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Impact of integrated pest management technology on cotton growers in Maharashtra

DD Aglawe, NK Bhute, ND Kale, RP Kadam, RD Ahire, JV Ekale and PS Kapse

Abstract

Cotton the important cash crop, globally known as “King of Fibre” offers an important natural fabric material to the world has been a point of fascination. In the 2016-17 *kharif* season the entire 42 lakh hectares of cotton crop in Maharashtra get infested by pink bollworm. Maharashtra government provided compensation of crores of rupees towards crop damage of cotton growers whose crop is damaged by the attack of pink bollworm. State Agriculture Department, SAU's, KVK,s conducted massive campaign for the Integrated Management of pink bollworm as Integrated Pest Management (IPM) is one of the important tool in pest management. In this investigation we identify 7 parameters that impacts on cotton growers with the help of structure interview schedule. The quantifications of impact of integrated pest management technology was appropriately defined based on expert knowledge and published relevant literature. The outcome of the investigation that the integrated pest management technology impact on cotton growers in terms of increase in yield, increase in income, reduction in number of insecticide sprays, reduction in expenditure on number of insecticide sprays, reduction in cost of cultivation, increase in gross return and increase in BC ratio of the cotton growers. We conclude that integrated pest management technology is better for the cotton growers.

Keywords: Impact, integrated pest (IPM) management technology, cotton growers

Introduction

Cotton the important cash crop, globally known as “King of Fibre” offers an important natural fabric material to the world has been a point of fascination. It is an important fiber crop of global importance which belongs to the genus *Gossypium* in the family *Malvaceae*. Cotton in a way is a gift of the Indian subcontinent to human civilization. Since it is grown as major cash crop in India, thus appears to have been the centre of an important cotton industry as early as 1500 BC. Besides serving as a source of natural fibre, it is also an oilseed crop, providing raw material to the oil and textile industries. Cotton bears seed coat fibres which can be spun into yarn. In broad sense, it includes all cultivated and wild species and perennial forms of the genus *Gossypium*. India is unique to grow all the four cultivated spp. (*Gossypium hirsutum*, *G. barbadense*, *G. arborium* and *G. herbaceum*) and intra as well as inter specific hybrids under diverse agro-ecological conditions.

India accounts for about 26 percent of the world cotton production. It has the distinction of having the largest area under cotton cultivation in the world ranging between 10.9 mha to 12.8 mha constituting about 38 to 41% of the world area under cultivation. The yield per hectare (i.e. 504 kg to 566 kg per hectare) is however still lower against the world average of about 701 kg to 766 kg per hectare. Country is expected to make more strides in cotton production in the years to come. (Anonymous 2017) [6].

Cotton fibre is an important raw material to the textile industries and plays a key role in national economy in terms of employment generation and foreign exchange. The development of *Bt* cotton in India from the conditional release of three Mahyco-Monsanto transgenic *Bt* hybrids viz., MECH-12, MECH- 162, MECH-184 for commercial cultivation on 26th march 2002 by govt. of India has brought new in cotton cultivation. Since then *Bt* cotton in India has jumped to about 1.34 m. ha in the current crop year from about 405.00 ha year earlier.

During recent year *Bt* cotton acreage has gone up and reached up to 99 percent of the total cotton acreage. The introduction of *Bt* cotton hybrids has helped in production increase from 156 lakh bales (170 kg lint per bale) in 2001 to an estimated 356 lakh bales in 2011. *Bt* cotton was introduced in 2002 and the area increased from 0.29 lakh hectares in 2002 to 116.14 lakh hectare in 2013-14.

The productivity was 309 kg per hectare in 2001 before the introduction of *Bt* cotton which increased to 495 Kg/ha in 2010. Cotton as is evident from the fact that more than 90% of the area in all the cotton growing states in India is now under *Bt* cotton. Maximum gains in yield increase have been obtained in Gujarat, Andhra Pradesh, Maharashtra, Haryana, Punjab and Tamil Nadu (Anonymous 2012) [4].

Cotton is one of the principal commercial crop contributing nearly 75% of total raw material needs of textile industry in our country. India was recognized as the cradle of cotton industry for over 3000 years (1500 BC to 1700 AD). India produces finest and beautiful cotton fabrics since time immemorial. India, being the earliest country in the world for domesticated cotton producers and manufacture of cotton fabrics, has led to today's first rank in cotton cultivated area (122.38 lakh ha) and production (361 bales of 170 kg) among all cotton producing countries in the world (2018-19). Cotton is one of the principal crops of India and plays a vital role in the country's economic growth by providing substantial employment and making significant contributions to export earnings. The cotton cultivation sector not only engages around six million farmers, but also involves another about 40 to 50 million people relating to cotton cultivation, cotton trade and its processing (Anonymous 2019) [7].

Cotton cultivation is not only a science but art and way of life for farming community of Maharashtra. Cotton cultivation needs to be sustainable; offering livelihood security to millions of marginal and small farmers such as enterprise has to be knowledge based and market driven and needs to evolve continuously through innovations in frontier sciences to break yield and quality barriers for satisfying present and future national needs and attaining global competitiveness with larger spin-off benefits. The farmers of Maharashtra feel it as a pride and privilege to cultivate cotton. Cotton is the only crop if yielded properly can change the financial status of small and marginal farmers. There is no viable alternative for cotton crop under rainfed ecosystem of Maharashtra. Cotton is natural fiber extension of seed coat- from baby wipes to blue jeans, wick to dynamite, cotton is more than just the fabric of our lives which is unavoidable from birth to last breath.

