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Assessment of integrated pest management module for the management of pink bollworm in cotton

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Abstract
A study on assessment of integrated pest management module for the management of pink bollworm in cotton was conducted in 2 ha in farmers fields in cotton growing tract of Prakasam district during 2018-19. Lowest per cent rosette flowers (5.6%), green boll damage (8%), open boll damage (17%) was recorded in IPM module over farmers practice of per cent rosette flowers (14%), green boll damage (15%), open boll damage (35%), respectively. IPM module recorded 12 q/ha (C:B ratio of 1: 0.8) which is 20 % higher than that obtained in farmers practice (10 q/ha with C:B ratio of 1:0.6).

Keywords: IPM strategies, pink bollworm, *Pectinophora gossypiella*, cotton

1. Introduction
Cotton (*Gossypium sp*) popularly called white gold is one of the important commercial crop of India particularly in Andhra Pradesh. Crop is attacked by 1326 insect pests among them 12 are important and Pink bollworm is most destructive pest [3]. Cultivation of Bt cotton in India has increased exponentially since its introduction [7]. Large scale cultivation of *Bt* cotton can impose a continuous and intense selection pressure on bollworms leading to the development of resistance to toxins [6]. Recently, in India, the development of resistance in Pink bollworm to Cry 1 Ac and Cry 2 Ab toxins has been reported [5]. Prakasam district of Andhra Pradesh is one of the traditional cotton belt with intensive cultivation. Crop occupied nearly 38467 ha during 2018-19 season. Management of Pink bollworm is very difficult with insecticides alone since it is an internal feeder. So, potential solution is adoption of integrated pest management strategies plays a key role. Cotton pest management includes different strategies to be combined to manage the complex of pest starting from sucking pest to bollworms of which pink bollworm in the recent past. Choice of insecticides and other management tactics will depend upon the occurrence of the pest. In this context, integrated pest management is an essential, suitable and sustainable for cotton production system which includes series of control measures (cultural, physical, mechanical, biological, chemical methods) keeping the pest below economic threshold level [1]. The feedback since the commercialization of Bt cotton indicated that, the technology is not a panacea for all pest problems and integrated approach would be necessary to draw maximum benefit and to sustain the technology [4]. Adoption of Integrated pest management measures in the region of Annur and Avinashi blocks of Coimbatore district helped to manage the major pests of cotton especially bollworms and sucking pests with reduced number of sprays and plant protection cost Rs. 5960 to Rs. 2080/ha over farmer practice. Besides, there was an yield increase of 15.85 per cent and a net profit of Rs. 9475/ha over farmer practice [13]. In this context following integrated pest management module has been validated in the field conditions at Prakasam district during 2018-19 to reduce the incidence of pink bollworm.

2. Materials and Methods
The present study was carried out, in *Kharif* season in the fields of Pasupugallu village (Mundlamur mandal) of Prakasam District during 2018-19bythe Krishi Vigyan Kendra, Darsi. In this study, five farmers were selected under onfarm trial of cotton. The improved technology were imposed, consisting using oforganic manure FYM (4t/acre) and recommended N (75kg/acre, 3-4 splits), removal and destruction of rosette flowers and dropped squares, dried flowers and pre-matured bolls, mass trapping with pheromone traps

(20traps/acre), application of insecticides based on economic threshold level *i.e*., spraying with thiodicarb 75% SP @300g/acre and spraying with lambda cyhalothrin 5% EC @200ml/acre at crop final stage and timely crop termination without extending the crop. Farmers practice includes indiscriminate spraying of different insecticides like acephate 75% SP (400g/ac), ampligo 150 ZC (80ml/ac), chlorantraniliprole 18.5%SC (80ml/ac) and synthetic pyrethroids lambda cyhalothrin 5% EC (250 ml/ac) from vegetative stage to end of the crop growth period.

The following observations were recorded
a) Per cent rosette flowers
b) Per cent green boll damage
c) Per cent green boll locule damage
d) Per cent open boll damage
e) Per cent open boll locule damage
f) Adult moth catches/trap/week
g) Seed cotton yield
h) cost benefit ratio

These studies also provide information about the favorable periods for pest buildup that help in the management of the pest. The weather parameters viz., maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall were recorded on daily basis from August, 2018 to November, 2018 and compiled the data as standard week.

