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Impact of Integrated Pest Management Technology (IPM) on Bt-Cotton Growers

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ABSTRACT: *The study revealed that, the complete knowledge of IPM technology to the Bt-cotton growers were, use of Bt seeds (85 per cent), keeping of yellow tins in Bt-cotton fields by applying grace for white flies (68.33 per cent), seed treatment with trichoderma (68.33 per cent). While, the complete adoption of IPM technology were use of Bt-seeds (85 per cent), deep ploughing to inhibit insect, pathogen, and nematode population (68.33per cent), picking and disposal of affected cotton bolls and twigs (53.33 per cent), seed treatment with trichoderma (68.33 per cent), collecting spodoptera egg masses and putting them into perforated cage (61.67 per cent), application of SlNPV (65 per cent), use of yellow pans/sticky traps 60.00 per cent, spray of NSKE (65 per cent). It was found that 61.67 per cent of the IPM respondents had average level of productivity between 21 to 22 q/ha. They were economically benefitted an additional income of Rs.22563 per hectare because of the adoption of IPM. Bt-cotton growers expressed that , due to adoption of IPM technology the 65 per cent saving in insecticides and money , decrease in insect resistance to insecticides (68.33 per cent), use of Bio-pesticides and natural enemies were found beneficial (81.67 per cent), per ha increase in the total yield of Bt-cotton (63.33 per cent) and Side effects due to chemical insecticides decreased (93.33 per cent) due to the IPM technology.*

Keywords: *Impact of IPM technology, Bt-cotton Growers, Adoption of IPM, Knowledge of IPM.*

INTRODUCTION

Cotton is an important commercial cash crop in India. India ranks third in the world in production, next only to china and USA. Farmers there face the challenge of losses due to various insect pests. The first genetically modified crop in India, Bt-cotton, has been introduced to address bollworm infestation. The area under Bt-cotton is projected to increase rapidly in the coming years.

The Bt-cotton contains a foreign genes obtained from a bacteria called *Bacillus thuringiensis*, which is an aerobic bacterium characterized by its ability to produce crystalline inclusions during sporulation. This bacteria is a natural enemy of the boll worm, a major pests (Aphids, Jassids, and Whiteflies) of cotton. This bacteria was first discovered by Japanese bacteriologist in 1901 and sub-sequently in 1915, a German scientist isolated the crystal toxin in Thuringen region of Germany. It was therefore, thought necessary to study the impact of the IPM technology on Bt-cotton growers with the objectives to study the Knowledge and the adoption of IPM technology and Impact of IPM in terms of the increase in total yield and annual income of the Bt-cotton growers.

MATERIALS AND METHODS

The present study was undertaken in year 2014 in the Shevgaon tehsil of Ahmednagar district of Maharashtra, India which was purposively selected for the study on the basis of maximum area (2890 ha) under Bt-cotton cultivation. Out of 112 the 5 villages having 12 IPM and 12 non IPM Bt-cotton growers from each village thus total 120 respondents were selected. Primary data were collected with the help of pretested interview schedule specially designed in local language for the purpose. Simple statistical tools like mean, percentage, mean standard deviation and Karl Pearson's correlation coefficient were used for the analysis of data.

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Table 1
Distribution of Bt-cotton growers according to their knowledge level

