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A COMPARATIVE FARM LEVEL CULTIVATION OF CONVENTIONAL AND BT COTTON

Sajjad A. MUHAMMAD

Institute of Molecular Biology and Biotechnology (IMBB), The University of Lahore, Pakistan, Phone: +92 308 7467839, E-mail: forestandfrost@yahoo.com

Corresponding author e-mail: forestandfrost@yahoo.com

Abstract

Pakistan is an agricultural country whereas cotton crop is the main cash crop. The crop has been problematic due to a multitude of pests incurring a large proportion of pesticide consumption in the country. Bt cotton although being cultivated in Pakistan for many years has been formally commercialized recently. The farmers' false perception about control of all insect pests as well as a boost in yield favoured the rapid adoption of this technology. There is a need to establish a comparative quantified economic advantage from this technology.The present study gives an overview of pesticide consumption, yield increase and monetary benefits in conventional and Bt cotton on per acre basis.

Key words**:** *Bt cotton, economic advantages, pest control.*

INTRODUCTION

Approximately 1300 species of chewing and sucking insects cause 10-40 percent yield loss of the cotton crop worldwide. An excessive use of pyrethroids and dry weather boost up the pest infestation.

Major sucking insects include aphids (*Aphis gossypii* L.) whitefly (*Bemisia tabaci* L.), jassid (*Amrasca biguttula biguttula* (Ishida.)), thrips (*Thrips tabaci* L.), and mites (*Tetranychus urticae* L.). Aphids cause honey dew production during sap sucking which stain the boll cotton lint thus reducing its quality cotton. Photosynthesis and plant growth is affected. Thrips, whitefly and jassid cause damage from June till October. The vegetative growth of the plant is affected which may result in shedding of the leaves, flower buds, bolls and immature boll opening. The fibre quality may also be compromised due to sever insect attack.

Lately, mealy bug (*Phenacoccus solani*) which has always been a minor pest has caused significant yield loss and the majority of existing cotton varieties is susceptible to it [1].

The complex of chewing insects causes the major yield loss and annually there has been a 20-30% loss of yield due to various bollworms. American bollworm (*Helicoverpa armigera* Hub.), spotted bollworm (*Earias insulana* Boisd*, Earias vittella* Fab.), army bollworm (*Spodoptera litura* Fab. *& Spodoptera exigua* Hub.) and pink bollworm (*Pectinophora gossypiella* Saunders) are the main insect pests of cotton in Pakistani fields. The bollworms' intensity period ranges from the end of July till mid October although the army bollworm is persistent in the field till harvest. The chewing insects' complex is the major cause of pesticide consumption. The lepidopteran larvae consume leaves, bolls and meristematic tissue. The control has been difficult due to egg laying and susceptibility period of the target insects being confined to early instars of development. Leaf curl, stunting, boll rot, bacterial blight, and root rot are main plant diseases of cotton in Pakistan. Cotton leaf curl is the major disease and causes upto 40% loss of yield [3]. Whitefly is the transmitter of this pathogenic virus. The leaves are curled, darkened and drop early thus the rate of photosynthesis along with a reduced crop growth, occurs.

It is estimated that in Pakistan, farmers spend US$300 million on pesticides annually, of which more than 80% is used on cotton, especially for the bollworms [5]. Total pesticides consumption in Pakistan during 2009-10 was 98,623 metric tons whereas in Punjab it has increased from 14,000 tons in 1990 to over 58,000 tons in 2010 (Fig. 1).

At the beginning of the decade 2000, many farms obtained Bt cotton seed from local agriculture market and private seed companies. The germplasm was mainly imported illegally from India,China and Australia [4]. Due to high cost of pesticides and the false notion about the Bt technology i.e. Bt cotton is effective against all types of pests-both chewing and sucking complex,the unapproved Bt cotton seed has been readily available in the market since 2002. The Bt cotton was formally commercialized in 2011. The following study was carried out to determine the comparative economic efficiency of Bt and conventional cotton crop under similar agronomic conditions on a local farm to determine cost effectiveness and on behalf of the Bt technology.

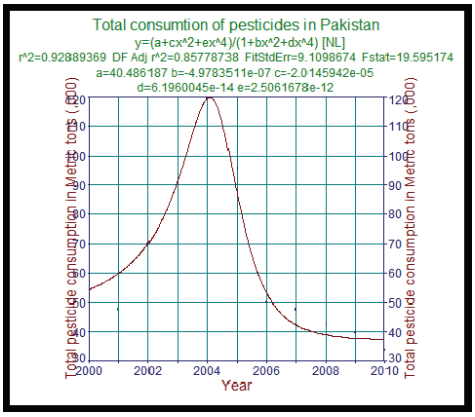

Fig. 1. Trend of Pesticide consumption in Pakistan
Source: DG Pest warning Punjab Agriculture Department [2]

MATERIAL AND METHOD

The comparative economic efficiency of Bt cotton was analyzed at Hassan Mahmood Qureishi farms (HQ), Multan (Pakistan).The farm is situated on Old Dunya Pur road, Multan and is a leading progressive farm in the area.The total farm area is 325 acres. Cotton is the major crop culture during Kharif (summer) season and covers 175 acres whereas the rest of the area is reserved for vegetables, fodder and minor crops. Irrigation is applied both from tubewell and canal sources. Bt cotton was gradually spread for cultivation and at the farm the area under Bt cotton has gradually increased over the years (Fig. 2).

