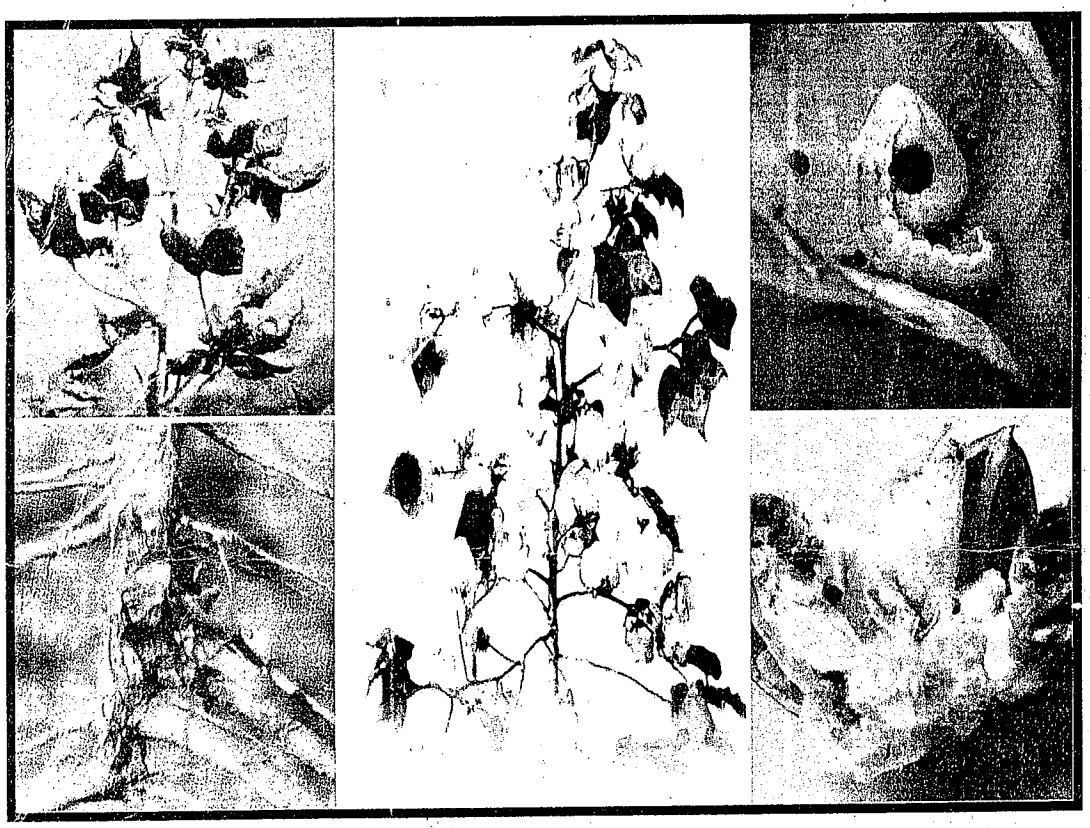
ISSN : 0972-8619 Volume 25(2) July, 2011

JOURNAL OF COTTON RESEARCH AND DEVELOPMENT



Cotton Research And Development Association (CRDA)
CCS Haryana Agricultural University,
Hisar-125 004 (Haryana), India

J. Cotton Res. Dev. **25** (2) 197-201 (July, 2011)

Sustaining rainfed *Bt* cotton (*Gossypium hirsutum* L.) productivity through moisture conservation and integrated nutrient management techniques

D. N. GOKHALE,* V.S. SHINDE, G.D. GADADE, G.L. SAWARGAONKAR AND K.K. ZADE
Department of Agronomy, Marathwada Agricultural University, Parbhani – 431 402
**E-mail : gokhaledn@yahoo.co.in*

ABSTRACT : Field studies were carried out at Department of Agronomy, Marathwada Agricultural University, Parbhani during, 2007 to 2010 to explore the suitability of different soil moisture conservation and integrated nutrient management (INM) techniques in relation to yield and economics of *Bt* cotton under rainfed conditions. The results revealed that opening of furrow in alternate row recorded significantly highest seed cotton yield (2758, 2214 and 1452 kg/ha) as compared to cotton + straw mulching (2421, 2003 and 1233 kg/ha) and intercropping of cotton with soybean (2036, 1626 and 1106 kg/ha) treatments during the three year of experitmentation respectively. However, intercropping of cotton + soybean recorded significantly highest seed cotton equivalent yield and thereby net returns and B:C ratio over wheat straw mulch and opening of furrow in alternate row. As regards to integrated nutrient management (INM) 100 per cent calculated RDF (100:50:30 N, P_2O_5 and K_2O kg/ha) + micronutrients (zinc, iron and boron) based on soil test recorded significantly highest seed cotton yield as compared to all other INM treatments. However, application of RDF with soil testing (75 per cent N, P_2O_5 and K_2O kg/ha through inorganic + 25 per cent N, P_2O_5 and K_2O kg/ha through vermicompost) was next best treatment which recorded significantly highest seed cotton yield over rest of the treatments

