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**RESEARCH ARTICLE :**

# Socio-economic correlates of insecticide usage by the Bt cotton farmers of Punjab

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**SUMMARY :** The present study was undertaken to analyse insecticide use pattern by the Bt cotton farmers of Punjab state. A total 150 cotton farmers were selected from three major cotton growing districts of the Punjab state. It was found that most of the respondents felt in the age group of 43 to 56 years and were matriculates. Nearly half of the respondents possessed the medium size of operational land holding. Majority of the farmers were found to have medium innovativeness and scientific orientation regarding Bt cotton cultivation. Study further revealed that on average, respondents had applied 8.91 insecticide sprays for management of various insect-pests on Bt cotton crop during the year 2015, incurring an expenditure of Rs. 8485/ha. Operational land holding and gross annual income were found to be positively and significantly related to total number of insecticide sprays whereas education level of the respondents had negative and significant relationship with total number of insecticide sprays used for management of insect-pests in Bt cotton.

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**KEY WORDS :**
Bt cotton, Insecticide use, Information sources, Chemical control, Adoption

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## BACKGROUND AND OBJECTIVES

Cotton crop plays a important role in economy of the country and is also known as 'white gold' and 'king of fibres'. India, as a major cotton producer in the world is having the largest area under cotton and is also the second largest consumer of cotton. India accounts for approximately one fourth of the world's total cotton area. It contributes about 30 per cent of the gross domestic product of Indian agriculture (Sundaram *et al.*, 1999). Cotton occupies an area of 119.78 lakh hectares in India with a production of 398 lakh bales in the year 2013-14. However, India`s average yield of cotton is 566 kg/ha as compared to worlds average productivity of 766 kg/ha (Anonymous, 2015a). This considerable gap in the yield may be attributed to various factors such as lack of irrigation facilities, pest problems and factors characterized by resource-poor and small-scale farming system. Apart from rainfed conditions, another major limiting factor is damage caused by infestation of various pests, especially the bollworm complex *i.e.* American bollworm (*Helicoverpa armigera*), pink bollworm (*Pectinophora gossipiella*) and spotted bollworm (*Earias vittella*). Sucking pests such as whitefly (*Bemisia tabaci*),

aphids (*Aphis gossypii*), and jassid (*Amrasca bigutulla*) are also a problem in terms of direct damage to the crop and the transmission of viruses. Farmers incur large expenditure on insecticides every year for the management of these insect pests. Cotton consumes about 45 per cent of total pesticides used in Indian agriculture and this indiscriminate use of pesticides resulted in the building up of resistance in many insect-pests of cotton crop and thus increased the cost of cultivation (Guillaume *et al.*, 2008).

Bt cotton produces an insecticidal protein from the naturally occurring soil bacterium known as *Bacillus thuringiensis*. This protein is toxic for bollworms. Global adoption of Bt cotton has risen noticeably from 0.8 million hectares in its year of introduction 1996 to 5.7 million hectares in the year 2003. Genetic Engineering Approval Committee (GEAC) on 26 March, 2002 gave approval for Bt cotton in India for the central zone (Maharashtra, Gujarat and Madhya Pradesh) and south zone states *i.e.* Andhra Pradesh, Karnataka and Tamil Nadu (Choudhary and Gaur, 2010). Commercial cultivation of Bt cotton for northern zone including Punjab state was approved in the *Kharif* season of year 2005. Bt cotton records for more than 93 per cent of adoption, out of total cotton grown in India within few years of its arrival (Kranthi, 2011).