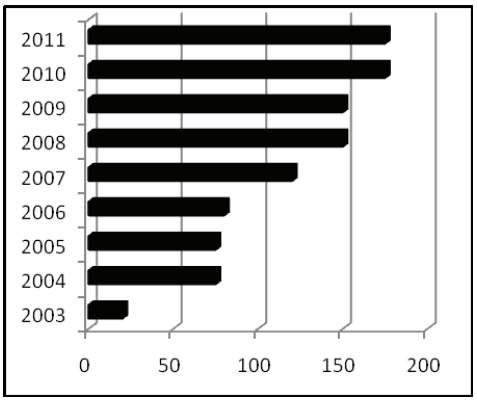

Fig. 2. The evolution of area reserved for Bt cotton cultivation at HQ farms

In the present study, Bt and conventional cotton was grown on adjacent one acre plots on ridges and similar agronomic practices were adopted from sowing till harvest. Bt cotton seed was purchased from a registered seed supplier company and the Bt plot was surrounded by a refuge conventional cotton on an area comprising 20% of the Bt plot size.

RESULTS AND DISCUSSIONS

It must be mentioned here that the Bt cotton is not designed for a default yield increase and there is no promise of productivity enhancement due to Bt seed only. But, the Bt plant has a season long resistance against main lepidopterans i.e. *Helicoverpa armigera* and *spodoptera litura*. The efficacy against *Pectinophora gossypiella* and *Earias insulana*, *Earias vitella* is not much promising, although significant control is there. The need to spray may arise depending upon the refuge size; level of pest infestation; vigour of parent genome; availability of nutrients especially nitrogen and the extent of expression of Bt toxin at the specific growth period.

The cost benefit table has been generated from the year round data for expenses on various operations on both plots to highlight key areas of differences for expenses and net profit/acre (Table 1, 2 & 3).

Table 1. Per acre cost of production (conventional cotton)
Yield 42 Mds per Acre, Crop Duration: 9 Months Monetary unit is Rs

Operation / Activity	**Operation / Inputs expense description**	**Quantity/Dose**	**Unit rate**	**Operation cost**	**Total cost**
Land Preparation	i) Cultivator	3	500	1500	2000
	ii) Drill / Planter	1	500	500	
Farm Yard Manure	Manuring	5 trolleys	500	2500	2500
Seed Sowing	i) Seed (Hybrid Variety)	8 kg	500	4000	4500
	ii) Seed Treatment (Confidar)	1 kg	500	500	
Fertilizer	i) NP	2 bags per acre	2450	4900	17050
	ii) SOP	1bages per acre	3600	3600	
	Urea	2 bags per acre	1700	3400	
	iii) CAN	3 bages per acre	1450	4350	
	iv) Transportation	8 bags	50	400	
	v) Labour Charges of Application	8 bags	50	400	
Weed Control	i) Weedicide (Dual Gold)	600 ml per acre	500	500	4000
	ii) Hoeing (Tarphali)	2	1500	3000	
	iii) Thinning	one thinning	500	500	
Irrigation	i) Water Rates (For 1Year)	5	1000	1000	7400
	ii) Additional Tube Well Irrigation	4	1200	4800	
	iii) Labour Charges for Irrigations	9	150	1350	
	iv) Water Channel Cleaning	1	250	250	
Insect - Pest Control	i) Pesticides	9 sprays	500	4500	5850
	ii) Labour Charges for Spray	9 sprays	150	1350	
Picking & Harvesting	i) Picking Labour Charges	42 maunds	200	8400	11340
	ii) Transportation	42 maunds	20	840	
	iii) Deduction for Inert Matter (1Kg for 1 Mds)	42 kg	2500/50kg	2100	
Land & Managerial Expenses	i) Land Rent (For 1 Year)	25000	25000	25000	25800
	ii) Manager Salary (For 100 acre @ 10000/- per month)	---------	800	800	
Total income	----------	42 maund	2500	----------	105000

Table 2. Per acre cost of production (BT Cotton)
Yield 50 Mds Per Acre Crop Duration: 10 Months