Material and Methods

Study area

Aurangabad district is situated at 635 meter above the Mean Sea Level. The district lays between 19° 54' North Latitudes and 75° 23' east Longitude. The total area of the district is

10,100 km² (3,900 sq. m). The district is bounded on the North by Jalgaon district, on the east by Jalna district, on the South by Ahmednagar, on the west by Nasik district and Nanded district lies between 18° 15' to 19° 55' North latitude and 77° 10' to 78° 25' East longitude at about 489 m. above mean sea level. Nanded is located in the south eastern part of the Maharashtra state. It is bounded on the North by Yavatmal district, on the North West by Parbhani district of Maharashtra state, on the East and South East by Adilabad and Nizamabad district of Andhra Pradesh and on the South by Bidar district of Karnataka state. The rainy season starts from June to September Aurangabad district. Winter is from approximately October to February and summer from March to May. The average rainfall of Aurangabad district is 734 mm. and the temperature range is about 5 to 46 degrees Celsius. Major field crops cultivated in Aurangabad district are cotton, *kharif* jowar, maize, bajra, soybean, black gram, pigeon pea, *rabi* jowar, wheat, gram, safflower, sunflower, groundnut, sugarcane. The horticulture crops like sweet-orange, mango, pomegranate and orange are grown in many parts of district, along with vegetables like chilli, onion, tomato, brinjal, okra, cabbage, medicinal and aromatic crops are also grown like turmeric, ginger and garlic etc. Cows and buffaloes are kept for dual purpose like milk and farm yard manure. Sheep, goat and poultry keeping are subsidiary occupations of the people. Landless labours are mostly engaged in agriculture.

Nanded is located on border of tropical monsoon and semi-arid. The area experiences very high temperature in the months of April and May, heavy rains in the month of August and September and frost in the month of December and January. The temperature of Nanded ranges between 46 °C maximum and 9 °C to 12 °C minimum temperatures. Most of the rainfall occurs in the monsoon season from the months of June to September. The average annual rainfall of the Nanded is 954 mm.

Major *kharif* season crops are *kharif* jowar, tur, mung, cotton, sunflower, urid and soybean, etc. whereas major crops grown in *rabi* season are *rabi* jowar, wheat, gram, safflower, sunflower etc. Total area under cotton crop of Nanded district in year 2017-18 was 3,64,300 ha. The horticultural crops like banana, papaya, citrus, fig, custard apple, mangos etc. are also cultivated as under annual crops. Sugarcane and banana are growing in many parts of the district. Cattle and buffaloes are kept for dual purpose like milch and FYM, sheep, goat, poultry keeping are the subsidiary occupations of the people.

