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Impact of IPM Technology on Yield, Economics and Pesticide Use in Cotton by KVKs of Madhya Pradesh

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Abstract Cotton plays a key role in the national economy in terms employment and income generation in the agricultural and industrial sectors. It is an important cash crop in the Madhya Pradesh. Madhya Pradesh, a part of the central zone (Maharashtra, Madhya Pradesh and Gujarat), occupying more than 67.23% of the total area and contributes around 62.11% to the total production and is characterized by rampant proliferation of hybrids. Bt technology has been extensively adopted in this region. Increasing trend has been observed in the area, from 11.78 ha in 2004-05 to 18.54 ha in 2011-12 and production of 16.00 lakh bales to 17.0 lakh bales. However, productivity has been declined from 472 kg cotton lint/ha in 2004-05 to 426 kg cotton lint/ha in 2011-12. This affects the farmers' returns from the cotton cultivation. Though IPM has been developed long back but its field application and adoption rate was low with the cotton farmers. After studying the cotton pest management constraints, large-scale contagious cotton growing tract was selected for the IPM demonstration and implemented in the selected districts of Madhya Pradesh. Frontline demonstrations were planned and implemented mainly to diffuse and influence the practices of IPM technology on yield, cost of plant protection and frequency of pesticides sprays has been developer. The present study is an attempt to investigate the cotton IPM technology effective in yield enhancement vis-à-vis reduction of the cost and pesticide application both in Bt and non-Bt cotton in the Madhya Pradesh.

Keywords Cotton, Yield, IPM technology, Pesticide use, Economics.

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Introduction

Cotton plays a key role in the national economy in terms employment and income generation in the agricultural and industrial sectors. India is the only country to grow all the four species of cultivated cotton *Gossypium arboreum* and *G. herbaceum* (Asian cotton), *G. barbadense* (Egyptian cotton) and *G. hirsutum* (American upland cotton) besides hybrid cotton. *Gossypium hirsutum* represents 90% of the hybrid cotton in India and all the current Bt cotton hybrids are *G. hirsutum*. Cotton is cultivated in three distinct

Table 1. Area, production and productivity of cotton during 2004-05 to 2011-12. Source: www.mpkrishi.org *National average productivity of cotton : 491 kg/ha, (2011-12).

Year	Area (lakh ha)	Production (lakh bales)	Productivity (kg/ha)
2004-05	11.78	16.00	472
2005-06	9.72	18.00	494
2006-07	9.72	18.00	479
2007-08	11.33	20.00	540
2008-09	13.99	18.00	490
2009-10	14.75	15.25	424
2010-11	17.84	17.00	462
2011-12	18.54	17.00	426

Table 2. Demonstrations conducted on cotton IPM during 2008-09 to 2010-11.

Year	No. of KVK districts	No. of demonstration	Area (ha)
2008-09	2	132	75
2009-10	4	161	90
2010-11	2	80	50
Total	8	373	215

agro-ecological regions (north, central and south) of the country. India has the largest acreage (121.80 lakh/ha) under cotton which accounts for 33% of the global cotton area and has the productivity of 491 kg lint/ha and ranks second in production (352.0 lakh bales) during 2011-12 [1]. It contributes to 23% of the global cotton produce. Approximately 65% of India's cotton is produced on dry land and 35% on irrigated lands. The northern zone is almost totally irrigated, while the percentage of irrigated area is much lower in the central (23%) and southern zones (40%). The lowest being in the central zone, which has nearly 60% of cotton area of our country. Under the rainfed growing conditions, rainfall ranges from <400 to>900 mm coupled with aberrant precipitation patterns over the years leading to large-scale fluctuations in production. In the irrigated tract canal and well irrigation are resorted to including the use of micro-irrigation system. India has become a significant exporter of cotton since 2005-06 due to successive bumper crop and the second largest exporter next to USA, particularly in the year 2009-10. Therefore cotton production in India is considered to have a wide reaching impact not only on the livelihood of farmers and economy of the country, but also on international trade.

