



COMPARATIVE RESISTANCE OF Bt. AND NON-Bt. COTTON VARIETIES AGAINST PINK BOLLWORM, *PECTINOPHORA GOSSYPIELLA* SAUND LARVAE

I. A. Rajput¹, T. S. Syed¹, I. Khatri¹ and A. M. Lodhi²

¹Department of Entomology, ²Department of Plant Protection, Sindh Agriculture University, Tandojam, Pakistan

ABSTRACT

Pink bollworm (PBW) *Pectinophora gossypiella* is an imperative insect pest of cotton which is not only responsible for yield reduction but also damages the lint quality by causing yellow spots on fiber that results in reduced market value of cotton. Although, the Cry protein in Bt. cotton provides an insecticidal activity against many lepidopterous insect species but evolved resistance of bollworms particularly PBW has raised an importance in the field of Entomology. Therefore, this study with comparative varietal preference of PBW on Bt and non. Bt was designed. A total number of 12 different cotton varieties were included (IR-901, MNH-886, NIBGES-3701, CIM-602, FH-142, TRAZAN1, CRIS-129, CRIS-134, CRIS-342, CRIS-613, FH-1000 and FH-901) in the study to investigate the infestation of PBW at district Sanghar, Sindh, Pakistan. In results, the maximum (1.30 ± 0.18) attack of larvae was recorded in IR-901 and minimum (1.15 ± 0.18) in CIM-602 Bt. cotton varieties. However, in non-Bt. cotton, maximum population (1.42 ± 0.19) of PBW larvae was observed on FH-901 and minimum (1.15 ± 0.24) on CRIS-129. It was concluded from the study that the attack of PBW was observed on all cotton varieties less discrimination in preference by pest was investigated on Bt, and non-Bt. varieties of cotton. Therefore, a depth research is further required to know the reasons of resistance evolved by pest on Bt. cotton varieties.

Keywords: cotton varieties, Bt. and non-Bt., *Pectinophora gossypiella*

INTRODUCTION

Cotton (*Gossypium hirsutum* L.), a major and cash crop of Pakistan, it is known as "white gold" it plays a crucial role in source of foreign exchange earnings in the country. Pakistan is the fourth largest cotton producer in the world, the third largest exporter of raw cotton, the fourth largest consumer of cotton and the largest exporter of cotton yarn with 1.3 million farmers (FAO, 2015). In Pakistan cotton is cultivated on 3.2 million hectares, covering 72% of the cultivated area in Punjab, 27% in Sindh and less than 1.0 % in Khyber Pakhtunkhwa and Balochistan (Khan, 2017). The crop contributes 1.0% in total GDP of the country and 5.1% in agriculture value addition.

In Pakistan, per hectare yield of cotton crop is very low as compared to other cotton producing countries. Besides other factors insect invasion is one of the serious threats to low yield. More than 1326 insect pest species have been reported attacking cotton all over the world (Atwal, 2002) and about 93 insect and mite pests have been reported to attack cotton crop in Pakistan (Yunus and Yousaf, 1979). The cotton crop is attacked by many insect pests, but PBW is one of the most noxious pests which do not only because 20-30% crop loss, but also affects the quality of crop. PBW is an imperative cotton pest all over the world, particularly in Asian and African countries along with reduction in yield, as well as damaging the lint quality (Ahmed, 2013). The introduction of high yielding seed and early maturing cotton varieties like NIAB-78 (Punjab) and Bt. varieties which replaced the most local cotton varieties of Sindh. On the same time the climatic conditions of Sindh province also favored the pest tremendously on these cotton varieties particularly PBW. In addition, an application of highly toxic synthetic pesticides further increased the pest resistance. The pink bollworm resistance was first observed after the introduction of Bt. cotton in 1996 (Simmons *et al.*, 1998). In Asia, China and India are major Bt. cotton growing countries. More than 50% of the total cotton area is genetically modified (James, 2008) and playing alarming situations in the world. Only few studies have been previously conducted in Sindh province and present scenario demands to carry out a depth study in the connection. Therefore, present study was designed to observe the effect of PBW on Bt. and non-Bt. cotton varieties that are locally cultivated in Sindh province.