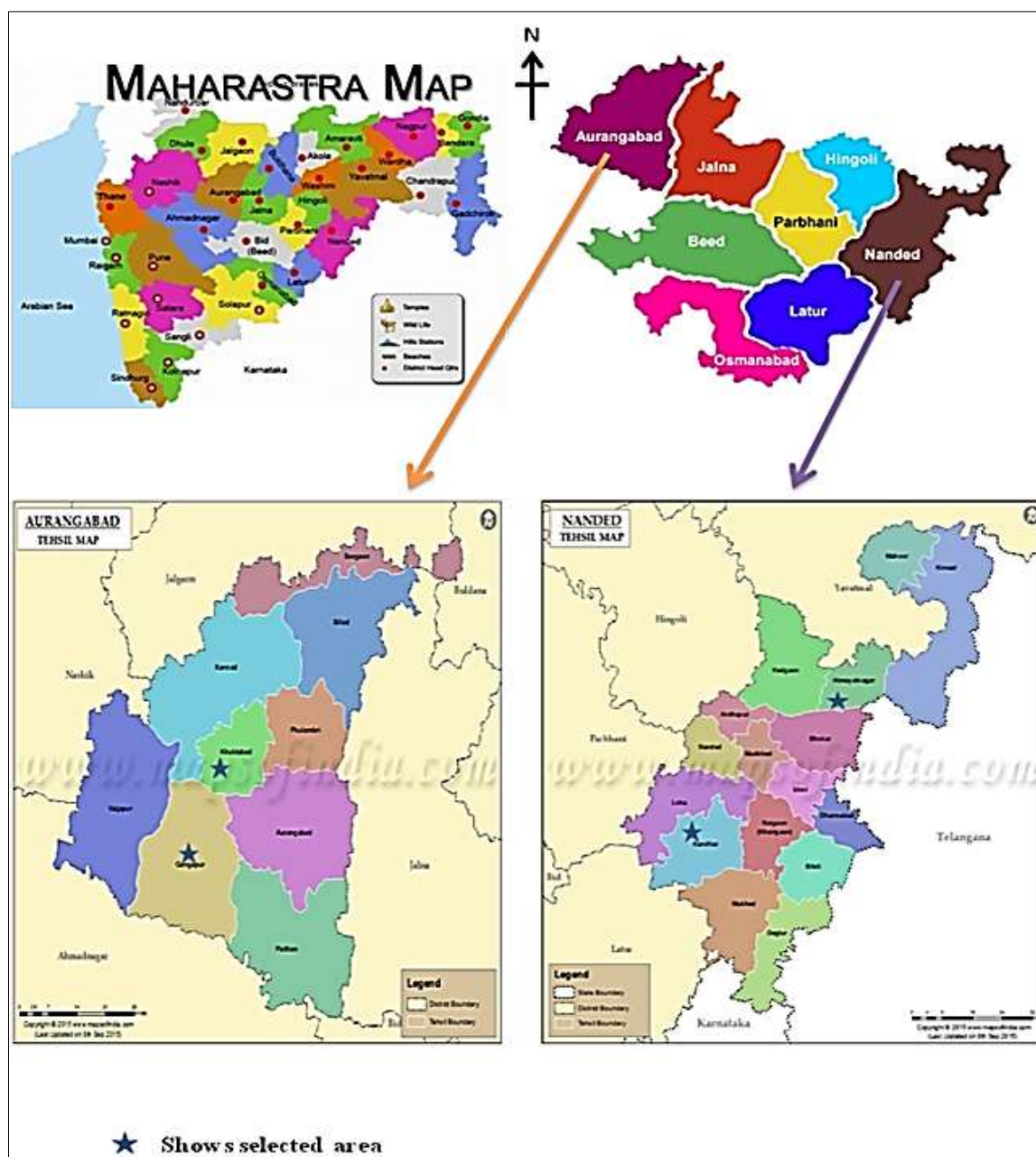


Fig 1: Study location map of Aurangabad and Nanded district

Research approach and sampling method

The present study was conducted during the year 2018-19. The location of study was determined by the applying purposive sampling methods. Aurangabad and Nanded district was selected purposively on the basis of maximum cotton area of the Marathwada region of Maharashtra state, from these two districts four tahsils were selected purposively on the basis of maximum cotton area. With irrespective of list of villages of IPM growers was collected from ICAR-KVK, Aurangabad and CRS Nanded. 24 °C cotton growers was selected in to two categories *viz.* IPM and non IPM cotton growers from selected twelve villages of 4 tahsils of Aurangabad and Nanded districts. Ex-post facto research design was adopted in this study.

Data collection

The cotton growers responses were collected through survey method. The primary data were obtained through face to face

personal interview and observation by the researcher using structured questionnaire then calculated it with scoring. The secondary data for this investigation and other relevant information were obtained through documentary study such as reports, research papers, reference books, bulletins, journals and periodicals originated from several institutions and literatures.

Results and Discussion

The data collected for the study were classified, tabulated and analyzed in the light of the objectives of the study and the results are presented under the following heads.

Impact of Integrated Pest Management technology on cotton growers was studied with respect to increase in yield, increase in income, reduction in number of insecticide sprays, reduction in expenditure on number of insecticide sprays, reduction in cost of cultivation, increase in gross return and increase in BC ratio of the cotton growers.

Impact of Integrated Pest Management technology in term of increase in yield

Table 1: Comparative distribution of cotton growers according to their yield N=240

Sr. No.	Category	IPM Cotton Growers (n=120)			Category	Non-IPM Cotton Growers (n=120)			'Z' value
		Yield (q/ha)	F	%		Yield (q/ha)	F	%	
1.	Low	Up to 16	12	10.00	Low	Up to 13	17	14.17	13.79**
2.	Medium	17 to 20	74	61.67	Medium	14 to 15	90	75.00	
3.	High	21 and above	34	28.33	High	16 and above	13	10.83	
	Total		120	100			120	100	
	Mean		18.45				14.73		
	SD		02.52				01.54		
Increase in yield 25.25 percent									

** Significant at 0.01 level of probability

It was revealed from Table 1 and Figure 2 that, 61.67 percent of the IPM Cotton growers were having medium yield i.e. 17 to 20 q/ha. followed by 28.33 percent of the IPM Cotton growers were having high (21q/ha. and above) yield. and 10 percent of IPM cotton growers were having low (up to 16 q/ha.) yield.

While, in case of non-IPM cotton growers, 75.00 percent of them were having medium yield (14 to 15 q/ha), followed by 14.17 percent of them were having low yield upto 13 q/ha and

10.83 percent of them were having high yield (16q/ha. and above). It was observed from table 18 that, 25.25 percent increase in yield of IPM cotton growers over non-IPM cotton growers due to implication of IPM technology in their farm.

The mean of yield (q/ha) of IPM cotton growers was 18.45 and in case of non-IPM cotton grower was 14.73 calculated 'Z' value 13.79 was highly significant which indicated that there was significant difference in the yield of IPM cotton grower and non-IPM cotton growers.