Cotton crop occupies an important place in agricultural scenario of Punjab. It is the main *Kharif* crop of south-western districts of the state *i.e.* Bathinda, Mansa, Fazilka (part of erstwhile Ferozepur), Muktsar, Faridkot, Barnala and Sangrur. Cotton crop was cultivated on an area 472 thousand hectares with average productivity of 16 quintal per hectare under irrigated conditions in Punjab in the year 2012. (Anonymous, 2015b). Two types of Bt cotton seeds were released in the Punjab state namely bollgard I and bollgard II. Bollgard I (BG I) carries single gene known to provide resistance to American bollworms, spotted bollworms and pink bollworms whereas Bollgard II (BG II) carries two genes known for providing resistance to tobacco caterpillar in addition to American bollworms, spotted bollworms and pink bollworms. BG II seeds are mainly used at present all over the Punjab due to its additional benefits (Khadi, 2015). This study attempts to analyse the information sources utilization and adoption of chemical control practices by the Bt cotton growers of Punjab state.

## RESOURCES AND METHODS

The study was conducted in the Punjab state. Three major cotton growing districts of the Punjab state *i.e.* Bathinda, Mansa and Fazilka were selected purposively because these were having their maximum area under Bt cotton cultivation. The five villages were selected from each of three districts (Bathinda, Mansa and Fazilka) and 10 cotton farmers from each village were taken for the study. Thus, a total sample of 150 farmers from 15 villages was selected for the present study. An interview schedule was developed to collect the data from respondents. The interview schedule was pretested on 20 non-sampled farmers to remove the ambiguities. Data were collected personally visiting the study area and interviewing the farmers. Proper precautions were taken to ensure unbiased response of the respondents by providing them necessary instructions after explaining the objectives of study. The Bt cotton crop was affected severely during the year 2015 due to widespread attack of whitefly in the entire north zone, so data related to economic parameters were also collected for the year 2014. After the data collection, the data were tabulated on master sheet for further processing. The tables were prepared according to the objectives of the study. The data were analyzed with the help of range, frequency, percentage, mean, standard deviation and multiple linear regression.

Multiple linear regression attempts to model the relationship between two or more explanatory variables and a response variable by fitting a linear equation to observed data. Every value of the independent variable x is associated with a value of the dependent variable y. Multiple regression technique was used to examine the influence of different factors on the number of sprays used for various insect pests in the Bt cotton.

The following regression equation was used for the analysis:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots\ldots\ldots\ldots + \beta_n X_n$$

where,

Y = Dependent variable

X = Independent variables

$\beta_0$ = Regression constant

$\beta_1, \beta_2, \beta_3 \ldots \beta_n$ = Regression co-efficients

## OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well

as discussions have been summarized under following heads:

**Socio-personal characteristics of Bt cotton growers:**

The data in Table 1 indicate that age of the respondents varied from 28-70 years. More than one third of the respondents *i.e.* 37.33 per cent and 36.00 per cent of respondents belonged to the age group of 43-56 years and 28-42 years, respectively while 26.67 per cent of them were in the age group of 57-70 years. It was also observed that 26.00 per cent of the respondents were educated upto primary and more than one third (36.00%) of the respondents were matriculate.

It was also observed that 68.00 per cent of the respondents had family size of 3-6 members followed by 28.00 per cent of them had 7-10 members in the family. It was also found that nearly half of the respondents (48.67%) were having medium (4-10 ha) operational land holding. More than one fifth *i.e.* 22.00 per cent and 21.33 per cent of the respondents had large (>10 ha) and semi-medium (2-4 ha) sized operational land holdings, respectively. While 6.67 per cent of the respondents had small (1-2 ha) and very few (1.33%) had marginal (<1 ha) operational land holding. All of the respondents used canal water as their main source of irrigation. The data in the Table 1 also reflect that the respondents were highly experienced in cotton cultivation, as 44.00 per cent of the respondents were having 25 to 38 years of cotton cultivation experience. It was also found that 58 per cent of the respondents were having gross annual income less than 12.73 lakhs and 22.67 per cent of them were having gross annual income ranging from 12.73 to18.38 lakhs.

