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Impact of Cotton Development Programme on Adoption of Recommended Bt-Cotton Cultivation Practices

Gurdeep Singh[1]*, Pritpal Singh[2], G. P. S. Sodhi[3], Ranvir Singh[1] and Kulwant Singh[1]

[1]Krishi Vigyan Kendra, Khokhar Khurd, Mansa-151505, Punjab, India
[2]Farm Advisory Service Centre (FASC), Bathinda-151501, Punjab, India
[3]Directorate of Extension Education, P.A.U., Ludhiana-141001, Punjab, India
*Corresponding author email id: gurdeepsingh@pau.edu

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ABSTRACT

The study assessed the impact of Cotton Development Programme (CDP) on the adoption of recommended management practices in Bt-cotton (*Gossypium hirsutum* L). The data was collected from 210 farmers over a period of six years to make quantitative comparison with baseline data collected during the initial three year period (2013-15) from Mansa district of Punjab. The adoption of crop management practices in Bt-cotton in terms of recommended Bt-cotton hybrids, seed rate, fertilizer dose, use pattern of potassium nitrate (KNO_3; 13:00:45) and reduction in insecticide use was investigated to quantify the impact of the CDP in the study region. These results revealed that area under recommended Bt-cotton hybrids increased from a meager 15.2 per cent to as high as 89 per cent; adoption of recommended use nitrogenous fertilizers increased by 15.1 per cent; and the productivity of Bt-cotton enhanced by 138 per cent during this period. Therefore, it could be concluded that implementation of CDP was successful in the revival of Bt-cotton cultivation which was severely affected due to severe attack of sucking pests particularly by whitefly (*Bemisia tabaci*) during *kharif*-2015.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is one of the important crops grown in India, USA, China and Pakistan, contributing 85 per cent to the total global cotton production (Singh & Kairon, 2013; Singh et al., 2021a). In India, cotton is grown on 9.2 million ha (mha) area, constituting 27 per cent of worlds' cotton area with the highest production in the world (Niranjan, 2017). Indeed, the social security and rural livelihood of vast majority of people are greatly dependent upon cotton crop through its production, picking, transportation, trade, processing and marketing etc. (Singh & Sharma, 2016). Therefore, it is important to increase the production and productivity of cotton, especially in traditionally cotton growing areas of arid and semi-arid regions (Singh et al., 2018a). Although after the introduction of Bt-cotton in India, the production levels were significantly increased and country became the leader amongst the top cotton producers (Singh et al., 2021a), but still productivity remained low compared with other cotton growing countries (Kranthi et al., 2011). Among different yield governing factors, the attack of bollworms and sucking pests decreased in Bt-cotton production resulting increase in productivity (Singh et al., 2021c), but the infestation of sucking pests increased after 2006-07, which has caused indiscriminate use of pesticides (Sabesh et al., 2014; Singh et al., 2021b).

Worldwide, various extension programmes have been launched to enhance adoption of recommended practices among farmers for yield improvement and poverty reduction (Godtland et al., 2003; Asfaw et al., 2012; Mariano et al., 2012; Singh et al., 2021b). The implementation of Integrated Cotton Development Programme (ICDP) launched during 1970s in India helped increasing cotton

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production through increased area under cotton (Sabesh et al., 2014). Government of India (GOI) launched technology mission on cotton in 2000 with the objective of improving the cotton production through improved seeds and integrated nutrient and insect-pest management. In Punjab, 'Cotton Development Program (CDP)' was launched by the state Government during 2016 to reduce the cost of cultivation, while enhancing productivity of Bt-cotton crop in the state. The CDP was launched after the devastation of Bt-cotton in the state amid epidemics of cotton whitefly (*Bemisia tabaci*) during 2015. The CDP was initiated with the objective of promoting scientific cultivation practices among farmers to revive Bt-cotton. During the period between 2015-17, numerous training programmes and awareness programmes were organized and field trials/ demonstrations were conducted to make the cotton growers aware regarding recommended Bt-cotton hybrids, optimum seed rate, fertilizer doses and application of recommended insecticides based on economic threshold level (ETL). The farmers were made aware for different site-specific component technologies to be followed for the management of whitefly and yield maximization.