MATERIALS AND METHODS

The studies were carried out to investigate the varietal preference of pink bollworm *P. gossypiella* Saund. on Bt. and non-Bt. cotton varieties at district Sanghar, Sindh, Pakistan. In non-Bt. cotton varieties, CRIS-134, CRIS-342, CRIS-129, CRIS-613, FH-1000 and FH-901 were grown. However, in Bt. cotton IR-901 (*Cry1Ac*), FH-142 (*Cry1Ac*), MNH-886 (*Cry1Ac*), NIBGE IR 3701 (*Cry1Ac*), CIM-602 (*Cry1Ac*) and Tarzan-1 (*Cry1Ac*) were grown. The seed of all these varieties was purchased from Central Cotton Research Institute (CCRI) Sakrand and Agriculture Research Institute (ARI) Tandojam. All these varieties were sown on 15th April in the area of ½ acre on ridges for two consecutive years (2015 and 2016). The net plot size was 17.5 × 20 sqft and had five separate rows inside it, however the distance from row-to-row and plant-to-plant was 30 and 11 inches, respectively. All these cotton plots were managed through recommended agronomic practices and no application of any pesticide was made on experimental plots. All these grown cotton varieties were started to observe pink bollworm population after 40 days of sowing until harvest at fortnightly interval. Therefore, the ten plants of each block of each variety were randomly selected to collect the data from five fruiting bodies such as squares, flowers and green bolls from top, middle and bottom portions. The observed bolls were further dissected with sharp knife to record the number of possible larvae inside it.

Statistical analysis

The total numbers of 12 selected cotton varieties (Bt. and non-Bt.) were sown under RCBD (Randomized Complete Block Design) layout with 60 blocks and

five replications. The data were subjected to analysis using analysis of variance (ANOVA) through SAS Statistics software. The means were further separated by Tukey's HSD (Highest Significant Differences) at $p < 0.05$.

RESULTS AND DISCUSSION

The results given in Table 1 show the larval population of pink bollworm on flowers of Bt. and non-Bt. cotton varieties during 2015 and 2016. The data indicated that the maximum overall mean larval population of 1.26 ± 0.18 was recorded on FH-142 in Bt. cotton varieties. However, on non-Bt. cotton varieties, the maximum overall mean larval population was 1.45 ± 0.20 on FH-901.

Table 1. Larval population of *P. gossypiella* in rosette flowers of Bt. and non-Bt. cotton varieties during 2015 and 2016

Varieties		Number of larvae/ 20 plants		
		2015	2016	Mean \pm S.E
Bt.	IR-901	1.41 \pm 0.19abc	0.97 \pm 0.16 abc	1.19 \pm 0.17
	MNH-886	1.28 \pm 0.20abc	1.16 \pm 0.22 abc	1.22 \pm 0.21
	NIBGE3701	1.32 \pm 0.23abc	1.12 \pm 0.16 abc	1.22 \pm 0.19
	CIM 602	1.23 \pm 0.19 bc	1.01 \pm 0.16 bc	1.12 \pm 0.17
	FH-142	1.49 \pm 0.20a	1.03 \pm 0.16 a	1.26 \pm 0.18
	TARZAN1	1.31 \pm 0.18abc	0.98 \pm 0.20 abc	1.15 \pm 0.19
Non-Bt.	CRIS-129	1.31 \pm 0.18abc	0.92 \pm 0.15 abc	1.12 \pm 0.16
	CRIS-134	1.35 \pm 0.20 ab	0.94 \pm 0.14 ab	1.15 \pm 0.17
	CRIS-342	1.31 \pm 0.18abc	1.10 \pm 0.15 abc	1.20 \pm 0.16
	CRIS-613	1.29 \pm 0.20 ef	1.00 \pm 0.17 a	1.15 \pm 0.18
	FH-1000	1.19 \pm 0.18 c	0.96 \pm 0.15 c	1.07 \pm 0.16
	FH-901	1.90 \pm 0.25 bc	1.00 \pm 0.15 bc	1.45 \pm 0.20

The results presented in Table 2 indicate the larval population of PBW on floral squares of Bt. and non-Bt. cotton varieties during 2015 and 2016. The data indicated that the maximum overall mean larval population of 1.12 ± 0.17 was recorded on NIBGE-3701 in Bt. cotton varieties. However, on non-Bt. cotton varieties, the maximum overall mean larval population was 1.08 ± 0.17 on CRIS-342.