**Innovativeness :**

It referred to the degree to which an individual is earlier in adopting Bt cotton cultivation than other members of the social system. It was measured with modified scale of Supe and Singh (1976) on three point continuum *i.e.* agree, undecided and disagree with scores of 3, 2 and 1, respectively. The scores were categorized into three categories low, medium and high. The data in the Table 2 reveal the innovativeness of farmers regarding

**Table 1 : Distribution of respondents according to their socio-personal characteristics** **(n=150)**

| Sr. No. | Socio-personal characteristics | Category | Frequency | Percentage |
|---|---|---|---|---|
| 1. | Age (in years) | 28 – 42 | 54 | 36.00 |
| | | 43 – 56 | 56 | 37.33 |
| | | 57 – 70 | 40 | 26.67 |
| 2. | Education | Upto Primary | 39 | 26.00 |
| | | Middle | 25 | 16.67 |
| | | Matric | 54 | 36.00 |
| | | Senior Secondary | 20 | 13.33 |
| | | Graduation and above | 12 | 8.00 |
| 3. | Family size (members) | 3 – 6 members | 102 | 68.00 |
| | | 7 – 10 members | 42 | 28.00 |
| | | 11 – 14 members | 6 | 4.00 |
| 4. | Operational land holding (in ha) | Marginal (< 1 ha) | 2 | 1.33 |
| | | Small (1 – 2 ha) | 10 | 6.67 |
| | | Semi-medium (2 – 4 ha) | 32 | 21.33 |
| | | Medium (4 – 10 ha) | 73 | 48.67 |
| | | Large (> 10 ) | 33 | 22.00 |
| 5. | Source of irrigation* | Electric motor | 67 | 44.67 |
| | | Canal | 150 | 100.00 |
| | | Diesel pump | 87 | 58.00 |
| 6. | Experience of cotton cultivation | 10 to 24 years | 52 | 34.67 |
| | | 25 to 38 years | 66 | 44.00 |
| | | 39 to 52 years | 32 | 21.33 |
| 7. | Gross annual income (in lakhs) | < 12.73 | 87 | 58.00 |
| | | 12.73 – 18.38 | 34 | 22.67 |
| | | > 18.38 | 29 | 19.33 |

*Multiple response

various operations or techniques involved in Bt cotton cultivation. It was found that 58.67 per cent of respondents were having medium innovativeness. Only 16 per cent farmers were found to be highly innovative, whereas nearly one fourth (25.33%) of respondents were found to be less innovative regarding the Bt cotton cultivation practices.

**Table 2 : Distribution of respondents according to their innovativeness (n=150)**

| Sr. No. | Innovativeness | f (%) |
|---|---|---|
| 1. | Low ( 10 – 13 ) | 38 (25.33%) |
| 2. | Medium ( 14 – 17 ) | 88 (58.67%) |
| 3. | High ( 18 – 21 ) | 24 (16.00%) |

It can be concluded that demonstrations or training camps can be organized regarding Bt cotton to build up the faith of farmers regarding Bt technology and shifting up their innovativeness to higher level as reported by Gujar and Padaria (2012). However, these findings are contrary with the that of Singh (2014) as majority of his cotton growing respondents were possessing low innovativeness.

**Scientific orientation :**

It refers to the degree to which respondents use scientific approach in cotton cultivation. It was measured with modified scale of Supe and Singh (1976) on three point continuum *i.e.* agree, undecided and disagree with scores of 3, 2 and 1, respectively. The scores were categorized into three categories low, medium and high. About 42.67 per cent of the respondents were found with medium scientific orientation regarding Bt cotton while 30.00 per cent of them had low scientific orientation (Table 3). Only 27.00 per cent of the respondents had high scientific orientation. It was because most of the respondents were satisfied with benefits of the scientific farming and were keeping the scientific approach towards the farming. As majority of the respondents agree that Bt cotton varieties give better yield and results than old non-Bt varieties and such new technologies should be adopted for progress in the farming.