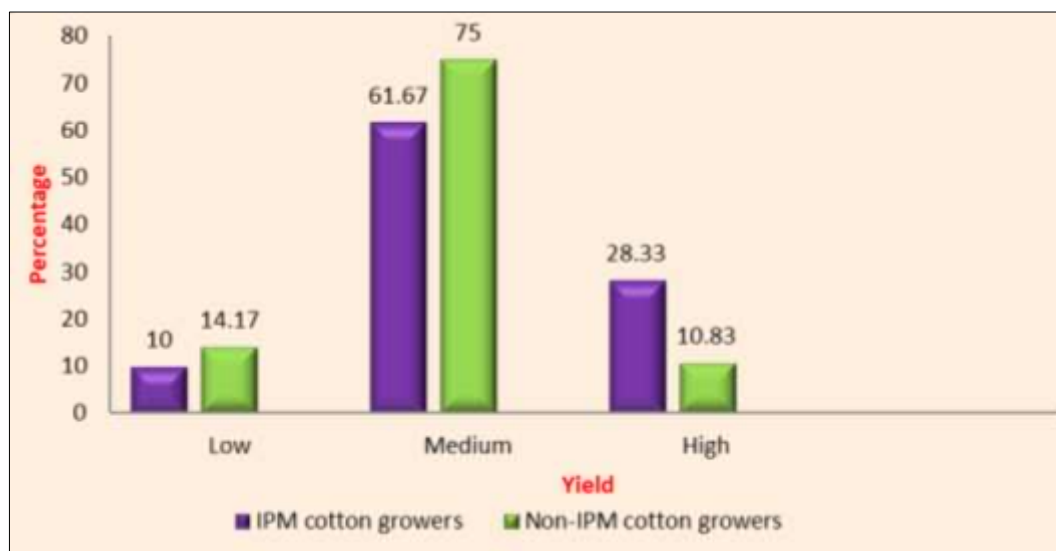


Fig 2: Comparative distribution of cotton growers according to their yield

Impact of Integrated Pest Management technology in terms of increase in income

Table 2: Comparative distribution of cotton growers according to their income N=240

Sr. No.	Category	IPM Cotton Growers (n=120)			Category	Non-IPM Cotton Growers (n=120)			'Z' value
		Rs./ha	F	%		Rs./ha	F	%	
1.	Low	Up to 71,308	33	27.50	Low	Up to 59,710	21	17.50	7.54**
2.	Medium	71,309 to 1,19,296	61	50.83	Medium	59,711 to 91,308	70	58.33	
3.	High	1,19,297 and above	26	21.67	High	91,309 and above	29	24.17	
	Total		120	100			120	100	
	Mean		95303.22				75509.99		
	SD		23994.74				15799.90		
Increase in income 26.21 percent									

** Significant at 0.01 level of probability

From Table 2 and Figure 3 it was observed that 50.83 percent of IPM cotton growers were having medium income (Rs. 71,309 to 1,19,296) from cotton followed by 27.50 percent of IPM cotton growers (up to Rs. 71,308) and 21.67 percent of IPM cotton growers them having high income (Rs.1,19,297

and above) from cotton yield.

Whereas in case of non-IPM cotton growers 58.33 percent of them had medium income (Rs. 59,711 to 91,308) from cotton yield followed by 24.17 percent and 17.50 percent of them were having high (Rs. 91,309 and above) and low income (Up

to Rs. 59,710) from cotton respectively. Due to implication of IPM technology there were 26.21 percent increase in income was observed in IPM cotton growers over non-IPM cotton growers.

The mean of income from cotton of IPM cotton growers was

Rs. 95,303.22 and in case of non-IPM cotton grower was Rs. 75,509.99 calculated 'Z' value 7.54 was highly significant which indicated that there was significant difference in the distribution of cotton growers according to their income of IPM cotton grower and non-IPM cotton growers.

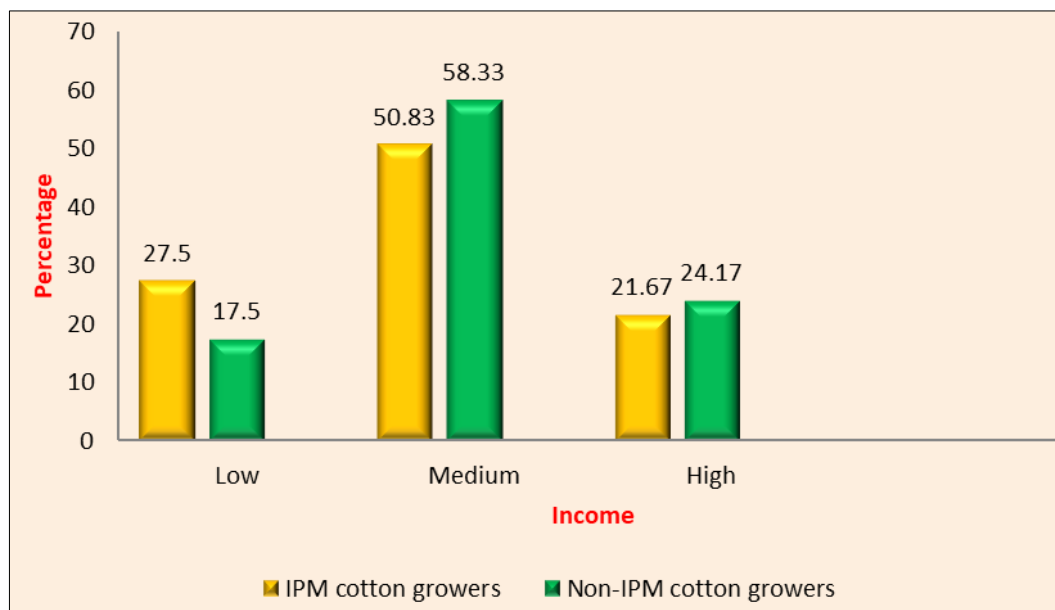


Fig 3: Comparative distribution of cotton growers according to their income

Impact of Integrated Pest Management technology in terms of reduction in number of insecticide sprays

Table 3: Comparative distribution of cotton growers according to their number of insecticide sprays N=240

Sr. No.	Category	IPM Cotton Growers (n=120)			Category	Non-IPM Cotton Growers (n=120)			'Z' value
		No. of sprays	F	%		No. of sprays	F	%	
1.	Low	Up to 1	16	13.33	Low	Up to 4	05	04.16	-36.43
2.	Medium	2	66	55.00	Medium	5	87	72.50	
3.	High	3 and above	38	31.67	High	6 and above	28	23.34	
	Total		120	100			120	100	
	Mean		2.18				5.75		
	SD		0.85				0.86		
Reduction in number of insecticide sprays 51.65 percent									

From Table 3 and Figure 4 it was observed that 55.00 percent of IPM cotton growers had medium (3) number of insecticide sprays followed by 31.67 percent and 13.33 percent of them had high (4 and above) and low (up to 2) number of insecticide sprays respectively.