It is perceived that the success of any extension programmes is judged by the adoption of improved practices and the productivity enhancement; therefore, institutions all over the world are giving importance to evaluation of the extension programmes. Therefore, the present study was conducted to assess the impact of CDP in terms of adoption of recommended Bt-cotton growing practices for productivity enhancement in Mansa district of south-western Indian Punjab.

METHODOLOGY

The present study used the quasi-experimental design. For the purpose of impact assessment primary source of data was used during the study. Firstly, three major cotton growing blocks viz; Jhunir, Sardulgarh and Budhlada blocks were purposively selected. From the each selected block seven major cotton growing villages were randomly selected, thus total 21 villages were selected. From each village 10 cotton growing farmers were randomly selected making total sample size of 210 farmers. The baseline survey was conducted during 2013-15 by including data from 210 randomly selected Bt-cotton growers in the study region. A data were again collected from same set of sampled farmers post implementation of CDP during 2016-18. For the purpose of data collection, a structured interview schedule was developed and implemented after pre-testing on 20 non-respondents farmers. Data were entered in Microsoft Excel spreadsheets (MS Office-2010) and were analysed using mean and percentage distribution of respondents among different categories. Impact was assessed in terms of increase in area under Bt-cotton, increase in adoption of recommended sowing time, seed rate, fertilizer use and decrease in insecticide use along with increase in seed cotton yield.

RESULTS AND DISCUSSION

Area under Bt-cotton in the study region decreased continuously from 2013 to 2015. The decrease in area under Bt-cotton was 13.1, 10.4, and 4.2 per cent during 2013,2014 and 2015, respectively. The decrease in area under cotton crop was ascribed to high incidence of sucking pests, low market prices and high picking costs of Bt-cotton. Area under Bt-cotton further decreased drastically by 37.9 per cent during 2016 (Table 1), due to epidemic of whitefly infestation that has led to almost complete failure of crop in cotton belt of Punjab during 2015 (Kranthi et al., 2015; Singh & Sharma, 2016; Singh et al., 2018a). However, after implementation of CDP, area under Bt-cotton among sampled farmers increased by 15.9 per cent during 2017 and further 20.6 per cent during 2018 (Table 1). Area under Bt-cotton increased during 2018 due to enhanced yield and improved produce quality owing to increase in knowledge level of farmers and adoption of recommended practices by farmers.

Impact of CDP on adoption of recommended Bt-cotton hybrids and management practices

During 2013-15, only ~15 per cent farmers were cultivating recommended Bt-cotton hybrids, while 89 per cent were cultivating Bt-cotton hybrids without adopting recommended package of practice. It exhibited a dramatic shift with reverse trend during 2016-18 showing that 78-100 per cent of farmers shifted towards adoption of recommended Bt-cotton hybrids. Severe infestation of cotton whitefly (*Bemisia tabaci*) and leaf curl virus (CLCuD) on non-recommended Bt-cotton hybrids during 2015 and the concentrated efforts by the extension workers, thereafter contributed towards increased adoption of recommended Bt-cotton hybrids in the study region.

To escape the crucial growth phase of cotton which is more conducive for the infestation of sucking pests, the farmers were advised to complete sowing of Bt-cotton well before 15th of May. The sowing on only 8.6 per cent of the total area under Bt-cotton was delayed during 2013-15, which was almost same (8.1%) after the implementation of CDP. Thus, number of farmers adopting timely sowing of cotton crop was 91.4 per cent after the implementation of CDP. Pulakkatu-Thodi et al., (2014) has reported lesser attack of insect pests, better boll quality and higher yield in early sown cotton crop. Results showed that after implementation of CDP, number of farmers using recommended seed rate increased by ~14 per cent (Table 2). Number of farmers using higher seed rate also increased due to problem of soil salinity and/ or sodicity, poor quality irrigation water and unfavorable climatic conditions. Gurjar et al., (2018) has reported unfavorable climatic conditions as major constraints in crop production. However, the number of farmers using lower seed rate than the recommended decreased from

Table 1. Change (Δ) in area under Bt-cotton before and after the implementation of CDP in south-western, Punjab