The results given in Table 3 showed the larval population of PBW on green bolls of Bt. and non-Bt. cotton varieties during 2015 and 2016. The data indicated that the maximum overall mean larval population of 1.71 ± 0.22 was recorded on IR-901 in Bt. cotton varieties. However, on non-Bt. cotton varieties, the maximum overall mean larval population was 1.89 ± 0.23 on FH-901.

The Table 4 showed the pooled larval population of pink bollworm on flower, floral squares and green bolls of Bt. and non-Bt. cotton varieties during 2015 and 2016. The data indicated that the overall maximum population 1.30 ± 0.18 of larvae was recorded in IR-901, however minimum population 1.15 ± 0.18 was recorded in CIM-602 among all Bt. varieties. Nevertheless, overall maximum

population 1.42 ± 0.19 of larvae was recorded in FH-901, however minimum population 1.15 ± 0.24 was recorded on CRIS-129 among all non-Bt. varieties of cotton.

Table 2. Larval population of *P. gossypiella* in floral squares of Bt. and non-Bt. cotton varieties during 2015 and 2016

Varieties		Number of larvae/ 20 plants		
		2015	2016	Mean \pm S. E
Bt.	IR-901	1.20 ± 0.18 bcde	0.82 ± 0.16 bcde	1.01 ± 0.17
	MNH-886	1.22 ± 0.18 ab	0.94 ± 0.14 ab	1.08 ± 0.16
	NIBGE3701	1.19 ± 0.19 abc	1.05 ± 0.15 abcd	1.12 ± 0.17
	CIM 602	0.98 ± 0.18 bc	0.80 ± 0.16 ef	0.89 ± 0.17
	FH-142	1.21 ± 0.19 a	0.90 ± 0.14 a	1.06 ± 0.16
	TARZAN1	1.10 ± 0.18 bcde	0.76 ± 0.14 cde	0.93 ± 0.32
Non-Bt.	CRIS-129	1.06 ± 0.21 abc	0.73 ± 0.15 ef	0.89 ± 0.18
	CRIS-134	1.21 ± 0.19 abc	0.85 ± 0.15 abc	1.03 ± 0.17
	CRIS-342	1.22 ± 0.18 abc	0.95 ± 0.17 abc	1.08 ± 0.17
	CRIS-613	0.99 ± 0.20 ef	0.77 ± 0.15 cde	0.88 ± 0.17
	FH-1000	0.88 ± 0.15 c	0.96 ± 0.15 f	0.92 ± 0.15
	FH-901	0.96 ± 0.18 bc	0.88 ± 0.14 ef	0.92 ± 0.16

Table 3. Larval population of *P. gossypiella* in green bolls of Bt. and non-Bt. cotton varieties during 2015 and 2016

Varieties		Number of larvae/ 20 plants		
		2015	2016	Mean \pm S. E
Bt.	IR-901	1.71 ± 0.24 c	1.72 ± 0.20 c	1.71 ± 0.22
	MNH-886	1.85 ± 0.21 c	0.96 ± 0.20 c	1.40 ± 0.20
	NIBGE3701	1.83 ± 0.23 c	1.22 ± 0.19 c	1.52 ± 0.21
	CIM 602	1.65 ± 0.21 c	1.24 ± 0.19 c	1.45 ± 0.20
	FH-142	1.82 ± 0.25 c	1.31 ± 0.21 c	1.56 ± 0.23
	TARZAN1	1.83 ± 0.23 c	1.11 ± 0.19 c	1.47 ± 0.21
Non-Bt.	CRIS-129	1.76 ± 0.24 c	1.10 ± 0.18 c	1.43 ± 0.21
	CRIS-134	2.13 ± 0.26 ab	1.24 ± 0.19 ab	1.68 ± 0.23
	CRIS-342	2.25 ± 0.24 a	1.31 ± 0.21 a	1.78 ± 0.23
	CRIS-613	1.96 ± 0.24 ab	1.34 ± 0.20 ab	1.63 ± 0.22
	FH-1000	1.74 ± 0.25 bc	1.37 ± 0.20 ab	1.56 ± 0.23
	FH-901	2.17 ± 0.25 ab	1.61 ± 0.20 ab	1.89 ± 0.23