Whereas in case of non-IPM cotton growers 72.50 percent of them had medium number of insecticide sprays (5) followed by 23.34 percent and 04.16 percent of them had high (6 and above) and low (up to 4) number of insecticide sprays respectively. It was observed from table 20 that, 51.65 percent

reduction in number of insecticide sprays in IPM cotton growers over non-IPM cotton growers, due to implication of IPM technology.

The mean of number of insecticide sprays of IPM cotton growers was 2.45 and in case of non-IPM cotton grower was 4.23 calculated 'Z' value -36.43 was highly significant with negative direction which indicated that there was significant difference in the distribution of respondents according to their number of insecticide sprays of IPM cotton grower and non-IPM cotton growers.

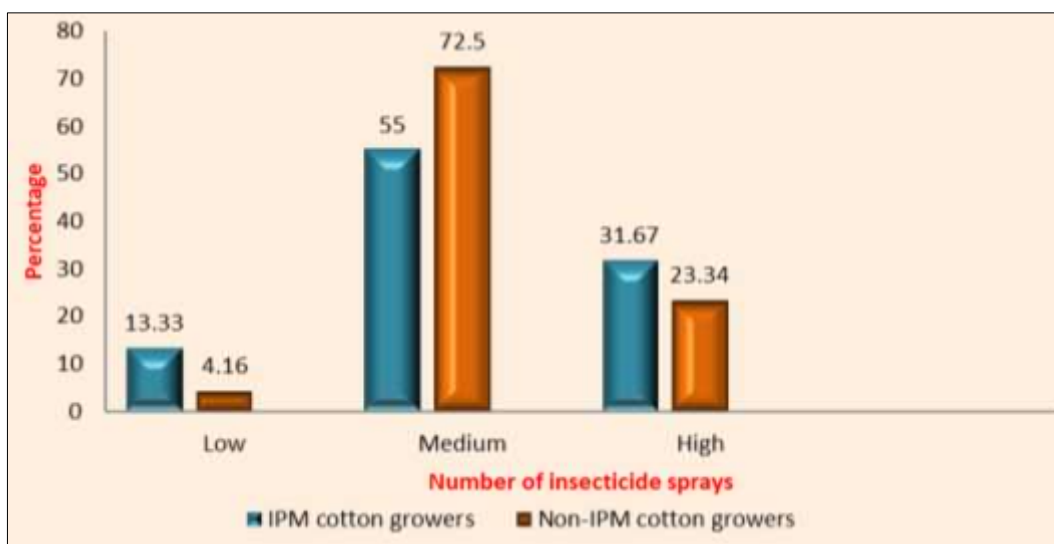


Fig 4: Comparative distribution of cotton growers according to their number of insecticide sprays

Impact of Integrated Pest Management technology in terms of reduction in expenditure on number of insecticide sprays

Table 4: Comparative distribution of cotton growers according to their expenditure on number of insecticide sprays N=240

Sr. No.	Category	IPM Cotton Growers (n=120)			Category (Rs./ha)	Non-IPM Cotton Growers (n=120)			'Z' value
		Rs./ha	F	%		Rs./ha	F	%	
1.	Low	Up to 1959	16	13.33	Low	Up to 5857	04	03.33	-24.86
2.	Medium	1960 to 3906	64	53.33	Medium	5858 to 9614	91	75.83	
3.	High	3907 and above	40	33.34	High	9615 and above	25	20.84	
	Total		120	100			120	100	
	Mean		2933.33				7736.67		
	SD		973.89				1879.00		

Reduction in expenditure on number of insecticide sprays 62.08 percent

From the Table 4 and Figure 5 it was found that 53.33 percent of IPM cotton growers were having medium expenditure (Rs.1960 to 3906) on number of insecticide sprays followed by 33.34 percent and 13.33 percent of them were having high (Rs.3907 and above) and low (Rs.9615 and above) expenditure on number of insecticide sprays respectively. Whereas, in case of non-IPM cotton growers 75.83 percent of them were having medium expenditure (Rs.5858 to 9614) on number of insecticide sprays followed by 20.84 percent and 03.33 percent of them were having high (Rs.9615 and above) and low (Up to Rs.5857) expenditure on number of

insecticide sprays respectively. There were 62.08 percent reduction in expenditure on number of insecticide sprays was observed from table 21 in case of IPM cotton growers over non IPM cotton growers.

The mean of expenditure on number of insecticide sprays of IPM cotton growers was 2933.33 and in case of non-IPM cotton grower was 7736.67 calculated 'Z' value -24.86 was highly significant with negative direction which indicated that there was significant difference in the number of insecticide sprays of IPM cotton grower and non-IPM cotton growers.