Madhya Pradesh, a part of the central zone (Maharashtra, Madhya Pradesh and Gujarat), occupying more than 67.23% of the total area but contributes around 62.11% to the total production and is characterized by rampant proliferation of hybrids. Bt technology has been extensively adopted in this region. In Madhya Pradesh, increasing trend has been observed in the area, from 11.78 ha in 2004-05 to 18.54 ha in 2011-12 and production of 16.00 lakh bales to 17.0 lakh bales. However, productivity has been declined from 472 kg cotton lint/ha in 2004-05 to 426 kg cotton lint/ha in 2011-12 [2]. The reason for yield decrease was severe pest problem, ineffectiveness of some insecticides and more dependence on chemical insecticides. IPM module has developed long back but the knowledge and adoption rate was low with the cotton growers. After studying the cotton pest management constraints, cotton growing tract was selected for the IPM demonstration and implemented in the selected district. The demonstrations were planned and implemented solely to diffuse and implement the practices of IPM technology on yield, economics and cost of plant protection. The present study in an attempt to investigate the status IPM in cotton in Madhya Pradesh.

Materials and Methods

IPM technology were demonstrated in cotton fields during *kharif* season of 2008-09 to 2010-11 in rainfed farming situations. The large-scale demonstration was carried out in 215 ha of area and total 373 demonstrations were conducted for farmers benefits. Eight KVKs had selected the sites keeping in view large contagious area of cotton, more pest problem and lack of knowledge about IPM technologies. The insect pest population level and stage of crop was considered to enforce the IPM components in farmers' cotton field and considered it as demonstration field. Traditionally used pest management practices were econsidered as local check for comparative study. In the present study data on gaps between the potential

Table 3. Average yield, technology gap, extension gap and technology index of IPM demonstration conducted during 2008-09 and 2010-11.

Type of cotton	Average yield (q/ha) Potential	Demonstration plots (DP)	Farmer practice (FP)	Yield increase (%)	Technology gap (q/ha)	Extension gap (q/ha)	Technology index (%)
Bt cotton hybrid	35.0	21.31	17.16	24.19	13.69	4.15	39.10
Non-Bt cotton hybrid	15.0	14.28	11.38	25.48	0.72	2.90	4.80

yield, demonstration yield, extension gap, technology index, quantity of insecticides used, and reduction in cost of plant protection were collected from large-scale IPM technology demonstrated plots and local check plots of cotton for analysis and interpretation. The statistical tool to estimate the technology gap, extension gap and the technology index the formulation as mentioned below were used as suggested by Samui et al. [3].

Technology gap =Potential yield – demonstration yield

Extension gap =Demonstration yield – farmers yield

Technology index =[(Potential yield – demo yield)/potential yield] × 100

Results and Discussion

Frontline demonstrations were conducted during 2008-09 to 2010-11 with the intention to demonstrate and develop conviction about the effectiveness of IPM strategies in the selected villages. The collected data were pooled on different parameters and the results obtained are discussed accordingly.

Scenario of cotton production in Madhya Pradesh

KVKs are engaged in the technology testing and its dissemination among the practicing farmers for enhancing their yield and income for bringing prosperity and sustainability to the production environments. Technology like IPM has greater potential for achieving the twin objective of the sustainable development through agriculture in the society. Data in the Table 1 indicates that area under crop has increased but the productivity has been declined which is a matter of concern for extension system. During 2011-12, average productivity of cotton in MP is 426 kg/ha against the national average of 491 kg/ha (Table 1). Hence, there is need for the concerted efforts to enhance the productivity of the crop in the state for increasing the net income of the farmers from cotton cultivation.

Demonstrations conducted in Madhya Pradesh

Demonstration has been considered the potential extension methods for teaching as well as conviction making about a new technology to the farming community. Keeping in view the importance of the IPM practices, a total of 373 demonstrations were laid out at the selected farmers fields covering 215 ha in the eight districts of Madhya Pradesh during three years duration as given in the Table 2.

Table 4. Economics of IPM demonstration. *Average price was taken as Rs 3000/q.

Type of cotton	Increased yield over local check (q/ha)	Additional income due to increased yield (Rs/ha)*	Amount saved in plant protection chemical over local check (Rs/ha)	Net gain (Rs/ha)
Bt cotton hybrid	4.15	12450.00	1544.00	13994.00
Non-Bt cotton hybrid	2.90	8700.00	2150.00	10850.00

Table 5. Cost of plant protection in cotton.

Type of cotton	Cost of plant protection (Rs/ha) Demonstration	Local check	Per cent reduction in cost of plant protection
Bt cotton hybrid	2830	3921	27.82
Non-Bt cotton hybrid	3904	5872	33.51

Table 6. Number of insecticidal sprays in cotton.

