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Extension Interventions for Enlightening Tribal Farmers for Enhancing Cotton Production in Nalgonda District, Telangana

M. Shankar[1], M. A. Aariff Khan[1], R. V. T. Balazzii Naaik[2] and K. Sumalini[1]

[1]Krishi Vigyan Kendra, Kampasagar, Nalgonda, PJTSAU, Hyderabad (508 207), India
[2]Krishi Vigyan Kendra, Rudrur, Nizamabad, PJTSAU, Hyderabad (503 188), India

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Corresponding shankar.ento2007@gmail.com

0000-0002-0649-0421

ABSTRACT

Cluster Frontline Demonstrations using IPM technologies were conducted on farmer fields' during two consecutive years of both *kharif* (June-November 2017 and 2018) by Krishi Vigyan Kendra, Kampasagar, Telangana State, India. The results revealed that, 16.9% increased cotton yield was observed in demonstration plot (2234.0 kg ha^{-1}) against farmers practice (1910.5 kg ha^{-1}). The average gross returns, net returns, and benefit-cost ratios were higher in the demonstration plot as compared to the farmers' practice. The average cost reduction was (₹ 41402.0 ha^{-1}) in the demonstration plot when compared to farmers' practice (₹ 46190.0 ha^{-1}). Incidence of sucking pests and pink bollworm was low in demonstrations plots and adoption of IPM practices i.e. stem application in cotton at 30 and 45 days after sowing with Monocrotophos and water (1:4) ratio and 60 days after sowing with Imidacloprid and water (1:20) ratio minimize the sucking pests. Further erection of pheromone traps @ 10 ha^{-1} at 45 DAS to monitor pink bollworm population and spraying of need-based plant protection chemicals i.e. Azadirachtin 0.15% EC @ 2.5 l ha^{-1} and Thiodicarb 75% WP @ 1.5 g l^{-1} at early stages and Emamectin benzoate 5% SG @ 0.5 g l^{-1} at later stages effectively controlled pink bollworm. The average extension gap, technology gap, and technology index were 323.25 kg ha^{-1}, 266.25 kg ha^{-1} and 10.65%, respectively. Hence, adoption of IPM technologies play a major role for controlling the pest complex and need arises to adopt and popularize this technology in the cotton farming to mitigate the wider extension gap between improved and farmers' practices.

KEYWORDS: Cotton, CFLD, economics, PBW, sucking pests, technology index, yield

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1. INTRODUCTION

Cotton (*Gossypium hirustum* L.) is the most important commercially cultivated fibre crop after jute in India. It is the backbone the industrial economy and offers direct or indirect employment in the textile industry. It is cultivated in India in an area 13.4 mha with a production 36.5 mbales and productivity 460.0 kg ha^{-1}. In Telangana, it occupies an area of 21.2 lakh ha with a production 54.0 lakh bales with the productivity of 432.0 kg ha^{-1} during 2019-20 (Anonymous, 2020).

Development of technology is an integral part of agricultural research and becomes successful only when farmers adopt them to find it as profitable. Progress in research is communicated to farmers through conduction of frontline demonstrations about the latest technologies (Singh et al., 2007). In extension system, 'Seeing and Believing' and 'Learning by Doing' accomplished through frontline demonstrations that helped Krishi Vigyan Kendra's for effective dissemination of new technologies. CFLDs are a concept of field demonstration developed by ICAR to demonstrate suitable latest crop production technologies and its management practices at farmers' field under supervision of KVK scientists. This will be helpful to have an appropriate technology which may be economically profitable, ecologically sustainable, technically feasible and culturally compatible. KVKs act as "Knowledge and Resource centre" at district level on niche areas of agriculturally and allied sectors to showcase the worthiness of technology (Sharma et al., 2017).