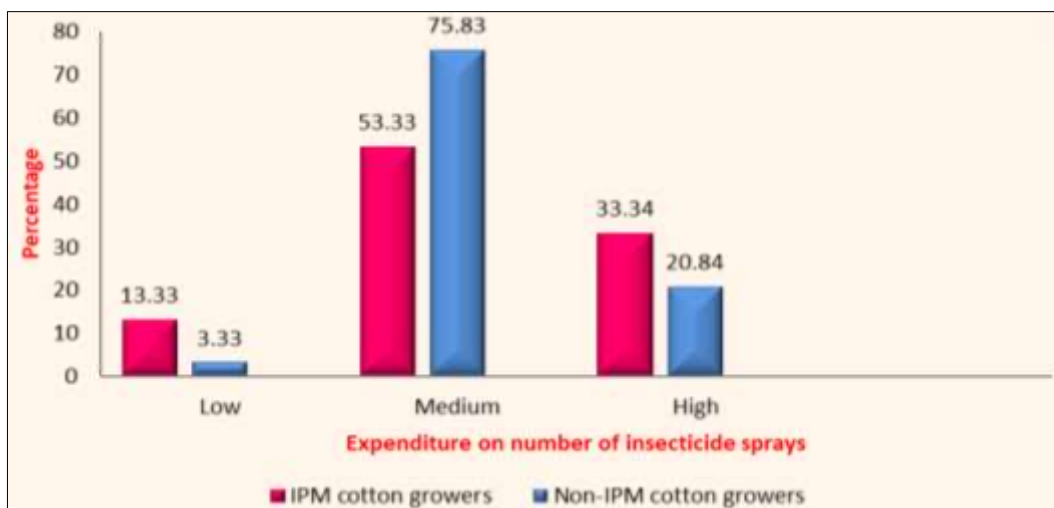


Fig 5: Comparative distribution of cotton growers according to their expenditure on number of insecticide sprays

Impact of Integrated Pest Management technology in terms of reduction in cost of cultivation

Table 5: Comparative distribution of cotton growers according to their cost of cultivation N=240

Sr. No.	Category	IPM Cotton Growers (n=120)			Category	Non-IPM Cotton Growers (n=120)			'Z' value
		Rs./ha	F	%		Rs./ha	F	%	
1.	Low	Up to 20,223	17	14.17	Low	Up to 22,111	11	09.16	-5.76
2.	Medium	20,224 to 27,280	98	81.67	Medium	22,112 to 31,624	105	87.50	
3.	High	27,281 and above	05	04.16	High	31625 and above	04	03.34	
	Total		120	100			120	100	
	Mean		23752.60				26868.67		
	SD		3529.19				4757.17		
Reduction in cost of cultivation 11.59 percent									

From the Table 5 and Figure 6 it was observed that 81.67 percent of IPM cotton growers were having medium (Rs. 20,224 to 27,280) cost of cultivation followed by 14.17 percent and 04.16 percent of them were having low (Up to Rs. 20,223) and high (Rs. 27,281 and above) cost of cultivation respectively.

Whereas, in case of non-IPM cotton growers 87.50 percent of them were having medium (Rs. 22,112 to 31,624) cost of cultivation followed by 09.16 percent and 03.34 percent of them were having low (Up to Rs. 22,111) and high (Rs.

31,625 and above) cost of cultivation respectively. It was observed from table 22 that there were 11.59 percent reduction in cost of cultivation of IPM cotton growers over non-IPM cotton growers.

The mean of cost of cultivation of IPM cotton growers was Rs. 23,752.6 and in case of non-IPM cotton grower was Rs. 26,868.67 calculated 'Z' value -5.76 was highly significant with negative direction which indicated that there was significant difference in cost of cultivation of IPM cotton grower and non-IPM cotton growers.

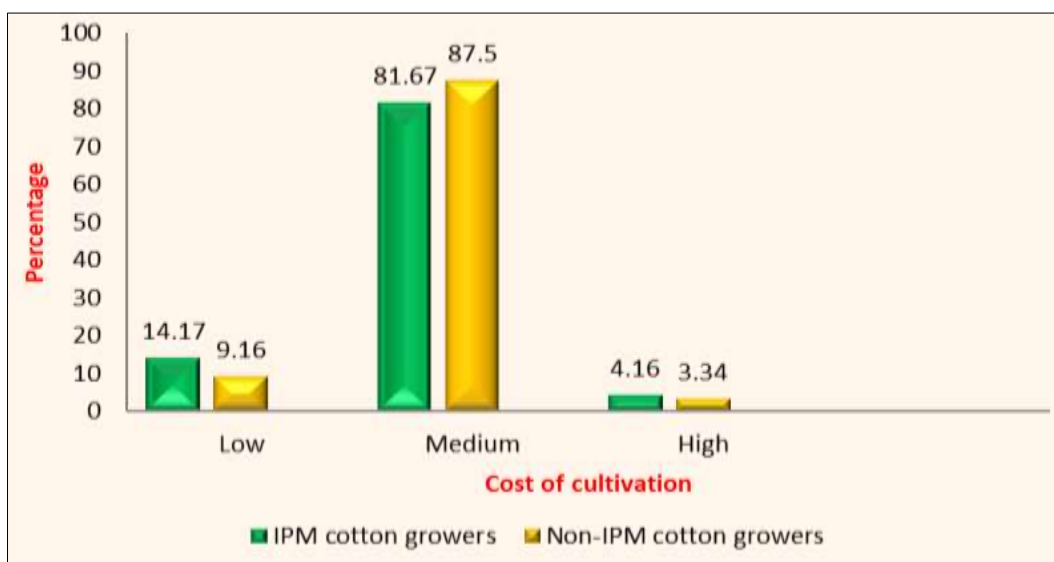


Fig 6: Comparative distribution of cotton growers according to their cost of cultivation