Key words : *Bt* cotton, INM, soil moisture conservation

The development of *Bt* cotton containing a genetically introgressed endotoxin gene from the gram negative soil bacterium (*Bacillus thuringiensis*) signifies the technological landmark in the scenario of global cotton research. Apart from the likelihood of reduction in insecticide use by at least 50 to 75 per cent, it is also expected to ensure favourable ecological, economical and sociological returns in contrast to the harmful effects due to large scale use of insecticides (Kranthi, 2002). Now a days *Bt* cotton is widely accepted, therefore special attention must be given to its agronomic management, so as to fully harness its economic benefits, delay the process of resistance development and help production system to sustain high productivity levels. Today, the coverage under *Bt* hybrids in India is almost saturated and further improvement in cotton yield is possible only through agronomic manipulations (Rao and Alapati, 2007). Thus, efficient crop production packages from the modern agronomy of cotton explore the avenues for realizing the potential crop yields of *Bt* hybrids in Maharashtra.

The cost effective technologies for efficient utilization of natural resources, effective rain water management as *in-situ* moisture conservation comprising the opening of furrow, intercropping, mulching, etc may prove vital in enhancing and stabilizing the yield. Indiscriminate use of chemical fertilizers, pesticides and herbicides leads in deteriorating the soil fertility and thereby productivity. To mitigate the challenges of increasing production while conserving resources as intact for further generation, the need arises to switch on towards the technology that is environmentally safe. Thus, taking into consideration the above facts, field experiments were conducted to evaluate the response of *Bt* cotton under different *in situ* rain water conservation and INM treatments.

MATERIALS AND METHODS

Field experiments were conducted during three consecutive years from 2007 to 2010 at Department of Agronomy, Marathwada Agricultural University, Parbhani. The soil of the experimental field was clayey in texture, slightly alkaline in reaction, medium in organic carbon, low in available nitrogen and phosphorus

and rich in available potash. The experiment was laid out in a split plot design with three replications. The treatments comprises of 3 soil moisture conservation techniques *viz.*, S_1 – opening of furrow in alternate row, S_2 – intercropping system *i.e.* cotton + soybean intercropping and S_3 – straw mulching after last interculture (second fortnight of August), whereas sub plot comprises of six integrated nutrient management practices *viz.*, I_1-100 per cent RDF of the region (80:40:40 N, P_2O_5 and K_2O kg/ha), I_2- RDF based on soil test {(100:50:30 N, P_2O_5 and K_2O kg/ha) as the soil sample tested were low in N and P and high in K, therefore 25 per cent more application of N and P and 25 per cent less application of K was given as per the RDF of the region (I_1) }, - 75 per cent inorganic + 25 per cent through FYM, I_3- RDF based on soil test, - 75 per cent inorganic + 25 per cent through vermicompost, I_4- RDF based on soil test, - 50 per cent inorganic + 50 per cent through FYM, I_5 - RDF based on soil test - 50 per cent inorganic + 50 per cent vermicompost and I_6- soil test based RDF + micronutrient (Zn, Fe and B). Sowing was done on last fortnight of June to early July during all the three years. Fertilizers were applied as per the treatments. Half dose of nitrogen and complete dose of phosphorus and potash was applied at the time of sowing by ring method and remaining half dose of nitrogen was applied after one month of sowing. All other recommended intercultural practices were uniformly followed. The rainfall during the crop growth period for the three consecutive years during 2007-2008, 2008-2009 and 2009-2010 were 718, 544 and 504 mm, respectively.

RESULTS AND DISCUSSION

Moisture conservation techniques : Opening of furrow in alternate row (2758, 2214 and 1452 kg/ha) recorded significantly highest seed cotton yield as compared to cotton + straw mulching (2421, 2003 and 1233 kg/ha) and intercropping of cotton with soybean (2036, 1626 and 1106 kg/ha) treatments during 2007-2008, 2008-2009 and 2009-2010, respectively (Table 1). Opening of furrow in alternate row is an effective soil and water management system to reduce runoff and soil erosion, while increasing infiltration of rainwater. A similar trend was observed by Giri *et al.*, 2008. Further, wheat straw mulching in cotton found significantly superior over cotton + soybean intercropping systems in respect of seed cotton yield.