In Nalgonda district, 25% accounting to tribal population (Lambadas) out of which majority are plain tribal population and their main occupation is farming and they are practicing traditional method of cotton cultivation (Patel et al., 2013) without adoption of new technologies viz. stem application to control sucking pest complex, installation of yellow sticky traps to control whitefly, installation of pheromone traps @ 10 ha^{-1} and Azadirachtin 1500 ppm, and novel insecticides to control pink bollworm, hence low yields and net income were realized. Cotton crop is being cultivated in low fertile red (Chalka) soils coupled with indiscriminate use of pesticides resulted in low yields (Srinivasarao et al., 2013). Educating farmers with extension interventions helps to adopt new technologies for increasing yields, net returns, and reducing the cost of cultivation (Raghava and Punnarao, 2013). The adoption of improved technology includes i.e. cultivation of high-yielding varieties/hybrids suitable for various agro-climatic conditions, Integrated Nutrient Management, and Integrated Pest Management, use of bio-fertilizers which helped the farmers in reducing usage of pesticides, cost of cultivation there by increasing crop yields (Ajanta et al., 2019).

Cotton crop attacked by 1326 insect species in all over the world (Hargreaves, 1948) and only 166 insect pests were in India (Puri et al., 1999) and estimated yield losses were ₹ 3,39,660.0 million annually (Dhaliwal et al., 2010). After introduction *Bt*-cotton, incidence of bollworm and insecticide usage was reduced. *Bt*-cotton resistanant to bollworms due to *Bt*-toxins but there is no resistance against sucking pests (Sharma and Pampathy, 2006). In recent years, 33.02% yield losses were observed due to sucking pests (Tukaram et al., 2017). Pink bollworm causes damage on squares, flowers and bolls (Ghosh, 2001; Amin and Gergis, 2006; Roopsingh et al., 2021) and reduction in yield 35-90% in Telangana (Naik et al., 2021). Stem application with Monocrotophos and water (1:4) at 30, 45 days after sowing (DAS) and Imidacloprid and water (1:20) at 60 DAS using with stem applicator at green portion on stem about 6 cm–10 cm, and is a cost effective and eco-friendly technology in cotton for effective control of sucking pests i.e. leaf hoppers, aphids and thrips in cotton (Gaur et al., 1999; Venkanna et al., 2019; Ravi et al., 2019), against aphid in cotton (Ramarao et al., 1998), against sucking pests in okra (Kiranmai et al., 2002), coffee (Kumar et al., 2006).

Low yields in most of the cotton varieties are due to use of spurious seeds, high input costs, indiscriminate use of pesticides and less extension interventions in transfer of technologies (TOT). Therefore, to overcome these problems Krishi Vigyan Kendra, Kampasagar had planned Cluster Frontline Demonstrations with the latest technologies on large scale in an area 100 acres by practicing IPM in cluster approach in cotton during *kharif* (June-November) 2017 and 2018.

2. MATERIALS AND METHODS

One hundred Cluster front line demonstrations (CFLD) were conducted in Nalgonda district Telangana in an area 100 acres during *kharif* (June-November 2017 and 2018) under rainfed situations at Srirampur Thanda and Kapuvarigudem villages. Farmers selection was done critically through surveys, farmers meetings and field diagnostic visits during the cropping period by discussing with farmers on sucking pests, pink bollworm problems, and awareness on Integrated Pest Management practices.

Under IPM package, inputs viz. one cotton stem applicator (plastic pipe inserted with a brush), 250 ml Monocrotophos, 50 ml Imidacloprid, pheromone traps @10 ha^{-1} for monitoring, Azadirachtin 0.15% EC @ 2.5 l ha^{-1}, Thiodicarb 75% WP @ 750 g a.i ha^{-1} and Emamectin benzoate 5 SG @ 250 g a.i ha^{-1} were distributed to each farmer. The intervention of integrated pest management demonstration i.e. method demonstration on stem application in *Bt*-cotton at 30, 45 days after sowing (DAS) with 1:4 ratio Monocrotophos and water, at 60 DAS, 1:20 ratio with Imidacloprid and water for control of sucking pests. To assess pink bollworm incidence and to impose improved technology, pheromone traps @10 ha^{-1} were installed at the time of 45 DAS for monitoring the pest. Spraying of Azadirachtin 0.15% EC @ 2.5 l ha^{-1} and thiodicarb 75% WP @ 750 g a.i. ha^{-1} at the time of early-stage and Emamectin benzoate 5% SG @ 250 g a.i. ha^{-1} at the time of final stage of the crop was done. Regularly agronomic practices were followed for the management of pink bollworm in cotton and insecticides were applied based on Economic Threshold Levels. Details on IPM were presented in Table 1 and the farmers' practice consists of indiscriminate use of pesticides, fertilizers, and non adoption of IPM practices from vegetative to harvesting stage.