Impact of Integrated Pest Management technology in terms of increase in gross return

Table 6: Comparative distribution of cotton growers according to their gross return N=240

Sr. No.	Category	IPM Cotton Growers (n=120)			Category	Non-IPM Cotton Growers (n=120)			'Z' value
		Rs./ha	F	%		Rs./ha	F	%	
1.	Low	Up to 49,480	27	22.50	Low	Up to 35,674	21	17.50	9.80**
2.	Medium	49,481 to 93,619	64	53.33	Medium	35,675 to 61,606	72	60.00	
3.	High	93620 and above	29	24.17	High	61,607 and above	27	22.50	
	Total		120	100			120	100	
	Mean		71550.60				48641.31		
	SD		22070.05				12966.50		
Increase in gross return 47.51 percent									

** Significant at 0.01 level of probability

From the Table 6 and Figure 7 it was revealed that 53.33 percent of IPM cotton growers had medium (Rs. 49,481 to 93,619) gross return followed by 24.17 percent and 22.50 percent of them had high (Rs. 93620 and above) and low (Up to Rs. 49,480) gross return respectively.

Whereas in case of non-IPM cotton growers 60.00 percent of them had medium (Rs. 35,675 to 61,606) gross return followed by 22.50 percent and 17.50 percent of them had high (Rs. 61,607 and above) and low (Up to Rs. 35,674) gross return respectively. At overall level there were 47.51 percent

increase in gross return of IPM cotton growers over non IPM cotton growers.

The mean of gross return of IPM cotton growers was Rs. 71,550.60 and in case of non-IPM cotton grower was Rs.

48,641.31 calculated 'Z' value 9.80 was highly significant which indicated that there was significant difference in the gross return of IPM cotton grower and non-IPM cotton growers.

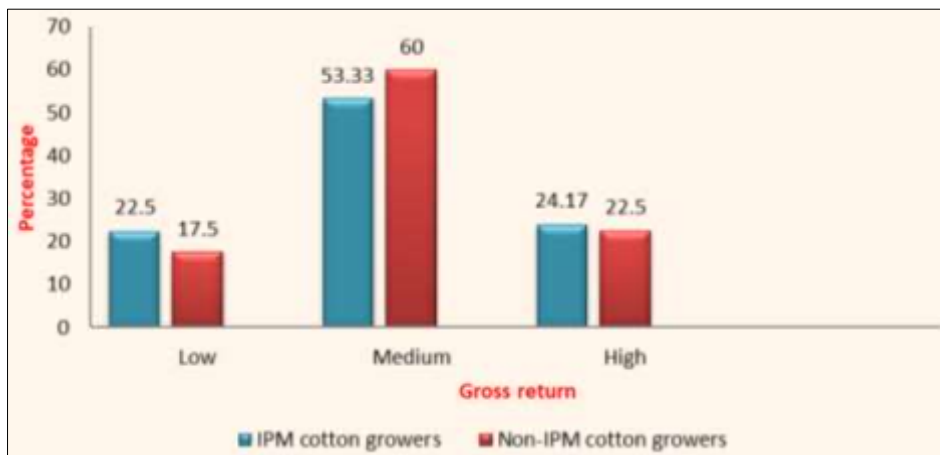


Fig 7: Comparative distribution of cotton growers according to their gross return

Impact of Integrated Pest Management technology in terms of increase in BC ratio

Table 7: Comparative distribution of cotton growers according to their BC ratio N=240

Sr. No.	Category	IPM Cotton Growers (n=120)		Category	Non-IPM Cotton Growers (n=120)		'Z' value		
		F	%		F	%			
1.	Low	Up to 2.08	22	18.33	Low	Up to 1.50	08	06.66	12.95**
2.	Medium	2.09 to 3.93	87	72.50	Medium	1.51 to 2.11	100	83.34	
3.	High	3.94 and above	11	09.17	High	2.12 and above	12	10.00	
	Total		120	100			120	100	
	Mean			3.01				1.81	
	SD			0.93				0.31	
Increase in BC ratio 66.29 percent									

** Significant at 0.01 level of probability

From the Table 7 and Figure 8 it was concluded that 72.50 percent of IPM cotton growers had medium BC ratio (2.09 to 3.93) followed by 18.33 percent and 09.17 percent had low (Up to 2.08) and high (3.94 and above) BC ratio respectively. Whereas, in case of non-IPM cotton growers 83.34 percent had medium (1.51 to 2.11) BC ratio followed by 10 percent and 06.66 percent of them had high (2.12 and above) and low (Up to 1.50) BC ratio respectively. At overall level it was

concluded from table 24 that there were 66.29 percent increase in BC ratio of IPM cotton growers over non-IPM cotton growers.

The mean of BC ratio of IPM cotton growers was 3.01 and in case of non-IPM cotton grower was 1.81. Calculated 'Z' value 12.95 was highly significant which indicated that there was significant difference in the their BC ratio of IPM cotton grower and non-IPM cotton growers.

