

Targeted disruption of cotton pink bollworm (*Pectinophora gossypiella*) using cost-effective mating disruption PBKnot technology in rain-fed cotton of Central India

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ABSTRACT

An innovative, easy to use, non-chemical and eco-friendly approach of gossypure-based mating disruption using PBKnot technology was deployed and demonstrated on 300 acres in five clusters of 60 acres each in the present study through area-wide participatory approach in farmers' cotton fields. The results revealed that in the PBKnot tied plots there was reduction in flower damage (49.2%), boll damage (58.3%) and locule damage by 51.8 per cent averaged over 300 acres of treated clusters. At the end of 10th week, the active ingredient of PBK not was still active as more than 93 per cent mating disruption was visible indicating the slow release of pheromone even after three months. The average yield increase based on 300 acres farmers' field demonstration was to the tune of 550 kg/ha. From the large-scale demonstration, it is evident that the mating disruption technology is a promising option for the cotton farmers to reduce the use of chemicals for management of pink bollworm in a contiguous cotton farming system.

Keywords: Bt cotton, *Pectinophora gossypiella*, Mating disruption, PBKnot dispenser, Participatory approach, Integrated pest management (IPM)

INTRODUCTION

Pink bollworm (*Pectinophora gossypiella*) has emerged as a dreaded pest of Bt cotton in recent years. The unprecedented outbreak of the pest has hit hard the smallholder cotton farmers in Maharashtra for first time during the monsoon season of 2017-18. There after it appeared with differential intensity in the last four seasons throughout cotton growing states. In Vidarbha region of Maharashtra, the South Asia Biotechnology Centre (SABC) and Agrovision Foundation (AF) jointly under took the scientific outreach using the on and offline digital tools of technology transfer on pink bollworm management in cotton. The tools included - knowledge generation in vernacular language, village posters, hoardings, radio jingles, TV dialogues, campaign floats and newspaper publicity for educating farmers (Mayee *et al.* 2019). Such campaigns have yielded desirable farmers awareness in the past in management of another dreaded pest; fall army worm of maize (Mayee *et al.* 2021). Since the management tips for PBW included the application of certain pesticides, the benefits of reducing the chemical use by adoption of Bt technology in cotton were waning

and hence there was demand for non-chemical method for management of PBW. Specialized Pheromone and Lure Application Technology (SPLAT), a wax-based formulation having sustained release pheromone tool has given some success in area-wide management of pink bollworm of cotton (Sreenivas *et al.* 2021; Desai *et al.* 2022). Fortunately, a better version of the cutting-edge mating disruption technology in the form of 'PBKnot' (supplied by M/s PI Industries Ltd., Gurugram) experimented at university farm of VNMAU, Parbhani, Maharashtra on small scale as PB Rope L gave encouraging results (Anonymous, 2018). This prompted us to take up mega-experiment under "Project Bandhan: A Knot of PBW Protection" in three villages of Nagpur district of Maharashtra during the monsoon season of 2021-22. This paper describes the outcome of the mega mating disruption project in farmers' field.

METHODOLOGY

Five clusters of 60 acres each (total 300 acres) were chosen for the mega demonstration of mating disruption using the PBK not technology, registered for its commercial application to manage Pink

Bollworm by Government of India in 2020. The details of the clusters, number of farmer participants are given in Table 1. The farmers had the freedom of

sowing a cotton hybrid of their choice in the remaining area of their farm but they preferred to sow same hybrid.

Table 1
Selection of cotton cluster(s) for mega field demonstration of mating disruption technology in Kalmeshwar Taluka of Nagpur District of Maharashtra

Name of Village	Cluster Nos	Total Acres and Numbers of farmers in Treated Plot		Total Acres and Numbers of farmers in Control Plot	
		Acres	Farmers	Acres	Farmers
Waroda	I	63	42	09	2
Waroda	II	66	31	11	3
Adasa	III	47	36	14	3
Adasa	IV	78	55	7	2
Methpanjara	V	46	04	9	1
Total		300	168	50	11
Each Cluster of ~60 acres (~25ha) for treatment and ~10 acres (~4 ha) for control					

The sowing of cotton was done on the onset of monsoon rains between 14th to 18th June 2021 in all the five clusters. Each cluster of 60 acres was treated with PBKnot for management of PBW and 10 acres of control plots nearly 1000 meter away from the treated contiguous 60-acre cluster. The PBKnot dispenser is a 20 cm hollow polyethylene rope encasing the formulation supported with aluminum wire to twist to desired shape. The PBK not dispenser consisted of 140 mg of active gossyplure (Hexdecadien-1-yl acetate 47.4% w/w min and ZE-7,11-Hexdecadien-1-yl acetate 42.7% w/w min) per rope (CIB & RC, 2020). A structured tagging of 9875 PBK not dispensers per 25 hectares or 62.5 acres was done on contiguous basis. The PBK not dispenser charges the surrounding air with Gossyplure, which confuses the adult male moths preventing them for finding and mating with female adults, thus resulting in considerable reduction in the egg laying and PBW population in subsequent generations. In treated plots, PBK not dispensers were tied on the main stem of the cotton plants at pin-head square stage approximately between 45-50 days after sowing. The entire border row plants plus the 7th plant in each row vertically and horizontally were tied with the PBK not dispenser.