3. Results and Discussions

Table 1: Per cent of rosette flower, green boll damage, green boll locule damage, open boll damage, open boll locule damage

Particulars	Per cent of rosette flowers	Per cent of green boll damage	Per cent of green boll locule damage	Per cent of open boll damage	Per cent of open boll locule damage
IPM module*	5.6	8	4.5	17	9.5
Farmer practice	14	15	8.75	35	23.75

*Mean of 5 farmers

Rosette flowers: Flowers don't open fully and get twisted. The data presented in Table 1 indicated that the pink bollworm infestation in rosette flower found to 5.6 per cent in IPM module as compared to 14 per cent in farmers practice.

Green boll damage: Blackspots on green bolls may often be indicative of pink bollworm damage. The data presented in Table 1 indicated that the pink bollworm infestation in green boll found to 8 per cent in IPM module as compared to 15 per cent in farmers practice.

Green boll locule damage: The data presented in Table 1 indicated that the pink bollworm infestation in green boll locule found 4.5per cent in IPM module as compared to 8.75per cent in farmers practice.

Open boll damage: Stained lint in open bolls is a distinct symptom of damage. It occurs in the later stages of crop growth, once the damage is done [8]. Stained lint around feeding areas resulting in bad quality lint due to improper boll opening with damaged seeds is noticed on the boll which also leads to inferior quality of lint. The data presented in Table 1 indicated that the pink bollworm infestation in open boll found 17 per cent in IPM module as compared to 35 per cent in farmers practice.

Open boll locule damage: The data presented in Table 1 indicated that the maximum pink bollworm infestation in open boll locule found 9.5 per cent in IPM module as compared to 23.75per cent in farmers practice.

The pink bollworm infestation on flowers found higher in second week of September with intensity of 6 and 7 larvae/30 flowers respectively during both years. While, peak larval population on bolls was recorded in the second week of September with intensity of 7 larvae/30 bolls in 2012 and in 2013 peak infestation was recorded in third week of September with intensity of 8 larvae/30 bolls. In *Kharif*, 2012 and 2013 open boll damage was 28.88 per cent and 29.99 per cent respectively and open boll locule damage was 17.22 per cent and 18.05 per cent respectively [14].

Table 2: Pink bollworm adult moth /trap catches

Standard week	Farmer 1	Farmer 2	Farmer 3	Farmer 4	Farmer 5	Average	Rainfall (in mm)	Temp Min	Temp max	R.H Morning	R.H Evening
35	5.25	9.5	3.8	6.5	7.8	6.57	2.2	26.4	34.8	43.8	87.9
36	6.65	9.2	5.3	6.15	10	7.46	0.0	27.0	37.6	33.0	70.2
37	3	2.05	3.65	3.3	1.15	2.63	6.8	24.6	39.1	34.5	95.2
38	1	1.1	1.45	3.4	1.75	1.74	1.0	24.9	35.1	50.1	97.6
39	2.55	2	2.3	2.85	1.75	2.29	0.0	25.1	36.7	39.0	100.0
40	1.55	1.8	1.75	1.5	1.15	1.55	0.6	24.6	36.4	40.3	100.0
41	1.35	1.1	1.8	0.9	1.35	1.3	0.0	25.2	36.7	28.7	81.0
42	0	0	0	0	0	0	4.9	24.2	34.5	48.4	98.9
43	3.05	0.05	0.4	0.15	1.4	1.01	0.0	22.5	34.8	36.9	93.1
44	3.45	0	0	0	5.5	1.79	2.5	23.5	32.8	46.6	93.3
45	17.1	0	0	0	12.85	5.99	0.0	22.9	34.1	47.1	100.0
46	8.9	0	3.6	0	0	2.5	1.5	22.5	32.7	46.1	92.0
47	0	0	0	0	1.65	0.33	0.3	23.7	31.9	52.1	98.8

Pink bollworm adult moth/trap catches: The data presented in Table 2 indicated that the 36th standard week having more adult moth/trap catches.

Correlation analysis between adult moth trap catches with weather parameters indicated that minimum temperature (0.51) showed positive significance and negative significance with evening relative humidity (-0.50).

