Research Article

Effect of Different Plant Extracts Against Pink Bollworm, *Pectinophora gossypiella* (Saund.) Larvae on Bt. and Non-Bt. Cotton

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Abstract | The frequent use of pesticides at repetitive application have increased the input cost of local farmer and similarly aroused the serious problem of pest resistance. The introduction of transgenic cotton since last decades has played a significant role in suppressing the pest population of *Pectinophora gossypiella* (Saund) which is the main pest of cotton in all over the world. Nevertheless, the indigenous botanical extracts have been used effectively against various sucking pests of cotton but only few studies have been attempted to observe their action against bollworms. Therefore, the present study has been designed to observe the dual action of transgenic cotton and botanical extracts against pink bollworm during two consecutive growing years (2015 and 2016). The three local extracts such as tobacco (*Nicotiana tabacium*), neem *(Azadirachtin indica)* and datura *(Datura stramonium)* were used in traditional method. The overall results showed that the sprays at different interval indicated the highest pest population reduction at tobacco (17.45-15.09%) followed by neem (14.58-15.33%) and datura (11.72-7.81%) in both varieties and similar trend was also noted in the second year of the study. The effect of varietal difference of Bt. and non-Bt. cotton varieties was not much recorded in the 2015 but later in 2016 the dual effect of tobacco and Bt. cotton on larval population was noticed. The bio-extracts were much effective until 48 hrs, which indicated that these bio-pesticides need to spray repeatedly. The present study suggested that these bio-extracts are useful in controlling the pest problem without destroying the natural enemies and environmental hazards.

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Introduction

Cotton (*Gossypium hirsutum* L.) is known as silver fiber due to its worldwide economic importance. It is attacked by number of insect pests that may results in 30-40% reduction in cotton production particularly in Pakistan (Ahmed, 1980). Bollworms are the major insect pests of cotton crops and among these pink bollworm is particularly one of the most destructive pest that do not only reduce the quantity through direct feeding of crops but their existence may also damage the lint quality of cotton (Waleed, 2003). The yearly losses by this pest in Pakistan are estimated about one million bales (Ahmed, 2013). Meanwhile, the introduction of Bt. cotton in1983 solved the problem of bollworm complex in many cotton-growing areas of the world, but soon after in 1996 the bollworm complex issue arose again and

this time only pink bollworm displayed first time resistance against Bt. cotton (Simmons et al., 1998). Since then, the regular attacks of this pest with severe damage on cotton crop has been reported (Wan et al., 2004; Tabashnik et al., 2005; Prasad and Rao, 2008) and require an essential management to suppress their population below economic threshold level. The use of synthetic pesticides play a vital role in controlling these insect pest (Ruscoe et al., 1996) nevertheless the continuous and abundance use of similar group of pesticides generated pest resistance and seemed different incidence of pest outbreak. However, in alternative control measures, the botanical pesticides are well-known and very important group of naturally occurring substances. These are highly effective with their slow affecting action in the field of crop protection and generally considered safe to living organism particularly to natural enemies (Isman et al., 1990).

In these eco-friendly bio pesticides, neem tree (*Azadirachtin indica*) has been a subject of great interest for scientists in all over the world. In addition, the previous studies have shown that the neem seed extracts, tobacco and datura have minimal toxicity to non-target organisms (parasitoids, predators and pollinators) and degrade rapidly in the environment. Furthermore, these extracts are useful in reducing the activity of pests and disruption of feeding potential and repelling from the targeted habitat (Mordue and Blackwell, 1993; Walter, 1999; Vaughn, 2000). The aim of this study therefore, this study was designed to observe the effect of different plant extracts against *P. gossypiella* on Bt. and non Bt. cotton crop.

Materials and Methods

The comparative effect of different plant extracts against larval population of pink bollworm on Bt. and non-Bt. cotton was carried out during two cotton-growing seasons (2015 and 2016). The seeds of cotton varieties "Bt. (MNH-886) and non-Bt. (FH-1000)" were obtained from the Central Cotton Research Institute, Sakrand and Agriculture Research Institute Tandojam, Sindh. Both Bt.and non-Bt. varieties weresown at farmer's field, district Sanghar, Sindh, Pakistan through dibbling method in ridges and furrows and all other agronomical practices were followed as per recommendations. The net size of plot was 30 x 30 sq ft that was divided into four blocks containing four treatments including control and all treatments were further replicated four times during experimentation (Figure 1).