Table 1: Details of front line demonstration on IPM in Bt cotton

Sl. No.	Technology/ demonstration	No. of farmers	Total area covered (ha)	Method of application
1.	Stem application in cotton	100	40	1. Stem application with Monocrotophos at 30 and 45 DAS @ 1:4 ratio and Imidacloprid at 60 DAS @ 1:20
				2. Installation of yellow sticky traps @ 10 ha^{-1}
2.	Pink bollworm in cotton	100	40	1. Installation of pheromone traps @ 10 ha^{-1} from 45 Days After Sowing (45 DAS) and continuing till the last picking of the crop.
				2. If Pheromone trap catches exceeds @ 8/day for 3 consecutive days or if 10% rosette flowers or 10% damaged green bolls.
				3. Need based spraying Azadirachtin 0.15% EC @ 5 ml l^{-1} with surf 1 g l^{-1} or sandovit 1 ml l^{-1} and thiodicarb @ 1.5 g a.i l^{-1} at early stage of the crop
				4. Spraying Emamectin benzoate @ 0.5 g a.i. l^{-1} at late stages of the crop
				5. Collection and destruction of rosette flowers

During the cropping period frontline demonstrations, training programs, diagnostic field visits by scientists and Departmental officials from time to time, distribution of leaf lets and brochures, guiding farmers through phone in live programmes, and farmer-scientist interaction meetings etc. were organized to create awareness on improved technologies among the farmers.

Data was collected from all the FLDs as well as practicing farmers on yield, pest incidence i.e. number of leafhoppers, thrips per 3 leaves, percent of rosette flowers, green boll damage, green boll locule damage, open boll damage, and open boll locule damage and economic parameters i.e. gross returns, cost of cultivation, net returns with benefit-cost ratio. All data were pooled and analyzed. Further the extension gap, technology gap, and technology index were estimated (Samui et al., 2000).

Technology gap (kg ha^{-1})=Potential yield (kg ha^{-1})-Demonstrated yield (kg ha^{-1})

Extension gap (kg ha^{-1})=Demonstrated yield (kg ha^{-1})-Farmers' yield (kg ha^{-1})

Technology index (%)=(Potential yield (kg ha^{-1})-Demonstrated yield (kg ha^{-1})×100)/Potential yield (kg ha^{-1})

3. RESULTS AND DISCUSSION

3.1. Yield

The data revealed that, 19.4% increased in cotton yield was obtained in front line demonstration (2300.0 kg ha^{-1}) against farmers' practice (1925.0 kg ha^{-1}) in *kharif* (June-November, 2017). Similarly, 14.3% increased in cotton yield was obtained in demonstrations (2167.5 kg ha^{-1}) over the farmers' practice (1896.0 kg ha^{-1}) during *kharif* (June-November, 2018). Poled data indicated, 16.9% increased in cotton yield in FLDs (2234.0 kg ha^{-1}) over the farmers' practice (1910.5 kg ha^{-1}) (Table 2). Performance of cluster frontline demonstrations for yield and pest incidence was better due to adoption of the latest technologies in IPM fields by motivating farmers through training programs, diagnostic field visits, and farmer-scientist interactions by KVK scientists etc. The present results are in agreement with the findings of many workers (Patel et al., 2013; Undhad et al., 2018; and Venkanna et al., 2019) who reported conduction of CFLDs with improved technologies increased cotton yields.

3.2. Pest incidence

Minimum number of leaf hoppers and thrips 2.4 and 3.1 number per 3 leaves respectively in *kharif* (June-November)

Table 2: Yield performance and economics of cotton under cluster frontline demonstrations and farmers' practice

Year	No. of demos	Yield (kg ha^{-1})		% increase yield over the control	Gross returns (₹ ha^{-1})		Cost of cultivation (₹ ha^{-1})		Net returns (₹ ha^{-1})		B: C Ratio	
		DP	FP		DP	FP	DP	FP	DP	FP	DP	FP
2017	50	2300.0*	1925.0*	19.4	123050.0*	102987.5*	41450.0*	46250.0*	81600.0*	56737.5*	3.0*	2.2*
2018	50	2167.5*	1896.0*	14.3	115961.0*	101450.0*	41354.0*	46128.0*	74608.0*	55321.0*	2.8*	2.2*
Average	50	2234.0	1910.5	16.9	119505.5	102219.0	41402.0	46190.0	78104.0	56029.0	2.9	2.2
t-value	4.77**											
p-value	<0.05											