Sr. No.	*Components*	*Knowledge (N = 120)*					
		IPM (n =60)			*Non IPM (n = 60)*		
		Complete	*Partial*	*No*	*Complete*	*Partial*	*No*
(A)	*Cultural method*						
1.	Deep ploughing to inhibit insect, pathogen, and nematode population	36 (60.00)	21 (35.00)	3 (05.00)	13 (21.67)	22 (36.67)	35 (58.33)
2.	Plant to plant spacing (90-90cm)	18 (30.00)	33 (55.00)	9 (15.00)	7 (11.67)	19 (31.67)	34 (56.67)
3.	Intercropping (Cotton-cowpea)	24 (40.00)	31 (51.67)	5 (08.33)	2 (03.33)	13 (21.67)	45 (75.00)
4	Use of Bt-seeds (Kanak, Mallika, Champion)	51 (85.00)	6 (10.00)	3 (05.00)	4 (06.67)	18 (30.00)	38 (63.33)
5	Animal (sheep) grazing in cotton field after last picking to kill bollworm larvae	37 (51.67)	19 (31.67)	4 (06.67)	12 (20.00)	38 (63.33)	10 (06.67)
6	Timely sowing (Mid May to 28-30 June)	31 (51.67)	28 (46.67)	1 (01.67)	3 (05.00)	17 (28.33)	40 (66.67)
7.	Seed treatment with trichoderma @ 4gm/ Imidachloprid 70 ws @10gm per kg of seed	35 (53.33)	22 (36.67)	3 (05.00)	5 (08.33)	21 (35.00)	34 (56.67)
(B)	*Mechanical methods*						
1.	Picking and disposal of affected cotton bolls and twigs	32 (53.33)	24 (40.00)	4 (06.00)	3 (05.00)	28 (46.67)	29 (48.33)
2.	Keeping of yellow tins in cotton field by applying grease for white flies	41 (68.33)	12 (20.00)	7 (11.67)	2 (03.33)	24 (40.00)	34 (56.67)
(C)	*Biological methods*						
I.	Seed treatment						
1.	Seed treatment with *Trichoderma*spp. @ 4 gm/ Imidachloprid 70 ws 10 gm per kg of seed	41 (68.33)	13 (21.67)	6 (10.00)	9 (15.00)	20 (33.33)	31 (51.67)
II.	Conservation						
1.	Install 8-10 bird perches per ha 90 DAS for crow, myna, blue joy.	33 (55.00)	17 (28.00)	10 (16.67)	11 (18.33)	16 (26.67)	33 (55.00)
2.	Conservation of predators (Lacewing, Lady bird beetle, Staphylinids, Predatory wasps)	35 (58.33)	20 (33.33)	5 (18.33)	0	7 (11.67)	53 (88.33)
3.	Collecting *Spodoptera* egg masses and putting them into perforated cage	37 (61.67)	19 (31.67)	4 (06.67)	4 (06.67)	18 (30.00)	38 (63.33)
III.	Augmentation						
1.	Monitoring the incidence of sucking pests and release egg of chrysopa	31 (51.67)	19 (31.67)	10 (16.67)	8 (13.33)	14 (23.33)	38 (63.33)
3.	Application of *SlNPV* 250-500 LE/ha or *HaNPV* @ 250LE/ha	39 (61.67)	18 (30.00)	3 (05.00)	5 (08.33)	17 (28.33)	38 (63.33)
IV	Monitoring						
1.	Use yellow pans /sticky traps @ 25 each/ha	36 (60.00)	13 (21.67)	11 (18.33)	3 (05.00)	18 (30.00)	39 (65.00)
2.	Use of pheromone traps (2 each/ha) on 55 DAS *i.e.* 24-26 Aug	31 (51.67)	19 (31.67)	10 (16.67)	2 (03.33)	14 (23.33)	44 (73.33)
3.	Follow up of Economic Threshold Levels (For white fly, Aphids, Jassids 10 % affected plants)	18 (30.00)	33 (55.00)	9 (15.00)	0	8 (13.33)	52 (86.67)
V	Botanical products						
1.	Spray of neem seed kernel extract 5% (3 sprays)	39 (65.00)	18 (30.00)	3 (05.00)	7 (11.67)	19 (31.67)	34 (56.67)
(D)	*Chemical Methods*						
1.	Need based, judicious, safe application of pesticides	48 (80.00)	12 (20.00)	0	8 (13.33)	21 (35.00)	36 (60.00)

*Figures in parentheses indicates percentage

RESULTS AND DISCUSSION

Knowledge of Bt-Cotton growers about IPM

From the Table 1, it is revealed that the complete knowledge of IPM technology to the Bt-cotton growers were, use of Bt seeds (85.00 per cent), keeping of yellow tins in Bt-cotton fields by applying grace for white flies (68.33 per cent), seed treatment with trichoderma (68.33 per cent), collecting spodoptera egg masses and put them in perforated

Table 2
Distribution of Bt-cotton growers according to their component wise adoption level