Particulars	Before implementation of CDP*			After implementation of CDP		
	2013	2014	2015	2016	2017	2018
Area (ha)	148.9	106.2	147.0	127.6	154.8	185.7
Δ in area (ha)	-13.1	-10.4	-4.2	-37.9	15.9	+20.6

*Field survey 2013-2018

Table 2. Impact of CDP on adoption of recommended Bt-cotton cultivation practices in south-western, Punjab (*N*=210)

Particular	Number of farmers		Difference (%)
	Before implementation of CDP	After the implementation of CDP	
Recommended Bt-cotton hybrids	32 (15.2%)†	187 (89.0)	73.8
Timely sowing (Between 15th April - 15th May)	192 (91.4%)	191 (90.9)	-0.5
Seed rate (g ha^{-1})			
< recommended	11 (5.2)	4 (1.9)	-63.6
Recommended (2850±450 g ha^{-1})	176 (83.8)	201 (95.7)	14.2
> recommended	5 (2.4)	23 (11.0)	-78.3
Fertilizer-N (kg N ha^{-1})			
< recommended	58 (27.6)	49 (23.3)	-15.5
Recommended (112.5-187.5 kg N ha^{-1})	139 (66.2)	160 (76.2)	15.1
> than recommended	13 (6.2)	1 (0.5)	-92.3
Fertilizer-P (kg P_2O_5 ha^{-1})			
Recommended (Nil)	70 (33.3)	91 (43.3)	30.0
Un-recommended (12.5-25)	140 (66.7)	119 (56.7)	-15.0
Fertilizer-K (kg K_2O ha^{-1})			
Recommended (Nil)	120 (57.1)	142 (64.5)	18.3
Un-recommended (0-25)	90 (42.9)	78 (35.5)	-24.4
Fertilizer-Zn ($ZnSO_4.7H_2O$)			
25 kg ha^{-1}	82 (39.0)	94 (44.8)	14.6
KNO_3 (13-00-45) sprays (kg ha^{-1})			
0-1 sprays (0-5 kg ha^{-1})	94 (44.8)	73 (34.8)	-22.3
2-3 sprays (10-15 kg ha^{-1})	100 (47.6)	117 (55.7)	17.0
4 sprays (20 kg ha^{-1})	16 (7.6)	20 (9.5)	25.0

†Figures in parenthesis are percentages

~5.0 to 1.9 per cent, a decrease of 63.6 per cent. The proportion of farmers applying recommended dose of fertilizer-N (112.5-187.5 kg ha^{-1}) increased from 66.2 to 76.2 per cent after implementation of CDP an increase of 15.1 per cent, so there was a significant impact of CDP on use of recommended fertilizer-N use (Table 2). The proportion of Bt-cotton farmers applying fertilizer-N less than the recommended dose decreased from 27.6 to 23.3 per cent a decrease of 15.5 per cent. Similarly, the proportion of farmers applying fertilizer-N more than recommended dose also decreased post implementation of CDP.

Farmers were advised to skip application of fertilizer-P in Bt-cotton, if recommended dose of fertilizer-P has been applied to previous winter (*rabi)* season crop. The number of farmers skipping application of fertilizer-P to Bt-cotton increased from 33.3 to 43.3 per cent (Table 2). Farmers were also advised to apply fertilizer-K to Bt-cotton based on the soil test report. The soils with available-K of 137.5 kg ha^{-1} are considered deficient. In K deficient soils, farmers were advised to apply K @ 30 kg ha^{-1}. Number of farmers skipping fertilizer-K to Bt-cotton increased from 57.1 to 64.5 per cent an increase of 18.3 per cent, after implementation of CDP in the study region. Farmers were also advised to apply $ZnSO_4.7\ H_2O$ @ 25 kg ha^{-1} to Bt-cotton. The data revealed that there was an increase in number of farmers applying zinc fertilizer after implementation of CDP (Table 2). However, still large number of farmers needs guidance regarding importance of balanced fertilizer use. Farmers were advised for four foliar application of potassium nitrate (KNO_3: 13-00-45) to Bt-cotton for yield gain and quality improvement. Over the years, farmers perceived the importance of foliar application of KNO_3 in terms of yield enhancement and economic gains. The proportion of farmers applying 2-3 foliar sprays of KNO_3 increased from 47.6 to 55.7 per cent. However, the proportion of farmers applying the recommended four foliar applications of KNO_3 was increased from 7.6 to 9.5 per cent. Although, the farmers realized the significance of KNO_3 on crop performance, yet shortage of labor and spray costs were the major constraint for this marginal increase in the proportion of farmers and in adoption of recommendation of 4 sprays.