DP: Demo plot; FP: Farmers' Practice; *: 50 farmers' field mean; **: Significant at $p<0.05$; ***: Non-significant at $p<0.05$; 1 US$= ₹ 69.47 (Average value of the harvesting month for both the years of 2017 and 2018)

2017 being 4.2 and 2.4 number per 3 leaves, respectively during *kharif* (June-November) 2018 in CFLDs as compared to farmers practice 10.5 and 9.0 number per 3 leaves, respectively during *kharif* (June-November, 2017) being 9.1 and 10.5 number per 3 leaves, respectively during *kharif* (June-November, 2018). The average leafhoppers and thrips 3.3 and 2.75 number per 3 leaves, respectively was noticed in the demonstration plot whereas in farmers' practice 9.8 and 9.75 number per 3 leaves, respectively during both seasons (Table 3). The incidence of sucking pests was low due to stem application in cotton in demonstration plot as compared to farmers' practice in both seasons. The yield increase in demonstrations was due to the adoption of IPM practices i.e. stem application at 30 and 45 DAS with 1:4 ratio of Monocrotophos and water and 1:20 ratio with imidacloprid and water at 60 DAS for controlling sucking pests. The stem application in cotton reduced 3 sprayings for management of sucking pests and an amount of ₹ 1890/- was saved on insecticides and safe to natural enemies. Adoption of IPM practices in cotton reduced incidence of sucking pests and conserved of natural enemies (Anjanta et al., 2019). Similar findings were reported by Kiranmai et al. (2002); Kumar et al. (2006); Venkanna et al. (2019); and Ravi et al. (2019).

The data on the incidence of pink bollworm i.e. percent of rosette flowers, green boll damage, green boll locule damage, open boll damage, and open boll locule damage were 11.0%, 4.5%, 8.0%, 9.0%, and 9.8%, respectively in demonstration plots as compared to farmers' practice (19.0%, 16.0%, 14.0%, 20.5%, and 21.8%, respectively) in *kharif* (June-November, 2017). While in *kharif* (June-November, 2018) the pink bollworm infestation indicated by percent of rosette flowers, green boll damage, green boll locule damage, open boll damage, and open boll locule damage were 5.0%, 6.0%, 5.2%, 8.4%, and 7.4%, respectively in demonstration plots against farmers practice 12.0%, 13.0%, 10.8%, 19.3%, and 20.5%, respectively. The average percent of rosette flowers, green boll damage, green boll locule damage, open boll damage and open boll locule damage observed in demonstration plots were 8.0%,

Table 3: Pest incidence of sucking pests and pink bollworm in cotton

Year	Leaf hoppers		Thrips		Rosette flower (%)		Green boll damage (%)		Green boll locule damage (%)		Open boll damage (%)		Open boll locule damage (%)	
	DP	FP	DP	FP	DP	FP	DP	FP	DP	FP	DP	FP	DP	FP
2017	2.4*	10.5*	3.1*	9.0*	11.0*	19.0*	4.5*	16.0*	8.0*	14.0*	9.0*	20.5*	9.8*	21.8*
2018	4.2*	9.1*	2.4*	10.5*	5.0*	12.0*	6.0*	13.0*	5.2*	10.8*	8.4*	19.3*	7.4*	20.5*
Average	3.3	9.8	2.75	9.75	8.0	15.5	5.25	14.5	6.6	12.4	8.7	19.9	8.6	21.15
t- value	-5.7**		-8.46**		-1.63***		-5.52**		-2.73***		-16.6**		-9.19**	
p- value	0.05		0.05		0.05		0.05		0.05		0.05		0.05	

DP: Demo plot; FP: Farmers' Practice; *: 50 farmers' field mean; **: Significant at $p<0.05$; ***: Non-significant at $p<0.05$

5.25%, 6.6%, 8.7% and 8.6%, respectively as compared to farmers' practice 15.5%, 14.5%, 12.4%, 19.9% and 21.15%, respectively (Table 3). The pink bollworm incidence was low due to installation of pheromone traps @ 10 ha^{-1}, spraying of Azadirachtin 0.15% EC @ 5 ml l^{-1}, Thiodicarb 75% WP @ 1.5 g a.i. l^{-1} at flowering stage, and emamectin benzoate 5 SG @ 0.5 g a.i. l^{-1} at boll formation to harvesting stage. Similar results were obtained by Santhosh et al. (2009); Unahad et al. (2018); and Roopsingh et al. (2021).