Sr. No.	*Components*	*Adoption*		
		IPM (N = 60)		
		Complete	*Partial*	*Not adopted*
(A)	*Cultural method*			
1.	Deep ploughing to inhibit insect, pathogen, and nematode population	41 (68.33)	17 (28.33)	2 (03.33)
2.	Plant to plant spacing (90-90 cm)	18 (30.00)	33 (55.00)	9 (15.00)
3.	Intercropping (Cotton-cowpea, Cotton- Soyabean)	24 (40.00)	31 (51.67)	5 (08.33)
4.	Use of Bt-seeds	51 (85.00)	9 (15.00)	0
5.	Animal (sheep) grazing in cotton field after last picking to kill bollworm larvae	37 (51.67)	19 (31.67)	4 (06.67)
6.	Timely sowing (Mid May to 28-30 June)	31 (51.67)	28 (46.67)	1 (01.67)
7.	Seed treatment with trichoderma	35 (53.33)	22 (36.67)	3 (05.00)
(B)	*Mechanical methods*			
1.	Picking and disposal of affected cotton bolls and twigs	32 (53.33)	24 (40.00)	4 (06.00)
2.	Keeping of yellow tins in cotton field by applying grease for white flies	41 (68.33)	12 (20.00)	7 (11.67)
(C)	*Biological methods*			
I.	Seed treatment			
1.	Seed treatment with *Trichoderma*spp. @ 4 gm/ Imidachloprid 70ws 10gm per kg of seed	41 (68.33)	13 (21.67)	6 (10.00)
II.	Conservation			
1.	Install 8-10 bird perches per ha 90 DAS for crow, myna, blue joy	33 (55.00)	17 (28.33)	10 (16.67)
2.	Conservation of predators (Lacewing, Lady bird beetle, Staphylinids, Predatory wasps)	35 (58.33)	20 (33.33)	5 (18.33)
3.	Collecting *Spodoptera* egg masses and putting them into perforated cage	37 (61.67)	19 (31.67)	4 (06.67)
III.	Augmentation			
1.	Monitoring the incidence of sucking pests and release egg of chrysopa	31 (51.67)	19 (31.67)	10 (16.67)
2.	Release of trichogrammachilonis @ 1,50,000/ha/week (2-3 releases) 40-50 DAS	37 (61.67)	14 (23.33)	9 (15.00)
3.	Application of S*l*NPV 250-500 LE/ha	39 (65.00)	18 (30.00)	3 (05.00)
4.	HaNPV @ 250LE/ha	40 (66.67)	16 (26.67)	4 (06.67)
IV	Monitoring			
1.	Use yellow pans/sticky traps @25 each /ha	36 (60.00)	13 (21.67)	11 (18.33)
2.	Use of pheromone traps (2 each/ha) on 55 DAS *i.e.*24-26 Aug	31 (51.67)	19 (31.67)	10 (16.67)
3.	Follow up of Economic Threshold Levels (For white fly, Aphids, Jassids 10% affected plants)	18 (30.00)	33 (55.00)	9 (15.00)
V	Botanical products			
1.	Spray of neem seed kernel extract 5% (3 sprays)	39 (65.00)	18 (30.00)	3 (05.00)
D	*Chemical methods*			
1.	Need based, judicious, safe application of pesticides	48 (80.00)	12 (20.00)	0

cage (61.67 per cent), application of SlNPV (61.67 per cent), use of yellow pans (60 per cent), spray of NSKE (65 per cent) and need based judicious safe application of pesticides(80 per cent). These findings are in line with those of Kalaskar *et al*. (2001), Borse (2002) and Patil (2007).

Adoption

It is seen from Table 2 that , the complete adoption of IPM technology by the Bt-cotton growers were use of Bt-seeds (85 per cent), deep ploughing to inhibit insect, pathogen, and nematode population (68.33per cent), picking and disposal of affected cotton bolls and twigs (53.33 per cent), seed treatment with trichoderma (68.33 per cent), collecting spodoptera egg masses and putting them into perforated cage (61.67 per cent), application of SlNPV (65 per cent), use of yellow pans/sticky traps 60.00 per cent, spray of NSKE (65 per cent), and the need based, judicious safe application of pesticides (80 per cent).

It could be inferred that the farming technology is the part and parcel of cultivation practices and low cost and no cost technology was adopted by majority of IPM and non IPM Bt-cotton growers. But percentage of IPM respondents adopting such practices was found higher than non IPM respondents due to gain in knowledge and exposure as well as interaction with IPM respondents and experts during Integrated Pest Management programme. These finding are in line with those of Jondhale*et al*. (2000), Deshmukh (2002) and Dhere (2009).