Impact of CDP on insecticide use

The most important component of CDP was the promotion of integrated pest management (IPM) strategies among the cotton growers and this was realized by the drastic reduction in insecticide use after the implementation of CDP (Table 3). It was found that average number of sprays decreased from 5.9 to 4.9 after the implementation of CDP due to application of insecticides based at ETL. The number of farmers applying lesser number of sprays increased, while those applying higher number of sprays decreased. Data showed that 15.2 per cent of the farmers applied seven insecticidal sprays before CDP, while only 10 per cent of the farmers applied same number of sprays after implementation of CDP. Similarly, the proportion of farmers applying eight insecticide sprays decreased from 8.1 to 4.3 per cent (Table 3).

The use of recommended insecticide formulations also increased from 50.5 to 78.6 per cent, while proportion of farmers using mixture (cocktail) of insecticides decreased from 41.0 to 29.5 per cent (Table 4). After 2017 onwards, the use of *neem* based insecticides was recommended to the farmers as a preventive measure for the management of sucking pests. The proportion of farmers using *neem* based insecticides were 30.4 per cent after implementation of CDP.

Table 3. Decrease in use of insecticides after implementation of CDP in south-western Punjab (*N*=210)

Number of pesticide sprays	Number of farmers		Difference (%)
	Before the implementation of CDP	After the implementation of CDP	
1 spray	0 (0.0)†	3 (1.4)	-
2 sprays	3 (1.4)	7 (3.3)	1.3
3 sprays	15 (7.1)	31 (14.7)	106.7
4 sprays	37 (17.6)	39 (18.6)	5.4
5 sprays	44 (21.0)	58 (27.6)	31.8
6 sprays	29 (13.8)	37 (17.6)	27.6
7 sprays	32 (15.2)	22 (10.5)	-31.2
8 sprays	17 (8.1)	9 (4.3)	-1.4
>8 sprays	33 (15.7)	4 (1.9)	-87.9
Average no. of sprays per farmer	5.9	4.9	-1.0

†Figures in parenthesis are percentages

Table 4. Use of recommended insecticides by Bt-cotton growers after implementation of CDP in south-western Punjab (India) (*N*=210)

Insecticide use	Number of farmers		Difference (%)
	Before the implementation of CDP	After the implementation of CDP	
Un-recommended	94 (44.8)†	55 (26.2)	-41.5
Recommended	106 (50.5)	165 (78.6)	55.7
Mixture of insecticides	86 (41.0)	62 (29.5)	-14.8
Neem based spray	0 (0.0)	64 (30.4)	-

†Figures in parenthesis are percentages

Impact of CDP on productivity of Bt-cotton

Mean seed cotton yield increased from 17.7 to 24.4 q ha^{-1} (an increase of 138%) after the implementation of CDP. The lowest seed cotton yield in 2015 was due to severe infestation of cotton whitefly and resulted in almost complete failure of Bt-cotton in some fields. The increase in yield was ascribed to the adoption of recommended Bt-cotton hybrids, appropriate fertilizer management practices and IPM technologies. Kumar et al., (2012) reported productivity of Bt-cotton crop improved as result of implementation of IRM program in Haryana state of India.

CONCLUSION

These results showed that there was significant increase in number of farmers adopting recommended Bt-cotton cultivation practices after the implementation of CDP. The results of long term study (2013-18) showed that CDP was successful in convincing farmers to reduce insecticide use, adopt balanced fertilizer use and increased seed cotton yield despite of several site-specific and general constraints. The pesticide load for the management of sucking pests in Bt-Cotton was significantly reduced after the implementation of CDP. The CDP was also successful as farmers were able to manage incidence of whitefly and Bt cotton yield also increased in the study area. The CDP was also successful in gaining the much needed confidence among farmers for increasing the area under Bt-cotton.

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