3.3. Economic impact

The economic impact of technology was calculated by total gross returns, cost of cultivation, net returns and benefit-cost ratio of demonstration plot and farmers' practice. In *kharif* (June-November, 2017) high gross returns (₹ 1,23,050.0 ha^{-1}), low cost of cultivation (₹ 41,450.0 ha^{-1}), high net returns (₹ 81,600.0 ha^{-1}) and high benefit-cost ratio (3.0:1) were obtained in demonstration plot as compared to farmers' practice with gross returns (₹ 1,02,987.5 ha^{-1}), cost of cultivation (₹ 46,250.0 ha^{-1}), net returns (₹ 56,737.5 ha^{-1}) and benefit-cost ratio (2.2:1). High gross returns of ₹ 1,15,961.0 ha^{-1}, low cost of cultivation of ₹ 41,354.0 ha^{-1}, high net returns of ₹ 74,608.0 ha^{-1} with benefit-cost ratio 2.8:1 were observed in demonstration plots against gross returns ₹ 1,01,450.0 ha^{-1}, cost of cultivation of ₹ 46,128.0 ha^{-1}, net returns of ₹ 55,321.0 ha^{-1} and benefit-cost ratio 2.2:1 in farmers' practice during *Kharif* (June-November, 2018). Pooled data revealed that, high gross returns and net returns of ₹ 1,19,505.5 ha^{-1} and ₹ 78,104.0 ha^{-1}, respectively with benefit-cost ratio 2.9:1 in demonstration plot as compared to farmers' practice ₹ 1,02,219.0 ha^{-1}, ₹ 56,029.0 ha^{-1}, and 2.2:1, respectively. The average cost reduction was ₹ 41,402.0 ha^{-1} in the demonstration plot when compared to farmers' practice ₹ 46,190.0 ha^{-1} during both seasons (Table 2). The results revealed that the high net returns and benefit-cost in the demonstration plot is due to the adoption of IPM practices with suggestions of KVK, scientists' from time to time achieved higher yields and higher net returns as compared to farmers' practice. Similar economic benefits owing to adoption of latest IPM practices were also reported by Patel et al. (2013); Unahad et al. (2018); Venkanna et al. (2019); and Anjanta et al. (2021).

Extension yield gap, technology gap, and technology index were 375.0 kg ha^{-1} and 271.5 kg ha^{-1}, 200 kg ha^{-1} and 332.5 kg ha^{-1}, 8.0% and 13.3%, respectively during *kharif* (June-November) 2017 and 2018, respectively in cluster front line demonstrations. The average extension gap, technology gap, and technology index were 323.25 kg ha^{-1}, 266.25 kg ha^{-1}, and 10.65%, respectively during the study period (Table 4). The extension gap and technology gaps were higher in the demonstration plots might be attributed to the adoption of the latest IPM practices. The higher technology gap depends on the identification and use of farming situation coupled with specific interventions may lead to increased productivity. Technology index shows the feasibility of the technology in the farmers' field and higher value of the technology index, the feasibility, is low. These results were on par with Patel et al. (2013) in *Bt*-cotton, and technology, extension gap and technology index higher in mustard (Shivan et al., 2020).

Table 4: Details of extension gap, technology gap and technology index under cluster frontline demonstrations in cotton

Year	Extension gap (kg ha^{-1})	Technology gap (kg ha^{-1})	Technology index (%)
2017	375.00	200.00	8.00
2018	271.50	332.50	13.30
Average	323.25	266.25	10.65

4. CONCLUSION

Adoption of IPM practices in cotton through CFLDs maximized yield with high gross returns, net returns, and benefit-cost ratio in demonstration plots against farmers' practice. A yield increase of 16.9% was observed in CFLDs over the farmers practice and incidence of sucking pests and pink bollworm was low in demonstration plots compared to farmers practice. Hence, farmers must enlightened on improved IPM practices for yield sustainability.

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