Pink bollworm is a major insect pest of cotton crop and its population has been observed on all fruiting bodies of crop. The present study showed the evidence of their population of PBW with significant damage on different selected non Bt. cotton as well as Bt. cotton varieties. In cotton growing seasons of 2015 and 2016, the population of PBW almost remained same on both Bt. and non-Bt. varieties. However, their population was observed 2015 as compared to 2016. In Bt. cotton varieties the FH-142 was more affected on flowers by PBW larvae and

less affected variety was CIM 602 in 2015. MNH-886 was more effected variety and IR-901 was less affected during 2016. In non-Bt. cotton varieties, FH-901 was more affected and FH-1000 variety was less affected in 2015. CRIS-342 was more affected and CRIS-129 was less affected variety in 2016. The attack of PBW on floral squares in Bt. cotton and non-Bt. varieties was also found in both years. Whereas in Bt. cotton variety: MNH-886 was more affected and CIM-602 was less affected variety in 2015 and NIBGE-3701 was more affected and Tarzan1 was less affected in 2016. In non-Bt. cotton variety more affected variety was CRIS-342 and less effected variety was FH-1000 in 2015. FH-1000 was more affected variety and CRIS-129 was less affected variety in 2016. The pink bollworm population on green bolls in Bt. cotton varieties results was more affected variety was MNH-886 and less affected variety was CIM-602 in 2015. IR-901 variety more affected variety and less affected variety was MNH-886 in 2016. In non-Bt. cotton variety CRIS-342 was more effected variety and FH-1000 was less affected variety in 2015. FH-901 was more affected variety and CRIS-129 was less effected variety in 2016. The maximum population of *P. gossypiella* larvae in flowers, floral squares and green bolls in Bt. cotton in 2015 and 2016 was found 1.30 ± 0.18 in IR-901 and minimum population was found 1.15 ± 0.18 in CIM-602 variety. In non-Bt. cotton maximum population 1.42 ± 0.19 was found in FH-901 cotton variety and minimum population 1.15 ± 0.24 was found in CRIS 129 cotton variety among all the varieties. The susceptibility of non-Bt. variety particularly FH-901 against PBW has also been previously reported by Jamshed *et al.* (2008) they worked on attacks of pink bollworm on squares in Bt. and non-Bt. cotton varieties and their results revealed that non-Bt. varieties were found more susceptible against PBW. Present results are in accordance with Dhillon and Sharma (2009) who reported previously the infestations of bollworms on both Bt. and non-Bt. cotton varieties.

Table 4. Larval population of *P. gossypiella* in flowers, floral squares and green bolls of Bt. and non-Bt. cotton varieties during 2015 and 2016

Varieties		Pooled over varieties			Overall mean
		Flowers	Floral squares	Green bolls	
Bt.	IR-901	1.19±0.17	1.01±0.17	1.71±0.22	1.30±0.18
	MNH-886	1.22±0.21	1.08±0.16	1.40±0.20	1.23±0.19
	NIBGE3701	1.22±0.19	1.12±0.17	1.52±0.21	1.28±0.19
	CIM-602	1.12±0.17	0.89±0.17	1.45±0.20	1.15±0.18
	FH-142	1.26±0.18	1.06±0.16	1.56±0.23	1.29±0.19
	TARZAN1	1.15±0.19	0.93±0.32	1.47±0.21	1.18±0.24
Non-Bt.	CRIS-129	1.12±0.16	0.89±0.18	1.43±0.21	1.15±0.24
	CRIS-134	1.15±0.17	1.03±0.17	1.68±0.23	1.28±0.19
	CRIS-342	1.20±0.16	1.08±0.17	1.78±0.23	1.35±0.18
	CRIS-613	1.15±0.18	0.88±0.17	1.63±0.22	1.22±0.19
	FH-1000	1.07±0.16	0.92±0.15	1.56±0.23	1.18±0.18
	FH-901	1.45±0.20	0.92±0.16	1.89±0.23	1.42±0.19