However, as regards to seed cotton equivalent yield, intercropping of cotton + soybean recorded significantly highest seed cotton equivalent yield over wheat straw mulch and opening of furrow in alternate row. The lowest seed cotton equivalent yield was recorded in wheat straw mulched treatment (Table 1). The pooled analysis data on seed cotton yield and seed cotton equivalent yield (kg/ha) presented in Table 1 revealed that significantly highest seed cotton yield was recorded with opening of furrow in alternate row after last inter culture operation as compared to cotton + soybean and cotton + straw mulching treatments. However, cotton + soybean intercropping system recorded significantly highest seed cotton equivalent yield as compared to opening of furrow in cotton and cotton + straw mulch treatments.

Integrated nutrient management : As regards to Integrated nutrient management, application of 100 per cent RDF + micronutrients Zn, Fe and B based on soil testing and application of RDF with soil testing, 75 per cent through inorganic + 25 per cent through vermicompost were *at par* with each other except seed cotton yield in second year and recorded significantly higher seed cotton and seed cotton equivalent yield as compared to rest of the fertilizer treatments, during 2007-2008, 2008-2009 and 2009-2010, respectively. As regards to pooled analysis of integrated nutrient management 100 per cent RDF (100:50:30 kg/ha) + micronutrients Zn, Fe and B based on soil testing recorded significantly highest seed cotton yield as compared to all other INM treatments. This was followed by application of RDF with soil testing 75 per cent through inorganic + 25 per cent through vermicompost which recorded significantly higher seed cotton yield over rest of the treatments.

Application of adequate quantity of water and supply of nutrients at active root zone of the crop might have enhanced the availability in soil, uptake by plant and translocation of nutrients to reproductive parts which was reflected in improved yield attributed under drip fertigation.

Table 1. Yield contributing characters and seed cotton yield as influenced by different treatments during 2007-2008 to 2009-2010

Treatments	Picked bolls/plant				Boll weight (g)				Seed cotton yield /plant (g)				Seed cotton yield (kg/ha)				Seed cotton equivalent yield (kg/ha)			
	2007-2008	2008-2009	2009-2010	Mean	2007-2008	2008-2009	2009-2010	Mean	2007-2008	2008-2009	2009-2010	Mean	2007-2008	2008-2009	2009-2010	Mean	2007-2008	2008-2009	2009-2010	Mean
Soil moisture conservation techniques																				
S_1 – Opening of furrow in alternate row	45.17	40.95	25.65	**37.26**	3.83	3.68	3.03	**3.51**	158.07	138.64	77.53	**124.75**	2758	2214	1452	**2142**	2759	2214	1452	**2142**
S_2 – Cotton + soybean intercropping	39.81	34.65	19.35	**31.27**	3.42	3.47	2.82	**3.24**	119.28	100.66	59.94	**93.29**	2036	1626	1106	**1589**	3291	2619	2190	**2700**
S_3 – Cotton + straw mulch	42.85	37.02	21.72	**33.86**	3.61	3.59	2.93	**3.38**	140.17	119.88	65.27	**108.44**	2421	2003	1233	**1886**	2421	2003	1233	**1886**
SE ±	0.44	0.35	0.34	—	0.03	0.03	0.03	—	1.96	1.41	1.35	—	32.9	10.04	25.6	**59.13**	70.9	73.2	25.8	**59.9**
CD (p=0.05)	1.28	0.93	0.99	—	0.09	0.08	0.08	—	5.66	4.05	3.89	—	94.9	28.95	73.8	**163.7**	212	211	74	**166**
Integrated nutrient management																				
I_1 – RDF (80:40:40 NPK kg/ha)	42.15	37.85	22.55	**34.18**	2.79	2.88	1.99	**2.55**	105.84	94.36	52.86	**84.35**	1818	1457	1061	**1446**	2213	1776	1411	**1800**
I_2 – RDF with soil test inorganic (75%) + FYM (25%)	40.77	35.08	19.78	**31.88**	4	3.87	3.28	**3.72**	146.77	121.36	68.72	**112.28**	2537	2093	1266	**1965**	2962	2427	1629	**2339**
I_3 – RDF with soil test inorganic (75%) + vermicompost (25%)	44.09	39.11	23.81	**35.67**	3.98	3.9	3.31	**3.73**	158.39	134.09	78.51	**123.66**	2754	2261	1442	**2153**	3188	2599	1810	**2533**
I_4 – RDF with soil test inorganic (50%)+ FYM (50%)	42.65	37.42	22.12	**34.06**	3.03	3.14	2.45	**2.87**	121.19	106.13	58.2	**95.17**	2053	1598	1086	**1579**	2452	1921	1439	**1937**
I_5 – RDF with soil test inorganic (50%) + vermicompost (50%)	39.7	34.14	18.84	**30.89**	3.91	3.87	3.19	**3.66**	138.18	120.5	64	**107.56**	2382	1887	1193	**1821**	2798	2215	1551	**2188**
I_6 – RDF + micronutrients Zn, Fe, B based on soil test	46.31	41.65	26.35	**38.1**	4.02	3.93	3.33	**3.76**	164.67	140.91	83.17	**129.58**	2887	2390	1533	**2270**	3327	2735	1909	**2657**
SE ±	0.65	0.54	0.54	—	0.073	0.04	0.04	—	3.71	2.82	1.77	—	69.5	23.54	32.52	**41.32**	52.9	122.9	32.6	**55.9**
CD ($p_=0.05$)	1.89	1.56	1.56	—	0.21	0.11	0.11	—	10.7	8.14	5.11	—	200.4	67.88	93.78	**114.34**	158	355	94	**155**
Interaction (S x I)																				
SE ±	1.13	0.94	0.94	—	0.12	0.07	0.07	—	6.42	4.89	3.07	—	120.4	40.71	56.33	**75.56**	279	213	56.5	**96.9**
CD ($p_=0.05$)	3.28	N.S.	N. S.	—	NS	N.S.	N.S.	—	NS	N.S.	N.S.	—	NS	N.S.	N.S.	**N. S.**	N.S.	N.S.	N.S.	**N.S.**
General mean	**42.61**	**37.54**	**22.24**	**34.13**	**3.62**	**3.58**	**2.92**	**2.18**	**2.14**	**119.73**	**67.58**	**63.15**	**2405**	**1948**	**1263**	**1872**	**2681**	**2279**	**1625**	**2242**