For detailed observations, each cluster of 60 acres, was divided into 30 equal quadrants.

Observations were recorded from randomly selected ten plants in each quadrant at weekly interval for parameters including trap catches of PBW, flower damage, green boll damage, locule damage and finally for yield and quality of bolls. The data of all the 30 quadrants were pooled and averaged as the mean of the 60 acres cluster. The same way the 5-acre control plots were also divided into two quadrants and the data were averaged for the control plots of each cluster. Average male moth counts in the traps installed in treated and untreated plots were taken into consideration at weekly interval throughout the crop season till third flush of bolls appeared on the plants. For each cluster the percent mating disruption was calculated by dividing the catches in treated plots by the catches in control plots, multiplied by 100. Farmers were allowed to harvest the cotton as per their convenience in all the clusters except that they have to weigh the produce of their plots before the representative of the project.

RESULTS AND DISCUSSION

Results on the evaluation of the PBK not tied to cotton plants in all the clusters revealed that overall incidence of pink bollworm in terms of flower damage and also the green boll damage was extremely low in all the clusters (4.00 to 4.72% and

7.14 to 11.43, respectively) where the treatment was executed as against 7.71 to 12.29 per cent flower damage and 20.0 to 65.0 per cent green boll damage in the respective non-treated fields (Table 2).The mean reduction flower and boll damages was to the tune of 51 per cent and 42 per cent respectively. Similarly, the locule damage which is one of the

effects of pink bollworm incidence, was found to be minimum (9.46 to 15.18%) in treated clusters as against 21.61 to 29.64 per cent locule damage in untreated control fields despite having given 4-5 rounds of insecticidal sprays exclusively to manage the pink bollworm. The mean reduction in locule damage was to the tune of 49 per cent.

Table 2
Flower, Green boll and Locule damage as influenced by PBKnot treatment in all the clusters

Cluster No	% Flower damage			% Green Boll damage			% Locule damage		
	PBKnot Treated Plot	Control Plot	% of Reduction	PBKnot Treated Plot	Control Plot	% of Reduction	PBKnot Treated Plot	Control Plot	% of Reduction
I	4.71	7.71	61	11.43	21.43	53	10.18	21.61	47
II	4.43	8.57	52	10.18	22.86	45	9.46	25.18	38
III	4.00	9.29	43	7.14	20.00	36	12.32	26.43	47
IV	4.71	10.18	46	8.57	23.57	36	15.18	29.64	51
V	6.57	12.29	54	9.64	24.82	39	14.11	24.29	58
<i>Average</i>	4.88	9.61	51.2 %	9.39	22.54	42 %	12.25	25.43	49 %

In all the clusters heavy catches were obtained in treated fields as against minimum catches in control fields. The mean percent mating disruption computed from the data of catches in treated and control fields indicated 86.3 to 88.1 per cent disruption with an average of 87.3 per cent mating disruption achieved due to the PBK not treatment. Lower incidence of pink bollworm and consequent less field damage due the pest resulted in higher yields in all the clusters (Table 3). Highest

seed cotton yield of 1,583 kg per ha was obtained in cluster III in treated fields as against 913 kg/ha in untreated control field. The data in Table 4 further revealed that the average cotton yield based on 300 acres improved by 550 kg/ha (408 to 742 kg/ha) due to mating disruption technology. As per the prevailing prices of the season Rs 9,900 per quintal, the project farmers obtained additional monetary benefit of nearly Rs. 54,450 per ha using the technology.

Table 3
Seed cotton yield in five clusters as influenced by PBKnot

Sl. No	Villages	Cluster No	PBKnot Treated fields Seed Cotton Yield (Kg/Ha)	Control Fields Seed Cotton Yield (Kg/Ha)	Additional Seed Cotton Yield due to PBKnot (kg/Ha)	Additional Income (Rs/Ha)
1	Waroda	I	1400	900	500	49,500
2	Waroda	II	1390	990	400	39,600
3	Adasa	III	1565	900	665	65,835
4	Adasa	IV	1240	800	440	43,560
5	Methapanjara	V	1560	820	740	73,260
Average			1430	880	550	54,350
* Average rate from (2021-22) season crop Rs.9,900 per quintal seed rate (1 quintal =100kg)						

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The mating disruption technology has been widely experimented and adopted as a tool in management of lepidopteran pests of many crops with some considerable success (Kong *et al.* 2014; Miller and Gut 2015; Carde and Minks 1995) reviewed the successes and constraints of mating disruption technology and concluded that the technology is ecofriendly technology and it fits well in to IPM practices. Mating disruption of Lepidopteran pests has been an important component of integrated pest management; however, commercial exploitation of the techniques needs further refining.

CONCLUSION

PBK not, a pheromone- based formulation with the simplicity of tying and comprehending the benefits of a knot (an analogous to the magic of tying a 'rakhi' on Raksha Bandhan) around the main stem was found effective in checking the mating process of pink bollworm of cotton. A mega field demonstration of the technology conducted in

Vidarbha in farmers field clear demonstrated that the new technology helped in reduced the incidence of the PBW and increased the yield. Being an eco-friendly technology, the mega field demonstration has paved ways for large scale adoption of the system.

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