Tabashnik *et al.* (2005) reported that resistance development of Bt. toxin in cotton bollworms due to continue grown of Bt. crops after nine years refutes the worst scenarios predicting pest resistance to Bt. crops in as little three years. Prasad and Rao (2008) also worked on Bt. and non-Bt. cotton resistant against pink bollworm and reported low damage square and green bolls. Wan *et al.* (2004) also observed the survival of pink bollworm larvae on Bt. cotton. Ahmad (2001); Ahmad *et al.* (2008) and Jamshed *et al.* (2008) worked on infestation of pink bollworm on flowers and bolls in different genotypes of cotton. Similarly, Singh and Agarwal (1987); Wilson and Smith (1992) and Jin *et al.* (1999) also found a significant difference in percent on green bolls damage in Bt. and non-Bt. cotton varieties against PBW.

CONCLUSION

In present investigation, the maximum attack of pink bollworm on different Bt. and non-Bt. cotton varieties were recorded. Nevertheless, in Bt. varieties CIM-602 and Tarzan1 were found better and showed some resistance against PBW, thus these varieties can be used in cotton hybridization program for further enhancement of resistant genotypes. Meanwhile, in non-Bt. varieties, CRIS-342 and FH-901 were observed more susceptible to PBW, thus farmers are suggested to avoid the plantation these cotton varieties.

REFERENCES

- Ahmad, G., M. J. Arif and S. M. I. Shah. 2008. Resistance in cotton genotypes against bollworm complex. *International Journal of Agriculture Biology*, 5 (2): 196-198.
- Ahmad, Z. 2001. IPM strategies for cotton. *The Pakistan Cotton Grower*, 5: 4-9.
- Ahmed, Z. 2013. Model farming saving cotton from Pink bollworm. Available at: <http://www.Pakistan.com/english/advisory/saving.cotton.from.the.pink.bllworm.shtml>.
- Atwal, A. S. 2002. *Agricultural pests of South Asia and their management*. Kalyani Publ., Ludhiana, India. 221.
- Dhillon, M. K. and H. C. Sharma. 2009. Impact of Bt. engineered cotton on target and non-target arthropods toxin flow through different trophic level and seed-cotton yield. *Karnataka. Journal of Agricultural Sciences*, 22 (3): 462-466.
- FAO. 2015. [FAOSTAT data 2015. <http://www.fao.org>. [accessed on 28 August 2015].
- James, C. 2008. *Global status of commercialized biotech/GM crops*. ISAAA, Ithaca, New York, USA.
- Jamshed, K., A. Suhail, M. Arshad, M. Asghar and M. M. Majeed. 2008. Comparative infestation of bollworms on transgenic Bt. and conventional cotton cultivars. *Entomological*, 30 (2): 193-198.
- Jin, Z. Q., G. D. Cao, S. S. Luo, J. M. Hong and Y. Q. Hung. 1999. Insect resistance and yield of different insect resistant hybrid cotton cultivars. *Zhejiang-Nongye-Kexue*, 12 (3): 142-144.
- Khan, M. Z. 2017. Cotton production to fall further, Ministry of Warns Pakistan. Government of Pakistan, Islamabad, Pakistan.

- Prasad, N. V. V. S. D and N. H. Rao. 2008. Field evaluation of Bt. cotton hybrids against insect pest complex under rainfed conditions. *Indian Journal of Entomology*, 70 (4): 330-336.
- Simmons, A. L., T. J. Dannely, L. Antilla, A. Bartlett and D. Gouge. 1998. Evaluation of Bt. cotton deployment strategies and efficacy against pink bollworm Arizona. Website at <http://ag.arizona.edu/pubs/crops/az1006/az10067b.html>.
- Singh, R. and R. A. Agarwal. 1987. Field resistance to pink bollworm in cotton. *Indian Journal of Entomology*, 49: 39-46
- Tabashnik, B. E., T. J. Denneley and Y. Carriere. 2005. Delayed resistance to transgenic cotton in pink bollworm. *Proceedings of the National Academy of Sciences*, 102 (43): 389-393.
- Wan, P., K. Wu, M. Huang and J. Wu. 2004. Seasonal pattern of infestation by pink bollworm *Pectinophora gossypiella* (Saunders) in field plots of Bt transgenic cotton in the Yangtze River Valley of China. *Crop Protection*, 23 (5): 463-467.

(Accepted: August 30, 2017)