Table 2. Economics of *Bt* cotton during 2007-2008, 2008-2009, 2009-2010 as influenced by different treatments

Treatments	Gross returns (Rs/ha)				Net returns (Rs/ha)				Benefit cost ratio			
	2007-2008	2008-2009	2009-2010	**Mean**	2007-2008	2008-2009	2009-2010	**Mean**	2007-2008	2008-2009	2009-2010	**Mean**
A) Soil moisture conservation techniques												
S_1 – Opening of furrow in alternate row	56275	63109	45005	**54796**	35661	42370	22016	**33349**	2.73	3.04	1.95	**2.57**
S_2 – Cotton + soybean intercropping	67129	74653	67895	**69892**	46210	53679	43427	**47772**	3.21	3.22	2.77	**3.07**
S_3 – Cotton + straw mulch	49384	57081	38218	**48228**	28196	36047	14934	**26392**	2.33	2.71	1.64	**2.23**
SE ±	2164	587	798	—	1929	272	797	—	0.13	0.01	0.04	—
CD (p=0.05)	6448	1695	2300	—	5773	785	2300	—	0.37	0.04	0.10	—
B) Integrated nutrient management												
I_1 – RDF (80:40:40 NPK kg/ha)	45147	50628	43730	**46502**	25664	29971	21394	**25676**	2.32	2.45	1.94	**2.24**
I_2 – RDF with soil test inorganic (75%) + FYM (25%)	60433	69176	50495	**60035**	37962	48200	26891	**37684**	2.69	3.29	2.12	**2.70**
I_3 – RDF with soil test inorganic (75%) + vermicompost (25%)	65025	74080	56120	**65075**	41969	53013	32047	**42343**	2.82	3.52	2.32	**2.89**
I_4 – RDF with soil test inorganic (50%) + FYM (50%)	50022	54733	44594	**49783**	27969	33886	20520	**27458**	2.27	2.63	1.84	**2.25**
I_5 – RDF with soil test inorganic (50%) + vermicompost (50%)	57083	63127	48097	**56102**	34072	42101	23621	**33265**	2.48	3.00	1.95	**2.48**
I_6 – RDF + micronutrients Zn, Fe, B based on soil test	67868	77941	59202	**68337**	45547	57019	36284	**46283**	3.04	3.73	2.57	**3.11**
SE ±	1914	1097	1012	—	1183	673	1011	—	0.06	0.03	0.04	—
CD (p=0.05) 3134	5721	3137	2918	—	3513	1941	2917	—	0.17	0.10	0.12	—
Interaction (S x I)												
SE ±	4821	1901.	5053	—	4519	1167	4569	—	0.25	0.07	0.08	—
CD (p=0.05)	NS	N.S.	N. S.	—	NS	N.S.	N. S.	—	NS	N.S.	N. S.	—
General mean	**57596**	**64947**	**50373**	**57639**	**35531**	**44032**	**26793**	**35452**	**2.60**	**3.10**	**2.13**	**2.61**