Parameters	Number of sprays Demonstration	Local check	Per cent reduction in sprays
Bt cotton hybrid	5.10	6.32	19.30
Non-Bt cotton hybrid	5.82	6.37	08.63

Yield performance of Bt and non-Bt cotton variety

The data of the yield level of Bt and non-Bt cotton showed significant increase due to IPM technology interventions as mentioned in the Table 2. The per cent increase in yield levels of IPM demonstrated plots of Bt and non-Bt was 24.19 and 25.48, respectively. These results indicated that the IPM technology on yield level might make less impact on Bt cotton than on yield level of non-Bt cotton fields.

The technology gap in Bt and non-Bt was 13.69 q/ha and 0.72 q/ha. The reason for this large gap may be due to cultivation of cotton with inadequate INM practices. The technology gap was also more in Bt hybrids, which might be due to cultivation of Bt hybrids in rainfed situation not performing well. Hence, the result indicated that cotton needs proper nutrient management and Bt cotton should be cultivated in irrigation situation for realizing the higher yield (Table 3).

The extension gap was 4.15 q/ha and 2.90 q/ha in Bt and non-Bt hybrids, respectively. The data showed that there was extension gap in yield hence more efforts are needed to convince the effectiveness of IPM technologies to the farming community. The knowledge up-gradation on IPM technology, time of use of IPM inputs and ease in availability would create positive impact on yield and cotton pest reduction. The results of technologies would eventually lead the farmers for replacement of old practices with new technology.

The technology index showed the feasibility of the evolved technology at the farmer' field. The lower the value of technology index more is the feasibility of technology. The technology index of Bt and non-Bt hybrid were 39.10% and 4.80%, respectively. It showed that the technology is feasible. But considering the ecological safety and net economic benefit, the technology is much more feasible as IPM technology includes ecologically safer pest management practices which helps in bringing sustainability to the production system.

Economics of IPM demonstration in cotton

IPM technology is capable of increasing the income of the farmers in two ways–yield enhancement and cost reduction. The additional income due to increased yield saving on plant protection chemical in Bt cotton was rupees 12450.00 and 1544.00 per hectare respectively, where as in non-Bt hybrids it was rupees 8700.00 and 2150.00 per hectare from additional income due to increased yield and saving on plant protection chemicals, respectively (Table 4). These data showed that both in Bt (Rs 13994/- per ha) and non-Bt (Rs 10850/- per ha) hybrid IPM technology found to increase the income of cotton farmers. Similar results were found during the IPM technology validation in Uttarakhand hills [4].

Cost reduction in plant protection

Analyzed data depicted in Table 5 indicates that there is considerable reduction in the cost of plant protection measures which is 27.82% in Bt and 33.51% in non-Bt cotton which is mainly due to the reduction of insecticide consumption due to less number of sprays in Bt and non-Bt hybrids. Hence the results conclude

that the IPM technology reduced pesticide load on plants and soil considerably and was found more eco–friendly technology for cotton growers.

Pesticide load reduction

Similarly, there has been reduced number of insecticide sprays also reported due to application of the IPM technology in the cotton cultivation in MP. The reduction is more in Bt cotton 19.30% than non-Bt cotton which is reported as 8.63%. This shows it is helpful for the farmers in reducing the risk of health hazards also which is more in non-IPM cotton cultivation.

Farmers feedback on
IPM demonstration

Foliar spraying of methyl-o-demeton and imidacloprid reduced the population of sucking pests (Aphid, Jassid, Thrips and whitefly). Incidence of bollworms and spodoptera is completely negligible by the use of tolerant cotton variety. Use of murate of potash as a basal dose produced good quality lint, sturdy growth of cotton and comparatively low incidence of sucking pest and infection of parawilt and wilt disease. Sticky trap should be compulsorily taken in demonstrations as it is helpful in management of white fly and green leaf hopper. Foliar spray of micronutrients increases growth, size of boll and hence yields of cotton. New resistant varieties/hybrids against bollworms and sucking pest in needed. Demonstration of integrated pest management technologies in farmers field brought confidence among the farmers community.

Conclusion

On the basis of these findings it is concluded that IPM technology-happened to be imperative for managing cotton pest problems. The application of IPM technology helped to increase the net income and the technology was found much safer for farmers and environment. The intensive use of the IPM technology in cotton would substantially increase the income as well as the livelihood of the farmers in the cotton growing region. There is need to adopt multipronged strategy for mass dissemination and upscaling the adoption of IPM technology in cotton for bringing sustainability in the state agriculture.

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