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Impact of extension activities on pink bollworm management in Bt-cotton in tribal areas of Adilabad district

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Abstract
The present investigations on Frontline demonstrations (FLDs) were carried out on large scale in an area of 50 acres and implemented successively in the operational area of ICAR- Krishi Vigyan Kendra, Adilabad (Telangana state) under rainfed conditions followed by other supporting extension strategies during the year 2018-2019 (*Kharif* season). All the 50 practicing farmers were trained on various aspects of Bt cotton production and protection technologies. In FLD practicing farmers fields, trap catches were low during July-September and ranged between (4-10 no. of adults/trap) and high during October and November (50 -110 adults/trap). Higher seed cotton yield (21.3 q ha^{-1}) with net return 68,187 (Rs. ha^{-1}) and a B:C ratio of 2.65:1 was recorded in the demonstrations compared to 17.5 q ha^{-1} in farmers' practice might be due to imparting knowledge on identification of pest and making farmers adopt right management practices particular to pink bollworm which in turn reduced the number of plant protection sprays. Hence, the technology may be popularized to minimize the extension gap.

Keywords: Rainfed**,** *Bt* cotton, pheromone traps, pectinolures, neem oil, lambdacyhalothrin

Introduction
With the introduction of Bt cotton in India, increasing trend in the cotton production area from 7.7 million hectares to 12.25 million hectares, fiber production from 13.6 million bales to 39.1 million bales observed [1]. Being a largest producer of cotton Telangana state harvests101 lakh bales of cotton from 25.00 lakh hectares of area contributing 36 per cent of the total national production. Among the different districts of Telangana, major districts involved in the production of Bt cotton are Nalgonda, Adilabad, Mahabubnagar, Warangal and Khammam. Cotton is the major sowing *kharif* crop in Adilabad district with 312200 ha area [2]
From 2003-04, the farmers of this area mainly grow *Bt*. Cotton and achieved higher income, but since 2015-16 farmers suffering from heavy infestation of pink bollworm and assumed major pest status in recent past and has known to cause loss in seed cotton yield, oil content, loss in normal opening of bolls, damage of locules, and reduction in seed cotton yield [3]. Pink bollworm lays eggs on squares, flowers or green bolls. Larvae feed on squares, flowers and bolls, including the seeds within bolls. Larvae immediately begin to bore into squares or bolls after hatching. Hence it is necessary to apply insecticide sprays at proper time. As the Pest is internal feeder on seeds, its effect remains undetected in early stages but from the last 2-3 years pink bollworm is appearing early in Bt cotton hybrids at 45-60 days after sowing in central and south India.
During 2017-18, it's infestation ranged from 8-92% with corresponding yield losses of 10-30% in major cotton producing states like Maharashtra, Telangana, Andhra Pradesh, Karnataka and Madhya Pradesh. [4]
Low awareness and low knowledge on integrated management of pink boll worm lead cotton growers to use pesticides indiscriminately resulted in increased cost of production. There are management strategies available to keep the pest below Economic Threshold Level (ETL). Hence, emphasizing the need for better dissemination frontline demonstration and other extension activities were planned and implemented successively in the operational area of ICAR- Krishi Vigyan Kendra, Adilabad (Telangana state) covering the district to provide technological knowledge about different biorational management practices against pink bollworm in Bt cotton with easily available critical inputs which will be helpful in minimizing chemical insecticidal pressure in cotton ecosystem.

Materials and Methods

Frontline demonstrations (FLD) were carried out on large scale in an area of 50 acres and implemented successively in the operational area of ICAR- Krishi Vigyan Kendra, Adilabad (Telangana state) under rainfed conditions followed by other supporting extension strategies during the year 2018-2019 (*Kharif*).

All the 50 practicing farmers were trained on various aspects of cotton production and provided with all the critical inputs *viz*. pheromone traps, pectinolures, neem oil and Lambdacyhalothrin. The proper method and time of traps installation in the field and change of lures in the traps was demonstrated to the farmers at their fields (Fig. 1) and right time of application of plant protection chemicals based on ETL level of pest.

Observations on the incidence of pink bollworm were made based on the number of Rosette flowers due to pink bollworm in 50 randomly selected cotton flowers, number of male adult moth trap catches and number of plant protection sprays recorded in FLD practicing and non practicing farmers field plots.