These results corroborates with the finding of Bharambe *et al,* 1997 and Reddy and Gopinath *et al.*, 2008. Application of FYM and growing of soybean as an intercrop in cotton not only changed the physico chemical properties of the soil, but also improved the nutrient status of the soil by the addition of major nutrients and traces of secondary and micronutrients thereby increased the nutrient uptake, which in turn had a positive influence on crop yields. The results are in agreement with the findings of Ratnakumari and Subbaramamma (2006).

Yield attributes : The yield attributes like bolls/plant, boll weight and seed cotton yield / plant were significantly influenced by different moisture conservation treatments and INM techniques (Table 1). Opening of furrow in alternate row recorded significantly highest picked bolls / plant (45.17,40.95 and 25.65), seed cotton yield / plant (158.07, 138.64 and 77.53) and boll weight (3.83, 3.68 and 3.03) over the cotton + soybean intercropping and straw mulch treatments during all the three consecutive years 2007-2008,2008-2009 and 2009-2010 respectively (Table 1). Further, wheat straw mulching in cotton proved significantly superior over cotton + soybean intercropping system. With respect to INM treatments, application of RDF + micronutrients Zn, Fe and B based on soil test recorded significantly highest bolls/plant (46.31, 41.65 and 26.35), boll weight (4.02, 3.93 and 3.33) and seed cotton yield / plant (164.67, 140.91 and 83.17) over all other treatments during 2007-2008, 2008-2009 and 2009-2010 respectively. The cumulative effect of fertilizer application proved beneficial in increasing the yield attributes. Similar trend of increasing yield attributes due to different nutrient management techniques was observed by Tomar *et al,* 2000.

Economics Among different soil moisture conservation treatments, cotton + soybean intercropping system recorded significantly higher gross returns, net returns and benefit: cost ratio as compared to rest of the moisture conservation techniques. As regards to integrated nutrient management, application of RDF along with micronutrients based on soil testing recorded significantly higher net returns and benefit : cost ratio as compared to all other INM treatments (Table 2). Similar results were reported by Sharma *et al.* (2001).

REFERENCES

Bharambe, P.R., Narwade, S.K., Oza, S.R., Vaishnava, V.G., Shelke, D.K., and Jadhav, G.S. 1997. Nitrogen management in cotton through drip irrigation. *J. Indian Soc. Soil Sci* **45** : 705-09.

Giri, A.N., Aundhekar, R.L., Kapse, P.S. and Suryavanshi,S.B. 2006. Response of *Bt* cotton hybrids to plant densities and fertilizer levels. *J. Cotton Res. Dev.* **22**:45-47.

Kranthi, K.R. 2002. Modalities of *Bt* cotton cultivation in India, its pros and cons including resistance management and potential ecological impact. In : National Seminar on *"Bt Cotton Scenario with special reference to India"*. University of Agricultural Sciences, Dharwad, pp : 26-50.

Reddy R. R. and. Gopinath M. 2008. Influence of fertilizers and plant geometry on performance of *Bt* cotton hybrid. *J. Cotton Res. Dev.* **22** : 78-80.

Ratnakumari, S and Subbaramamma, P. 2006. Effect of farm yard manure, chemical fertilizers and micronutrients on yield, economics and fibre properties of cotton. *J. Cotton Res. Dev.* **20** : 64-70.

Rao, P.M. and Alapati, S. 2007. *Bt* cotton offers planting at higher planting densities in India. In: Proceedings *"World Cotton Research Conference"*, 10-14 September, 2007, Lubbock, Texas, USA.

Sharma J.K., Upadhaya, B.D., Mishra, U.S., Khamparia, S.K. and Madndloi, K.C. 2001. Effect of spacing and fertility levels on growth and yield of *hirsutum* genotypes. *J. Cotton Res. Dev.* **15** : 151-53.

Tomar, R.S., Kushwaha, A.L., Julka R. and Mandloi, K.C. 2000. Productivity of upland cotton (*Gossypium hirsutum*) genotypes under different fertility levels and spacing. *Indian J. Agron.* **45** : 776-81.

Received for publication : December 22, 2010