**Table 3 : Distribution of respondents according to their scientific orientation (n=150)**

| Sr. No. | Scientific orientation | f (%) |
|---|---|---|
| 1. | Low ( 9 – 12 ) | 45 (30.00%) |
| 2. | Medium ( 13 – 16 ) | 64 (42.67%) |
| 3. | High ( 17 – 20 ) | 41 (27.33) |

**Insecticide use pattern :**

The data set placed in the Table 4 reveal the number of insecticide sprays used for management of various insect pests of cotton crop during the years 2014 and 2015. As Bt cotton is resistant to the bollworms, it can be observed that very less number of insecticides were used for the bollworm complex in both the years 2014 and 2015. On an average, respondents had applied a total 6.20 insecticide sprays on cotton crop in the year 2014 which further increased to 8.91 in the year 2015 due to severe attack of whitefly on Bt cotton. It can be seen from Table 4 that average number of insecticide sprays for management of bollworm complex decreased from 0.84 to 0.55 from the year 2014 to 2015 whereas slight increase in number of insecticide sprays was observed for the management of tobacco caterpillar in the year 2015.

However, a steep rise in insecticide usage for management of sucking pests was observed in the year 2015. Average number of insecticide sprays for management of whitefly rose from 1.90 to 4.11 from the year 2014 to 2015, thereby increasing the insecticide expenditure from Rs. 2116/ha to Rs. 4819/ha in the corresponding years. Farmers were found to be spraying their cotton crop two to seven times for management of whitefly during the year 2015. Similarly average number of insecticide sprays increased to 2.36 in the year 2015 from 1.78 in the preceding year.

Increase in number of insecticide sprays on cotton crop also led to the increase in expenditure occurred by the farmers and it rose to Rs. 8485/ha in the year 2015 from Rs. 5327/ha in the preceding year. The respondents revealed that Bt cotton helped in reducing the number of insecticide sprays as compared to number of sprays used on non-Bt cotton. But due to widespread attack of whitefly all over the Punjab state, the number of insecticide sprays was again increased in the year 2015 to a significant level. The findings are similar to that of Kapoor *et al* (2011) and it was stated that average number of sprays per hectare decreased with arrival of Bt cotton (Mayee and Choudhary, 2013). With the advent of Bt cotton, the average number of sprays is reduced from 5.28 to 3.37 in Maharashtra and 8.11 to 4.27 in the case of Andhra Pradesh (Gandhi and Namboodhiri, 2006). The major challenge for Bt cotton nowadays is attack of sucking pests on this crop. It is evident from the fact that most of the pesticides used in Bt cotton

crop in the year 2015 were against the sucking pests such as whitely. Peshin *et al.* (2007) also indicated the increase in incidence of secondary pests and discussed that the undesirable, indirect and unanticipated consequences of innovation go together, as do the desirable, direct and anticipated consequences. Susceptibility of Bt cotton hybrids cultivated in north zone to sucking pests was also stated by Kranthi *et al.* (2011).

**Spraying of chemicals :**

The data in the Table 5 show that majority of respondents (40.00%) used labour for spraying the chemicals, whereas 38 per cent of the farmers sprayed the chemicals along with labour and 21.33 per cent of the respondent sprayed themselves or with the help of family members without hiring the additional labour. Similar results were also reported by Lalitha *et al.* (2017) in the study conducted on labour use for insecticide application in the cotton crop in Gujarat and Maharashtra state. Majority of the respondents (78%) had used the engine or battery operated power sprayers by the single person. The tractor operated power sprayers were used by nearly 58 per cent of the respondents, whereas 20 per cent farmers also used the manually operated knapsack hand spray pumps. Strengthening of community programmes about the safe use of pesticides can minimize the risks of intentional and unintentional pesticide poisoning of farmers and primarily agricultural workers may reduce the pesticide poisoning (Sunil *et al.*, 2014).