Table 1: Details of Frontline demonstrations on Pink bollworm management in Bt-Cotton

S. No.	Technology / Demonstration	No. of Farmers	Total Area (ha)	Method & time of Application
1	Neem oil	50	20	Sprayed Neem oil 1500ppm@ 1 ml+ sandovit@1ml in one litre of water at the time of initiation of flowering.
2	Pheromone trap/ lure	50	20	Installed Pheromone traps @ 8per acre from 45 days after sowing (45DAS) and continued them till the last picking / end of crop period and advised to change lures in traps at every 21 days intervals.
3	Trained on identification of infested (rosette flowers) and uninfested cotton flowers and advised them to Collect and destroy Rosette flowers in early crop stages.			
4	Advised to initiate pink bollworm monitoring by installing pheromone traps starting from flowering stage.			
	Provided knowledge on assessment of ETL by picking 20 green bolls from randomly selected plants across one acre. ETL of pink bollworm -10% infested flowers or 10% infested bolls (at least two bolls out of 20 having white or pink larvae or exit holes) or 8 male moths catches/trap/night for 3 consecutive nights. When pink bollworm damage crossed Economic Threshold Level (ETL), advised to initiate Chemical control measures: September- Quinolphos 20% AF 20 ml Or Thiodicarb 75% WP October- Chlorpyriphos 20% EC Or Thiodicarb 75% WP November-Lambdacyhalothrin 20% EC or Cypermetherin 10% EC [5]			

Farmers practices

- Not installing pheromone traps
- No application of neem oil at the time of flowering
- Spray of organophosphtes and synthetic pyrethroids twice at weekly interval Lambdacyhalothrin @ 1ml or Cypermethrin @1ml per liter of water

The economics of IPM module and farmers practice were worked and qualitative data were converted into quantitative form and expressed in terms of per cent increase in yield **[6]**. Finally, the extension gap, technology gap, technology index along with benefit cost ratio were worked out **[7]** by using following formula as given below:

Technology gap = Potential yield – Demonstration Yield
Extension gap = Demonstration yield – Farmers yield
Technology index = {(Potential yield - Demonstration yield) / Potential yield} X 100

Alongside the FLDs on management of pink bollworm among the cotton growers, KVK-Adilabad had adopted different extension methods *viz*. Training, group meeting, Diagnostic visit, Field day, Presentation, postering, mass awareness campaigns, telephone advisory, radio talks, Print and media, Farmer- scientist interaction etc. to overcome the above situation during the year 2018-19.

To measure the impact of different extension strategies for its management in Adilabad district, the data on critical inputs and insecticides sold specific to control pink bollworm during 2017 and 2018 was recorded from randomly selected 40 retailer shops by personal contact and analysis done.

Results and Discussion

Perusal of the data (Table 2) revealed that there was a remarkable decrease in number of damaged flowers (Rosette flowers) due to pink bollworm ranged from 3-4 numbers in the IPM FLD practicing farmers field while in Farmers field it ranged from 10-15 number of rosette flowers for every 50 flowers observed randomly during flowering time. In FLD practicing farmers fields, trap catches were low during July-September and ranged between (4-10 no. of adults/trap) and high during October and November (50 -110 adults/trap). Based on the crop stage and pest ETL level, FLD practicing farmers were advised recommended insecticide *viz*., Profenophos @ 2ml or Thiodicarb 75% WP @1.5g or Quinolphos @ 2ml at early stages. Lambdacyhalothrin @ 1ml or Cypermethrin @1ml per litre of water (later stages of the crop.) while, in farmers fields pheromone traps were not installed due to of lack knowledge on traps availability and insecticidal sprays were done indiscriminately without knowledge on ETL level of pest.

Observations on pest incidence during picking time revealed that in FLD practicing fields, first and second picking free from infestation while during third picking infestation noticed in few practicing farmers fields which controlled by spraying Lambdacyhalothrin @ 1ml/lit. water while in farmer fields infestation negligible during first picking and noticed above ETL during second and last pickings. The reduced pest load with pest free yields might be due to trapping of male insects and timely application of plant protection sprays.Similar findings have also been documented by [8]

Table 2: Data on Pink bollworm status during 2018-19 in IPM FLD and farmers practice in cotton crop

Observations	IPM FLD practicing farmers	Farmers field
Rosette flowers/50 flowers (No.)	3-4	10-15
Trap catches (no.)	Low during July-September and ranged between (4-10 adults/trap) High during October and November (50 -110adults/trap).	No knowledge on PBW traps availability
Picking time	1st and 2nd picking: free from infestation (negligible) 3rd picking :In few fields infestation noticed	1st picking- negligible 2nd and 3rd picking -Noticed