Table 3
Distribution of Bt-cotton growers according to their level of productivity

Sr. No	Category (qt./ha)	IPM (n = 60)	Non-IPM (n = 60)	Total (N = 120)
1.	Below average (below20)	6 (10.00)	29 (48.33)	35 (29.16)
2.	Average (between 21 to 22)	37 (61.67)	21 (35.00)	58 (48.34)
3.	More than average (23 and above)	17 (28.33)	10 (16.67)	27 (22.50)
	Total	60(100)	60(100)	120(100)

*Figures in parentheses indicates percentage

Table 4
Distribution of Bt-cotton growers according to their additional gain in yield

Sr. No.	Level of additional gain in yield (qt.)	IPM (n=60)	Non-IPM (n=60)	Total (N=120)
1.	Low (Upto 4)	8(13.33)	20(33.33)	28(23.34)
2.	Medium (between 5 to 9)	38(63.33)	23(38.33)	61(50.84)
3.	High (10 and above)	14(23.34)	17(28.34)	31(25.82)
	Total	60(100)	60(100)	120(100)

*Figures in parentheses indicates percentage

Impact of Integrated Pest Management Technology

Productivity level achieved by the respondent

Level of crop productivity refers to crop yield per unit area of crop expressed in q/ha.

From the data presented in Table 3, it was observed that majority (61.67 per cent) of the IPM respondents had average level of productivity between 21 to 22 q/ha. While, 28.33 per cent of the respondents had more than average level (23 and above q/ha) and 10.00 per cent of them had below average level (below 20 q/ha) of productivity. It was observed that near about one half (48.33 per cent) of non IPM Bt-cotton growers had below average level of productivity followed by 35.00 per cent of them who had average level of productivity. While, 16.67 per cent of non IPM Bt-cotton growers had more than average level of productivity. 48.34 per cent of Bt-cotton growers had average level of productivity between 21 to 22 q/ha. It can be concluded from the above finding that in case of Bt-cotton crop, introduction of Integrated Pest Management, had certainly helped the respondents to increase productivity level of Bt-cotton crop. Also the technical guidance, training conducted were major factors in increasing the level of cotton crop productivity. These findings are similar with the findings of Dhere (2009).

Impact in Terms of Additional Gain in Yield

From Table 4, it is revealed that, majority (63.33 per cent) of the IPM respondents possessed medium level (5 to 9 q/ha) of additional gain in yield while, 23.34 per cent and 13.33 per cent were having high and low level of additional gain in yields, respectively. It is observed that more than one third (38.33 per cent) of non IPM respondents possessed medium level of additional gain in yield followed by 33.33 per cent of them having low level of additional gain in yield, only 28.34 per cent of non-participants had high level of additional gain in yield. It can be concluded from the data that, 50.84 per cent of Bt-cotton growers had gained medium level (5 to 9 q/ha) of additional gain in yield.

Table 5
Impact of IPM in terms of average additional gain in yield

Sr. No.	Particulars (q/ha)	
1.	Yield/ha during Integrated Pest Management 2012-13	20.83
2.	Yield/ha of previous year 2011-12	16.35
3.	Additional gain in yield/ha over previous year	04.48

It is observed from Table 5, that the average per hectare yield of Bt-cotton during the previous year 2011-12 was 16.35 qt/ha, while average per hectare yield of Bt-cotton from Integrated Pest Management was 20.83 qt/ha. From the above results, it can be revealed that there was an increase in the per hectare yield by about 4.48 quintals as compared to average yields of Bt-cotton crop of previous year 2011-12 with that of yields obtained during IPM obtained during 2012-13. From the above findings it is seen that majority of IPM Bt-cotton growers had medium level of additional gain in yield and more than one third of the non IPM Bt-cotton growers were medium level of additional gain in yield. The findings of present study are partially in line with the findings of Dhere (2009).