Operation / Activity	Operation / Inputs expense description	Quantity/Dose	Unit rate	Operation cost	Total cost
Land Preparation	i) Cultivator	3	500	1500	2000
	ii) Drill / Planter	1	500	500	
Farm Yard Manure	Manuring	5 trolleys	500	2500	2500
Seed Sowing	i) Seed (Hybrid Variety)	8 kg	500	4000	4500
	ii) Seed Treatment (Confidar)	1 kg	500	500	
Fertilizer	i) NP	2 bags per acre	2450	4900	18750
	ii) SOP	1bages per acre	3600	3600	
	Urea	3 bags per acre	1700	5100	
	iii) CAN	3 bages per acre	1450	4350	
	iv) Transportation	8 bags	50	400	
	v) Labour Charges of Application	8 bags	50	400	
Weed Control	i) Weedicide (Dual Gold)	600 ml per acre	500	500	4000
	ii) Hoeing (Tarphali)	2	1500	3000	
	iii) Thinning	one thinning	500	500	
Irrigation	i) Water Rates (For 1Year)	5	1000	1000	11450
	ii) Additional Tube Well Irrigation	7	1200	8400	
	iii) Labour Charges for Irrigations	12	150	1800	
	iv) Water Channel Cleaning	1	250	250	
Insect - Pest Control	i) Pesticide	6 sprays	500	3000	3900
	ii) Labour Charges for Spray	6 sprays	150	900	
Picking & Harvesting	i) Picking Labour Charges	50 maunds	200	10000	14125
	ii) Transportation	50 maunds	20	1000	
	iii) Deduction for Inert Matter (1Kg for 1 Mds)	50 kg	2500	3125	
Land & Managerial Expenses	i) Land Rent (For 1 Year)	25000	25000	25000	25800
	ii) Manager Salary (For 100 acre @ 10000/- per month)	---------	800	800	
Total income	----------	50 maund	2500	----------	125000

Table 3. A comparative economic evaluation of the two crop systems

Economic difference for the two crop types	BT Cotton	Conventional Cotton	Difference for BT culture (+/-)
Total expenditure	87025	80440	+6585
Total expenditure /40 Kg	1741	1915	-174
Net Income	37975	24560	+13415
Net Income /40 Kg	760	585	+175

In comparison with conventional crop culture, Bt cotton required higher amount of nitrogenous fertilizer for its more flourishing growth and long crop season. More irrigations were subsequently applied to Bt crop. As Bt cotton gave promising control of chewing pest complex, fewer pesticide sprays were applied while the yield was 8 maunds/acre higher. Picking and harvesting charges increased consequently. The net income for each maund from Bt crop was significantly more than its comparator crop (Fig. 3).

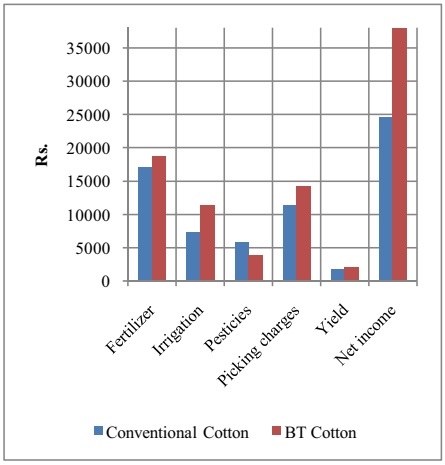

Fig. 3. Important agronomic factors contributing to higher economic return from the BT crop

The results prove an economic benefit for growing of Bt cotton Several studies have examined the extent of the impact of Bt cotton on yield and pesticide use in developing countries. Although results differ across countries and seasons, these studies are in agreement that Bt cotton helped farmers in controlling yield losses, reducing pesticide expenditures, and hence increasing their incomes. According to a study conducted by Qaim et al. in Argentina in 2003, it was revealed that Bt cotton can reduce the pesticide application rates up to half thus contributing to agronomics and sustainability of agriculture in a given country. There are a number of secondary benefits associated with the reduction in insecticide (non biological) use, which include enhanced populations of beneficial insect and wild life, reduced potential runoff of insecticides; and improved safety for farm workers by reducing potential exposure. Similarly in China, recently it has been reported that plantation of Bt crops is also beneficial in reducing pests of nearby non-Bt crops. Although the Bt crop is economically beneficial at the moment; however, the non-compliance of refuge crop may result in a surge in resistance in target insect pests and a return to bio-pesticides in the future.

CONCLUSIONS

The Bt cotton causes less financial burden on the farmers. However it may cause hidden environmental costs. The majority of the farmers planting Bt cotton are unaware of the refuge crop culture along with Bt crop. Moreover, the long duration of the Bt crop might delay the upcoming cultivation time of the following crop and a reduction in its yield.All this necessitates the selection of a proper sowing time for Bt culture allowing a sufficient delay for the next crop.

There is a need to incorporate a biotechnological solution in Bt cotton genome to prevent losses from sucking insects' complex. The farmers must be educated to plant refuge crop along with Bt crop culture to prevent a resistance build up in target insect pests.

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