**Relationship between socio-economic variables of farmers with total number of insecticide sprays used in Bt cotton crop** :

Data pertaining to Table 6 reveal that education level ($X_2$) of the respondents had significant relationship with number of insecticide sprays used for management of insect-pests on Bt cotton having p-value 0.035 with a negative co-efficient value of -0.08. It establishes that

**Table 4 : Insecticide usage and expenditure incurred by the Bt cotton farmers during the year 2004 and 2015** **(n=150)**

| Insect-pest | 2014 | | 2015 | |
|---|---|---|---|---|
| | Avg. no. of sprays | Avg. Exp. (Rs ha$^{-1}$) | Avg. no. of sprays | Avg. Exp. (Rs ha$^{-1}$) |
| Bollworm complex | 0.84 ( 0 – 2 )* | 1003.67 | 0.55 ( 0 – 3 )* | 691.00 |
| Tobacco caterpillar | 1.68 ( 1 – 3 )* | 1829.50 | 1.88 ( 1 – 4 )* | 2081.50 |
| Whitefly | 1.90 ( 1 – 3 )* | 2116.50 | 4.11 ( 2 – 7 )* | 4819.50 |
| Jassids and other sucking pests | 1.78 ( 1 – 2 )* | 378.50 | 2.36 ( 1 – 4 )* | 891.30 |
| Total | 6.20 | 5327 | 8.91 | 8485 |

* Figures in parentheses denotes the range of number of sprays done by a single farmer

**Table 5 : Distribution of respondents according to person spraying chemicals and sprayers used** **(n=150)**

| Sr. No. | Particular | f* | % |
|---|---|---|---|
| 1. | Spraying person | | |
| | Self and family member | 32 | 21.33 |
| | Only labour | 61 | 40.66 |
| | Both self and labour | 57 | 38.00 |
| 2. | Sprayers used | | |
| | Knapsack hand sprayer | 31 | 20.67 |
| | Engine/Battery operated sprayer | 117 | 78.00 |
| | Tractor operated sprayer | 87 | 58.00 |

*Multiple response

**Table 6 : Regression analysis of selected socio-economic variables of farmers with total number of insecticide sprays used in Bt cotton crop**

| Sr. No. | Particulars | Co-efficients | S.E | p-value |
|---|---|---|---|---|
| 1. | Age ($X_1$) | 0.00 | 0.01 | 0.887$^{NS}$ |
| 2. | Education level ($X_2$) | -0.08 | 0.04 | 0.035* |
| 3. | Operational land holding ($X_3$) | 0.88 | 0.41 | 0.034* |
| 4. | Innovativeness ($X_4$) | 0.07 | 0.06 | 0.308$^{NS}$ |
| 5. | Scientific orientation ($X_5$) | -0.02 | 0.05 | 0.758$^{NS}$ |
| 6. | Gross annual income ($X_6$) | 0.00 | 0.00 | 0.042* |
| 7. | Farming experience ($X_7$) | 0.03 | 0.03 | 0.193$^{NS}$ |

* indicates significance of value at P=0.05 level , NS= Non significant

less educated farmer would go for more number of sprays and *vice-versa*. Operational land holding ($X_3$) was found to be positively and significantly related to total number of sprays with p-value 0.034 which implies more the operational land holding, more will be the number of sprays and vice-versa. Gross annual income ($X_6$) also found to be in significant relationship with number of sprays with p-value 0.042 which showed that gross annual income was directly proportional to number of sprays. Findings were in line with that of Bondarwad *et al.* (2010). production technology Data in table also showed that results for variables like age ($X_1$), innovativeness ($X_4$), scientific orientation ($X_5$), farming experience ($X_7$) were found to be non significant to the total number of sprays used in Bt cotton crop having p-values 0.887, 0.308, 0.758, 0.193, respectively. The regression equation for these relationships is depicted as under:

$$Y = 6.98 - 0.08X_2 + 0.88X_3 + 0.07X_4 - 0.02X_5 + 0.03X_7$$

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## REFERENCES

Anonymous (2015b) *Agricultural handbook*. 6 pp. Punjab Agricultural University, Ludhiana, Punjab, India.

**Bansod, S.K.**, Katole, R.T. and More, G.B. (2016). Extent of adoption of integrated pest management practices by the brinjal growers and its correlates. *Agric. Update,* **11**(4): 390-393.

**Bondarwad, S.P.**, Wangikar, S.D. and Deshmukh, N.D. (2010). Correlation of adoption of Bt cotton production technology. *Agric. Update,* **5** (3 & 4): 300-302.