Table 6
Impact of IPM for additional gain in income

Sr. No.	Particulars	(Rs/ha)
1.	Income/ha during Integrated Pest Management 2012-13	83,320
2.	Income/ha of previous year 2011-12	60,757
3.	Additional gain in income/ha over previous year	22,563

Impact in Terms of Additional Gain in Income

The data in Table 6, clearly indicate that the respondents were economically benefitted because of the Integrated Pest Management. They received an additional income of Rs. 22,563/- per hectare in crop under IPM 2012-13 over the previous year. This achievement of increase in the additional gain in income can be attributed to the timely and sufficient supply of farm requisites such as fertilizer, improved seed, insecticides and with the role played by the University in imparting technical knowledge, Agricultural Department by giving incentives and whole hearted participation of the respondents in Integrated Pest Management practices.

Table 7
Distribution of respondents according to their additional gain in income

Sr. No	*Level of additional gain in income (Rs.)*	*IPM (n = 60)*	*Non-IPM (n = 60)*	*Total (N = 120)*
1.	Low (up to 13128/-)	12 (20.00)	29 (48.33)	41 (34.16)
2.	Medium (13129 /- to 32000/-)	37 (61.66)	20 (33.33)	57 (47.50)
3.	High (32001/- and above)	11 (18.34)	11 (18.34)	22 (18.34)
	Total	60 (100)	60 (100)	120(100)

* *Figures in parentheses indicates percentage*

It was found from Table 7, that majority (61.66 per cent) of the IPM Bt-cotton growers medium level *i.e.* Rs.13129 to 32000/- additional gain in income, followed by 20.00 per cent of them had low level of additional gain in income, only 18.34 of the IPM Bt-cotton growers had high level of additional gain in income. It was observed from above finding that near about one half (48.33 per cent) of non IPM Bt-cotton growers had low level of additional gain income. Whereas 33.33 per cent of non IPM Bt-cotton growers were medium level of additional gain in income and 18.34 per cent of non IPM Bt-cotton growers were have high level of additional gain in income. This indicates that the majority (47.50 per cent) of the Bt-cotton growers were medium level of additional gain in income *i.e.* Rs 13, 129 to 32,000/–.

From Table 8, it is revealed that, majority of the (65 per cent) Bt-cotton growers found saving in insecticides and money due to use of IPM technology. More than half of the respondents (68.33 per cent) found that decrease in insect resistance to insecticides. (81.67 per cent) Bt-cotton growers said that use of Bio-pesticides and natural enemies were found beneficial. (63.33 per cent) of the Bt-cotton growers found that per ha increase in the total yield of Bt-cotton. (93.33 per cent) Bt-cotton growers found that Side effects due to chemical insecticides decreased due to the use of IPM technology.

Table 8
Distribution of respondents according to overall Impact of Integrated Pest Management technology

Sr. No	*Details*	*Impact IPM (N = 60)*		
		Complete	*Partial*	*No.*
1	Saving in insecticides and money due to use of IPM technology	39 (65.00)	17 (28.33)	4 (06.67)
2	Decrease in insect resis tance to insecticides	41 (68.33)	13 (21.67)	6 (10.00)
3	Use of Bio-pesticides and natural enemies found beneficial	49 (81.67)	8 (13.33)	3 (05.00)
4	Per ha increase in the total yield of Bt-cotton	38 (63.33)	13 (21.67)	9 (15.00)
5	Side effects due to chem ical insecticides decreased	56 (93.33)	3 (05.00)	1 (1.67)
6	Change in attitude about the use IPM technology	40 (66.67)	18 (30.00)	2 (03.33)
7	Change in damage level of pests	28 (46.67)	23 (38.33)	9 (15.00)
8.	Increase in the level of productivity	35 (58.33)	25 (41.67)	0
9.	Increase in the additional gain in the yield`	45 (75.00)	13 (21.67)	2 (03.33)
10.	Increase in the additional gain in income	47 (78.33)	11 (18.33)	2 (03.33)

**Figures in parentheses indicates percentage*

Change in attitude about the use of IPM technology takes place among the (66.67 per cent) Bt-cotton growers. (46.67 per cent) said that change in damage level of pests, (58.33 per cent) Bt-cotton growers found that increase in the level of productivity and (78.33 per cent) found that increase in additional gain in income per ha due to the use of IPM technology.

From above results, it is observed that by the use of Integrated Pest Management Technology total cost of plant protection and total cost of production got minimized as compared to Non IPM Bt-cotton cultivation. The findings of present study are partially in line with the findings of Dhere (2009).

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