Regression analysis of data showed influence of weather

parameters on pink bollworm incidence in cotton.
The full model regression equations developed were
Y = -16.340 + (-0.3.08) RF + (-0.467) Min Temp + (1.168) Max Temp + (0.368) Morning RH + (-0.276) evening RH +2.340
Regression analysis of the pink bollworm incidence during August, 2018-November,2018 indicated that all the weather parameters i.e., maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall together influenced pink bollworm incidence to the extent of 44.8 per cent (R^2=0.448).
Studies on pheromone trap adult moth catches of pink bollworm indicated that th early catches of adults noticed during October 2001-2002 and August 2005-2006 with a peak adult emergence (December and January) in the first three years and low from mid October to January in subsequent years [12].

Table 3: Economic analysis of onfarm trial on cotton

Particulars	Yield/ha	Per cent increase in yield over check	Cost of cultivation Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	C:B ratio
IPM module	12	20	70500	60000	1:0.8
Farmer practice	10		74300	50000	1:0.6

*Market price of cotton was Rs. 5000/q

Yield impact
The information regarding the impact of OFT in terms of increase in yield have been presented in table 3.
The data in table 3 revealed that the yield of cotton increased by 20% in OFT plots. Economic performances of cotton under on farm trial are depicted in (Table- 3).

Economic impact
In this study, the economic impact of technology was worked out by calculating total cost of cultivation, gross return, net return and C:B ratio of IPM module followed plot and farmer practice plot. Total cost was calculated by total sum of expenditure of land preparation, seed, irrigation and labour component.
The data in table 3 revealed that the yield of IPM module followed plot was 12q/ha whereas farmer practice plot the yield was 10q/ha.
The economic analysis results revealed that the cotton crop recorded higher returns from IPM module were 60000 Rs ha^{-1} as compared to 50000 Rs ha-^{1}in farmers practice. The C:B ratio in IPM module was 1:0.8 while in farmer practice plot was 1:0.6. IPM module proved beneficial in respect of yield and economics of cotton.
It was evident from the results that C:B ratio of cotton crop in IPM module was higher than the farmer practice. The factor responsible for lower C:B ratio in farmer practice because of non adoption of IPM module for pink bollworm management in cotton crop. However, increase in C:B ratio in treatment plot was due to the adoption of IPM module. Thus, favorable C:B ratio and higher net returns in IPM module proved the economic viability of the assessed technology and convinced the farmers on the utility of technology provided at real farming situation.
Present results are in confirmation with the earlier studies, who reported that the adaptability of IPM module integrated with *Bt* cotton genotypes proved superior by recording least percentage of infestation and higher seed cotton yield with more net returns [11]. In IPM module, documented higher seed cotton yield with gross returns Rs. 41555.71 which was about 9.50 per cent higher than the non IPM module Rs. 37946.98 [2]. Under IPM technology, higher net profit was recorded from Bunny BG-II followed by Nathbaba (Rs. 103905.00/ha). On the contrary net profit in non *Bt* IPM module was more compared to the farmer practice [10].

4. Conclusion
Studies were made on the assessment of integrated pest management module for the management of pink bollworm in cotton during 2018-2019. Lowest per cent rosette flowers (5.6%), green boll damage (8%), open boll damage (17%) was recorded in IPM module over farmers practice of per cent rosette flowers (14%), green boll damage (15%), open boll damage (35%), respectively. During 36th standard week recorded more adult moth/trap catches. Correlation analysis between adult moth trap catches with weather parameters indicated that minimum temperature (0.51) showed positive significance and negative significance with evening relative humidity (-0.50).The full model regression equations developed were Y = -16.340 + (-0.3.08) RF + (-0.467) Min Temp + (1.168) Max Temp + (0.368) Morning RH + (-0.276) evening RH +2.340. Regression analysis of the pink bollworm incidence during August, 2018-November, 2018 indicated that all the weather parameters i.e., maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall together influenced pink bollworm incidence to the extent of 44.8 per cent (R^2=0.448).The economic analysis results revealed that the cotton crop recorded higher returns from IPM module were 60000 Rs ha^{-1} as compared to 50000 Rs ha-^{1}in farmers practice. The C:B ratio in IPM module was 1:0.8 while in farmer practice plot was 1:0.6. IPM module proved beneficial in respect of yield and economics of cotton.
The IPM based practices were found effective in comparison to farmer practice. So, the above said management practices must be followed by the cotton farmers.

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