.	$K2_{Bt}$	7.6	0.7	225	18.5	189	10.0	0.5	0.6
3.	$K3_{Bt}$	7.8	0.45	245	8.9	172	13.1	0.9	0.5
4.	$K4_{Bt}$	7.8	0.5	271	14.6	142	5.1	1.3	0.4
5.	$K5_{Bt}$	7.5	0.7	252	9.1	121	7.3	0.4	0.5
6.	$K6_{Bt}$	7.8	1.0	237	16.5	97	6.2	1.4	0.4
7.	$K7_{Bt}$	7.9	0.5	174	18.2	85	11.5	0.8	0.9
8.	$K8_{Bt}$	7.5	0.7	281	17.1	187	13.4	1.6	0.6
9.	$K9_{Bt}$	7.7	0.7	124	20	173	4.5	0.3	0.3
10.	$K10_{Bt}$	7.6	0.9	185	18.3	157	14.2	1.3	0.8
Range		7.5-7.9	0.45-1	124-281	8.9-20	85-189	4.5-14.2	0.3-1.6	0.3-1.1
Mean		7.69	0.65	224.4	15.6	148.5	9.3	0.97	0.6

Table2:

S.no	site	P^H	OC (%)	Available N (Kg/ha)	Available P (Kg/ha)	Available K (Kg/ha)	Available S (ppm)	Available B (ppm)	Available Zn (ppm)
1.	$K1_{NBt}$	7.5	0.5	300	15.1	165	8.0	1.4	0.9
2.	$K2_{NBt}$	7.5	0.7	213	19.1	182	11.2	0.4	0.6
3.	$K3_{NBt}$	7.6	0.5	262	9.0	175	13.4	1.1	0.5
4.	$K4_{NBt}$	7.6	0.6	280	14.2	139	5.0	1.1	0.35
5.	$K5_{NBt}$	7.4	0.9	268	9.3	126	7.5	0.5	0.6
6.	$K6_{NBt}$	7.6	1.0	242	17.1	99	6.4	1.6	0.5
7.	$K7_{NBt}$	7.5	0.6	180	18.5	88	12.2	0.8	1.1
8.	$K8_{NBt}$	7.3	0.7	292	18.2	195	15.3	1.7	0.5
9.	$K9_{NBt}$	7.6	0.7	141	20.5	181	5	0.4	0.4
10.	$K10_{NBt}$	7.5	1.o	191	18.5	162	15.1	1.5	0.8
Range		7.3-7.6	0.5-1	141-300	9-20.5	88-195	5-15.3	0.4-1.7	0.35-1.1
Mean		7.51	0.72	236.9	15.9	151.2	9.7	1.05	0.62

TABLE 3:

s.no	Soil test	low	medium	High
1.	OC (%)	<0.5	0.5-0.75	>0.75
2.	Avaible N_2 Kg/ha (alkaline $KMnO_4$)	<280	280-560	>560
3.	Phosphores Kg/ha (0.5M $NaHCO_3$)	<10	10-24.6	>24.6
4.	Avaible K Kg/ha (ammonium acetate)	<108	108-280	>280
5.	Sulphur ppm (turbidometric method)	<10	10-20	>20
6.	Boran ppm (Hot water)	<0.5	0.5-1	>1
7.	Zinc ppm (DTPA extration)	<0.4	0.4-0.6	>0.6

TABLE 4:

Sample varients	Microbial Population(cfu/gm)		
	Fungi	bacteria	Actinomycetes
Bt Cotton soils	$16x10^{-4}$	$26x10^{-6}$	$12x10^{-5}$
Soils other than Bt Cotton.	$20x10^{-4}$	$35x10^{-6}$	$15x10^{-5}$

Table5:

Sample variants	Nutrient index							
	N	P	K	S	B	Zn	OC(%)	P^H(average)
Bt cotton soils	1.1	1.8	1.8	1.9	2.3	2.0	0.65	7.69
Soils other than Bt cotton	1.3	1.8	1.8	2.0	2.4	2.3	0.72	7.51

Figure 1:Nutrient status of Bt and NBt soils under study:

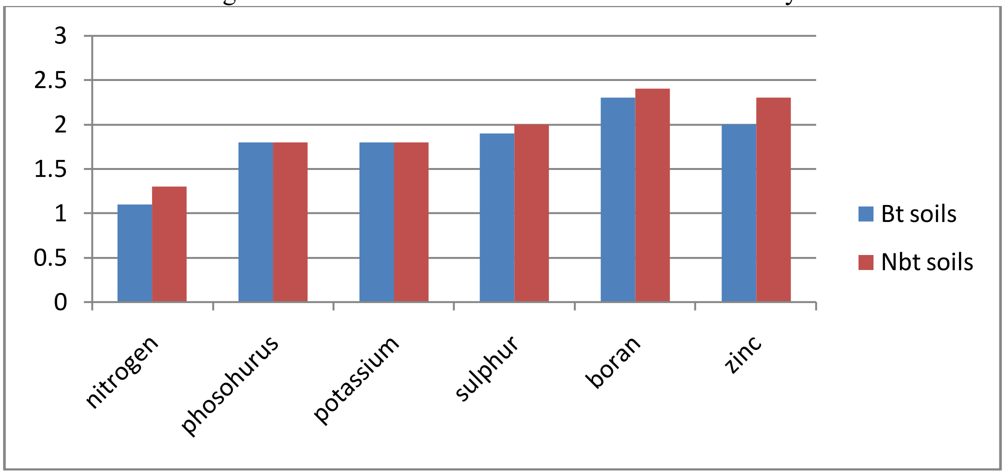

Figure 2: Microbial population in Bt and NBt soils.