**Choudhary, B.** and Gaur, K. (2010). *Bt Cotton in India: A country Profile.* ISAAA Series of Biotech Crop Profiles. ISAAA, Ithaca, New York, USA

**Gandhi, V.** and Namboodhiri, N.V. (2006). *The adoption and economics of Bt Cotton in India: Preliminary results from a study*. IIMA Working Paper No. 2006-09-04, pp 1-27.

**Guillaume, P.**, Mehta, P. and Sengupta, D. (2008). IFPRI discussion paper on Bt cotton and farmer suicide in India. Retrieved from http://www.ifpri.org/publication/Bt-cotton-and-farmer-suicides-india on 23-07-16.

**Gujar, L.R.** and Padaria, R.N. (2012). Farmer perception and constraint in adoption Bt cotton technology. *J. Comm. Mob. Sustain Dev.,* **7** : 45-49.

**Kapoor, C.J.**, Verma, J.R. and Bhati, D.S. (2011). Bt cotton in Rajasthan: problems and prospects. *J. Prog. Agric.,* **2** : 33-38.

**Khadi, B.M.** (2015). Biotech cotton: Issues for consideration. Retrieved from https://www.icac.org /tis/ regional_networks/ documents/asian/papers/khadi.pdf on 31.03.2015.

**Kiresur, V.R.** and Ichangi, M. (2011). Socio-economic impact of Bt cotton - A case study. *Agric. Eco. Res. Rev.,* **24** : 67-81.

**Kranthi, K.** (2011). *10 years of Bt in India.* C.f. 10 Years of Bt Cotton: False Hype and Failed Promises. Retrieved from https:/ /indiagminfo.org/wp-content/.../Bt-Cotton-False-Hype-and-Failed-Promises-Final.pdf.

**Kranthi, K.R.**, Venugopalan, M.V., Sabesh, M. and Yadav, M.S. (2011). *Vision 2030*. Central Institute for Cotton Research, Nagpur,India.

**Lalitha, N.,** Ramaswami, Bharat and Viswanathan, P.K. (2017). India's experience with Bt Cotton: Case studies from Gujarat and Maharashtra. Retrieved from http://www.isid.ac.in/ ~bharat/Research/tripp.pdf.

**Mayee, C.D.** and Choudhary, B. (2013). *Adoption and Uptake Pathways of Biotech Cotton among Farmers in Selected Cotton Growing Villages of Maharashtra, Andhra Pradesh and Punjab in India*, Executive Summary, Indian Society for Cotton Improvement (ISCI), Mumbai.

**Peshin, R.**, Dhawan, A.K., Vatta, K. and Singh, K. (2007). Attributes and socioeconomic dynamics of adopting Bt-cotton. *Econ. Polit. Weekly,* **42** (52):73–80.

**Singh, A.** (2014). Adoption gaps in recommended production techniques of Bt cotton (*Gossypium hirusutum* L.) in Muktsar district of Punjab. M.Sc. Thesis, Punjab Agricultural University, Ludhiana, PUNJAB (INDIA).

**Supe, S.V.** and Singh, S.N. (1976). *Dynamics of rational behaviour of Indian farmers*. New Heights Publisher, New Delhi, pp. 60 and 141.

**Sundaram, V.**, Basu, A.K., Iyer, K., Narayanan, S.S. and Rajendran, T.P. (1999). *Handbook of cotton in India Indian*. Society for Cotton Improvement. Mumbai, India.

**Sunil, M.**, Kaur, G. and Vishwakarma, G.S. (2014). Effects of environmental pesticides on the health of rural communities in the Malwa region of Punjab, India: A review. *Human & Ecological Risk Assessment: An Internat. J.*, **20** (2): 366-387.

## WELIOGRAPHY

Anonymous (2015a) Area, production and productivity of cotton in India. Retrieved from http://cotcorp.gov.in/ statistics.aspx on 24.03.2015.

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