The results indicated that the higher seed cotton yield (21.3 q ha^{-1}) was recorded in the demonstrations compared to 17.5 q ha^{-1} in farmers' practice (Table 3).The per cent increase in the yield over farmer practice was 21.7%. Number of plant protection sprays in FLD practicing farmers 4 (2 sprays are neem oil which is eco friendly) and in farmers fields was 6 sprays, respectively with 33.33% reduction in plant protection sprays in demonstrations for management of pink bollworm. Similar observations on yield enhancement and saving cost in sprayings on cotton through FLD has also been documented [9, 10]

Table 3: Effect of FLD on pink boll worm management technology on yield of Bt-Cotton during 2018-19

Crop	Year and season	No. of Farmers /demos	Area (ha)	Yield (q ha^{-1})				% Increase in yield
				Demo			Check	
				High	Low	Average		
Bt-Cotton (RCH -659)	*Kharif*, 2018	50	20	21.25	17.5	21.3	17.5	21.7 %

The results indicate that the increase in yield in the IPM FLD fields may be due to imparting knowledge on identification of pest and making farmers adopt right management practices particular to pink bollworm which in turn reduced the number of plant protection sprays in IPM FLD fields (2 sprays).The data showed that the reduction in number of sprays, can be due to the adoption of physical control measures inturn reduced the number of insecticide sprays (Table 4) hence, it can be concluded that this technology reduces usage of plant protection chemicals for pink bollworm management in cotton production system.

Table 4: Details on number of sprays in the demonstration and farmers practice fields

Number of sprays under Demonstration (per acre)	4
Number of sprays under Local Check (per acre)	6
Per cent reduction in sprays	33.33
Extension Gap	-2

Negative digits of extension gap can be read as reduction in number of plant protection chemical sprayed in one acre area.

In demonstration plots there was a net return 68,187 (Rs. ha^{-1}) and a B:C ratio of 2.65:1 as compared to farmers' practice 44,875 (Rs. ha^{-1}) net return and a B:C ratio of 1.99:1 as evidenced by [11].

Table 5: Effect of FLD on pink boll worm management technology on Economics of Bt-Cotton during 2018-19

Crop	Economics of demonstration (Rs. ha^{-1})				Economics of check (Rs. ha^{-1})			
	Gross Cost	Gross Return	Net Return	BCR	Gross Cost	Gross Return	Net Return	BCR
Bt-Cotton (RCH -659)	41250	109438	681878	2.65:1	45250	90125	44875	1.99:1

The data presented in the table revealed that there was difference in the yield of Bt hybrids both in the demonstration and local check. The per cent increase in the yield of Bt was 21.7. These results indicate that the IPM technology had an impact on Bt hybrids yields. The technology gap in the yield of Bt was 3.7 q/ha. The extension gap was 3.8 q/ha in Bt cotton hybrids (Table 6). The data shows that there was much extension gap in the yield levels; however some more efforts are yet to be intervened to convince the advantages and effectiveness of IPM technologies. Improving knowledge on cost reducing and eco friendly technologies, time of proper use and availability of IPM inputs when needed may enhance productivity with good quality produce of Bt cotton hybrids and also influence in the reduction of pink bollworm. The IPM technologies demonstrated eventually lead the farmers to discontinue the old practices with adoption of demonstrated practices and this data is in line with findings [12]

The technology index showed the feasibility of the evolved technology at farmer's fields. The technology index of the demonstrated technology was 14.8 per cent. Considering these data it seems that the technology is 14.8 per cent feasible. However, in view of the eco friendly practices and net returns (Table 6) the technology is much feasible as it includes ecologically safer pest management practices. The results of the present study are in consonance with the findings of [13, 14]

Table 6: Productivity, Yield Gap and Technology Index of IPM Demonstration

Average Yield (q/ha) under Potential	25
Average Yield (q/ha) under Demonstration	21.3
Average Yield (q/ha) under Local Check	17.5
Per Cent Increase in Yield (%)	21.7
Technology Gap (q/ha)	3.7
Extension Gap (q/ha)	3.8
Technology Index (%)	14.8

KVK-Adilabad organized five on and off campus trainings, 8 mass awareness campaigns for farmers, extension functionaries and Agro input dealers covering the district with total 4,350 beneficiaries. KVK along with ATMA (Agricultural Technology Management Agency) distributed 10,400 no. of pheromone traps and lures covering 1,050 number of farmers. More than 975 farmers were benefited through various extension activities carried out by KVK scientist i.e. Group discussions, Method Demonstrations, field visits and field days.

Through News paper/Radio/Video Coverage/Short video modules, Phone advisory, AKPS covered approximately 5,500 number of farmers. Thus, total of 18,677 farmers benefited directly by the KVK activities during 2018-19 (Table 7).