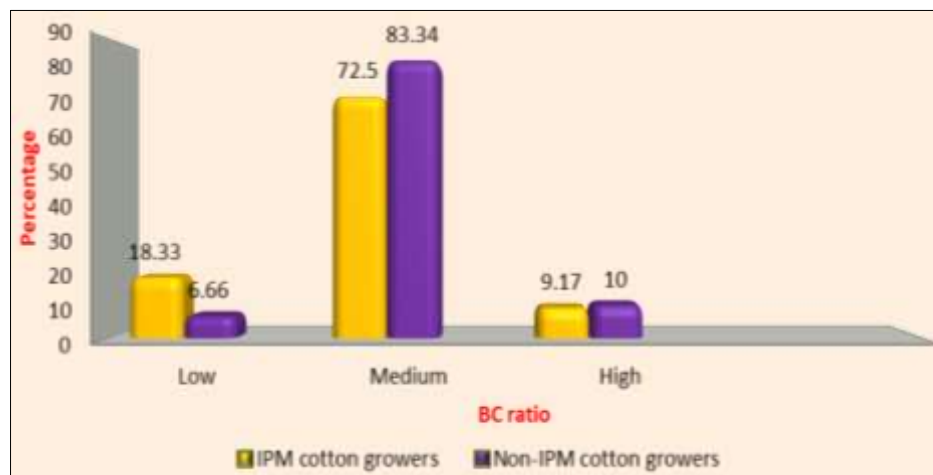


Fig 8: Comparative distribution of cotton growers according to their BC ratio

Overall Impact of IPM technology

The overall impact of Integrated Pest Management technology was computed with the help of formula as given below

$$\text{Overall Impact of IPM technology} = \frac{25.25+26.21+51.65+62.08+11.59+47.51+66.29}{7}$$

$$= \frac{290.58}{7}$$

$$= 41.51 \text{ percent}$$

The overall impact of IPM technology was on cotton growers was calculated by summing up all the seven parameters of impact and it converted in percentage.

It could be stated that IPM technology had created 41.51 percent impact at overall level on the IPM cotton growers

over non IPM cotton growers.

Table 8: Distribution of cotton growers according to their overall impact of IPM technology

Sr. No.	Category	IPM Cotton Growers (n=120)		
		Score	F	%
1.	Low	Up to 91.25	12	10.00
2.	Medium	91.26 to 118.78	93	77.50
3.	High	118.79 and above	15	12.50
	Total		120	100
	Mean			105.02
	SD			13.77

It was concluded from Table 8 and Figure 9 that the findings regarding overall impact of IPM technology was found as, majority of the respondents 77.50 percent were found in medium (91.26 to 118.78) category followed by 12.50 percent of them were in high (118.79 and above) category and 10.00 percent were found in low (upto 91.25) category of overall impact.

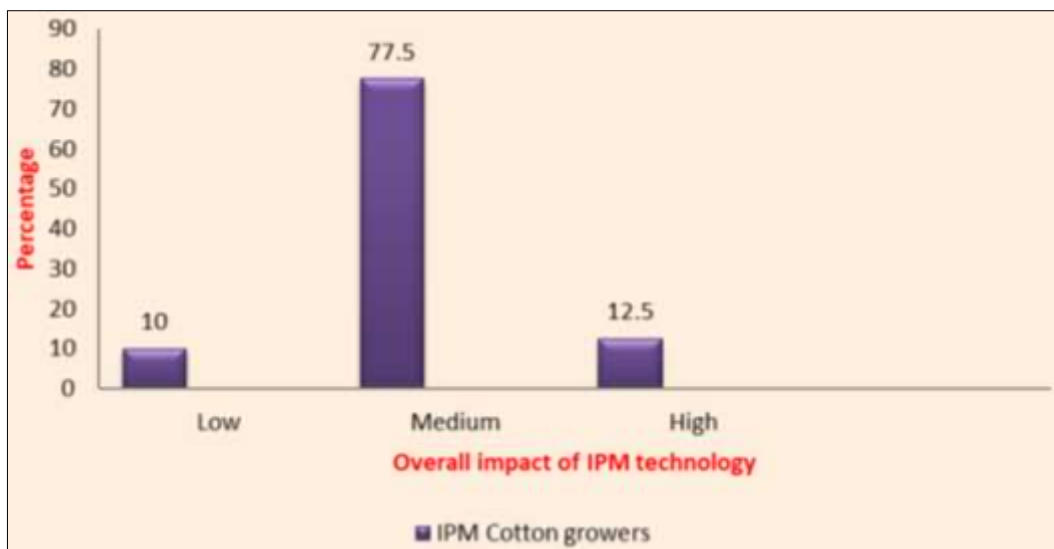


Fig 9: Distribution of cotton growers according to their overall impact of IPM technology

Conclusions

Thus, it is concluded that a majority of the IPM cotton growers had medium level of impact of IPM technology. The objective of IPM technology to increase yield, increase in income, reduction in number of insecticide sprays, reduction in expenditure on number of insecticide sprays, reduction in cost of cultivation, increase in gross return and increase in BC ratio were achieved by IPM cotton growers. Hence, there may be the medium impact of IPM technology on IPM cotton growers. Integrated Pest Management technology created significant impact on IPM cotton growers over non-IPM cotton growers in terms of increase in yield (25.25 percent), increase in income (26.21 percent), reduction in number of insecticide sprays (51.65 percent), reduction in expenditure on number of insecticide sprays (62.08 percent), reduction in cost of cultivation (11.59 percent), increase in gross return (47.51 percent) and increase in BC ratio (66.29 percent). It is therefore the State Department of Agriculture, State Agricultural Universities, ICAR-KVK's should give more emphasis for diffusion of Integrated Pest Management Technology among the cotton growers.

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