Table 7: Different extension activities undertaken for Management of pink bollworm in Bt. Cotton during 2018-19 in Adilabad District (Telangana State)

S. No.	Activities / Technology		Total no. of Activities / Technology / Inputs	Participants / Beneficiaries
1	On campus training		03	165
2	Off campus training		02	110
3	Group discussions		18	325
4	Method Demonstrations		15	320
5	Mass Awareness campaigns		8	4350
6	Field visit		35	150
	Field days		03	180
7	FLD on Farmer fields	Pheromone traps (No.) PBW lures (No.) Neem oil (lit.)	400 400 50	
8	Distribution of IPM inputs (through ATMA)	Pheromone traps (No.) PBW lures (No.)	10000 10000	1000
9	Poster on IPM		06	2300
10	Phone advisory and what's app information dissemination		35	2365
11	News paper/Radio/Video Coverage/Short video modules		43	5500
12	IIDS-Annapurna Krishi Prasar Seva (AKPS)		30	1912

Impact of extension activities for management of pink bollworm in Bt-Cotton

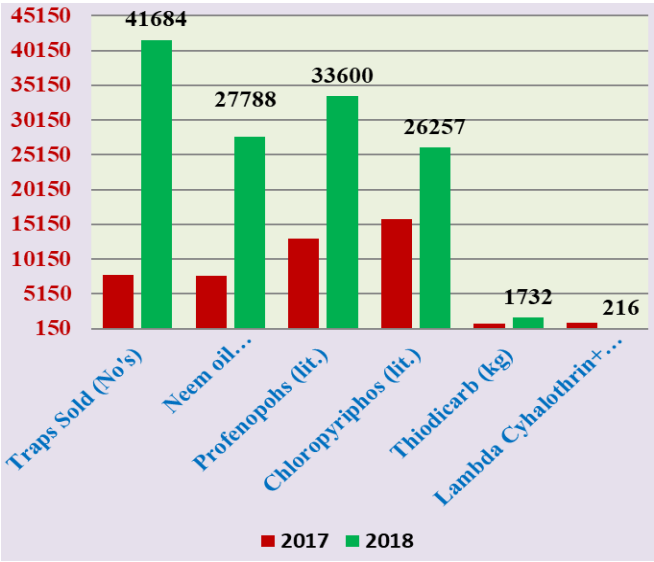
Data on critical inputs sold in 40 pesticide retailer shops revealed that during 2017-18, about 7,890 no.of pheromone traps, 7,708 lit. of Neem oil, 13,123 lit. of Profenophos, 15,956 lit. of Chlorpyrifos were sold while during consecutive year 2018-19, pheromone traps (41,684 No.), neem oil (27,788 lit.), Profenophos (33,600 lit.) and Chlorpyrifos (26,257 lit.) were sold (Table 8). It can be concluded that most of the farmers have changed their attitude and followed management practices on pink bollworm by including IPM components i.e. use of pheromone trap, neem oil, ETL based pesticide usage etc.

Table 8: Data on critical inputs and insecticides sold specific to manage pink bollworm in the district during 2017-18 and 2018-19

Inputs sold	2017-18	2018-19
Pheromone traps (no.)	7890	41684
Neem oil (lit.)	7708	27788
Profenophos (lit.)	13123	33600
Chlorpyrifos (lit.)	15956	26257

Note: Recorded from randomly selected 40 retailer shops by personal contact.

Based on the details of inputs sold particular to pink boll worm management observed that during 2018-19 more number of inputs was sold than 2017-18. Input dealers expressed that it is due to the awareness created among the farming community by source of information received from KVK Scientists, Agricultural Extension Officers and fellow farmers.



Inputs Data analysis for Management of PBW in Adilabad during 2017-18 & 2018-19

4. Conclusion

The results from the present study revealed that adoption of different extension strategies for integrated management of pink bollworm helped in early detection of the pest and careful monitoring by pheromone traps lowered infestation by reducing the number of moth population which otherwise subsequently oviposit and produce economic infestations of larvae in bolls. Tribal farmers both large and smallholders benefited by this technology. Use of environmentally safe and viable pest management practices increase productivity and time savings which can be understood from the benefit cost ratio [15].

The demonstration is to convey the technical message to farmers that if they use recommended package for pest management they are sure to get higher yields**.** During 2018, it's infestation and subsequent yield loss likely to be aggravated if suitable management strategies are not followed. Hence, the technology may be popularized to minimize the extension gap.

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