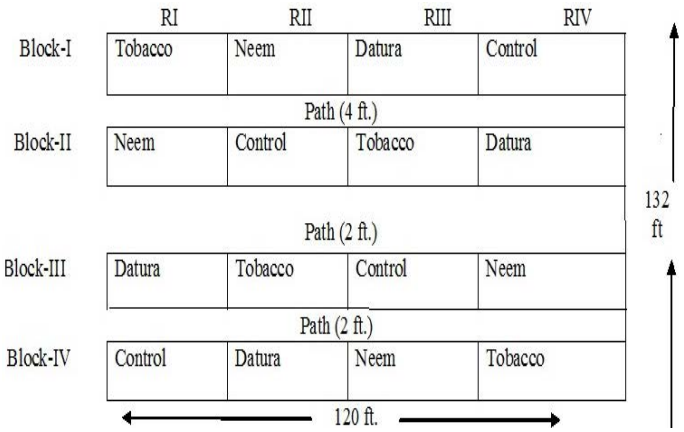

Figure 1: *Trial layout of different bio extracts applied in Bt. and non-Bt. Cotton.*

There were three plant extracts tobacco (*Nicotiana tabacium*), neem *(Azadirachtin indica)* and datura *(Datura stramonium)* were used in this study (Figure 2). The total net weight of 500 grams of dry flue-cured tobacco leaves were crushed and soaked for 24 hours in 1 liter of water. After that, water (extract) was diluted in 37.19 ml/ 2 liters of water. Similarly, 10 kg leaves

Figure 2: *Plant extracts* **(a)** *tobacco,* **(b)** *neem and* **(c)** *datura plants.*

of each neem and datura were collected sep arately. Later, these leaves were chopped and boiled in 5 liters water until 2 liters boiled water left that was drained through muslin cloth and prepared it to use. In preparation of botanical extracts, methods of Lawrence (2012) and Chang et al. (2013) were used. All these prepared extracts were sprayed at the proper dose of 37.19 ml/ 2 liters on both Bt. and non-Bt. cotton crops through knapsack sprayer at fortnightly.

All selected plots were sprayed four times with similar procedure. In regard to observe the effect of these prepared extracts against pink bollworm, there were 50 bolls from each replication (200 bolls/treatment) were observed before and after each spray. The pre-treatment observations were recorded 24 hours before spraying meanwhile the post-treatment observations were taken at 48 hours, 96 hours, one week and two weeks. In last, the data were compared with control plot within both Bt. and non-Bt. cotton varieties.

Data analysis

The experiment was Randomized Complete Block Design (RCBD) with each treatment was replicated four times. The collected data were subjected to statistical analysis using three-way factorial analysis of variance (ANOVA). The data were calculated after each spray (total four spray) and the results were presented with overall means (Means±S.E). All treatments were further compared through LSD (Least Significance Difference) at p value (0.05) using statistical software SAS (ver. 9.1). Moreover, the reduction percentage (%) of pink bollworm population was also calculated using following formula. The results were presented with getting overall means of pest population.

$$\text{Reduction \%} = \frac{\text{Pre treatment} - \text{Post treatment}}{\text{Pre treeatment}} \times 100$$

Results and Discussion

The results for both growing seasons showed that the efficacy of different plant extracts against larval population of pink bollworm were varied significantly at different intervals (F=95.80 at 48 hrs; F=190.77 at 96 hrs, F=365.20 at 1week and F=616.28 at 2 weeks, dF=3 at $P<0.05$). The use of botanical extracts on both Bt. and non-Bt. cotton crops were observed effective in reducing the mean larval population of *P. gossypiella*. The effect was observed dominant until 48 hrs after spray that maintained more or less in comparison with control plot until two weeks. The population was also monitored started to incline again in different selected treatments in both cotton crops after 48 hrs of spray (11.88±0.51) but still it was less in comparison to control plots.

Furthermore, the results in Table 1 indicated the reduction percentage of larval population in Bt. and non-Bt. cotton crop. The overall larval population ranged from 15.87 to 16.93 before the application of different plant extracts on both (Bt. and non-Bt.). The mean larval population ranged from 11.88±0.51 to 12.31±0.88 on tobacco and datura at 48 hrs, 13.13±0.65 to 14.13±68on tobacco and neem at 96 hrs, 13.75±0.53 to 16.81±77on tobacco and neem at 1st week and 15.63±0.46 to 18.38±68 on tobacco and neem at 2nd week in Bt. cotton crop, respectively. However, in non-Bt. cotton crop the larval population was almost same ranged from 15.50 to 16.37 before the application of different bio-pesticides. The mean larval population of 12.69±0.77 to

Table 1: *Overall mean larval population of P. gossypiella after application of different plant extracts at variable intervals in 2015.*

Cotton	Treatments	Pre treatment	Post treatments				Mean
			48hrs	96hrs	1st week	2nd week	
Bt.	Tobacco	15.87	11.88±0.51^{c}	13.13±0.65^{b}	13.75±0.53^{b}	15.63±0.46^{b}	13.59
	Neem	16.93	12.00±0.84^{b}	14.13±68^{bc}	16.81±77^{bc}	18.38±68bc	15.33
	Datura	16.12	12.31±0.88^{b}	13.75±1.34^{b}	15.88±1.36^{c}	17.44±1.27^{c}	14.84
	Control	17.34	20.56±2.04^{a}	28.69±1.97^{a}	32.13±1.40^{a}	36.94±1.58^{a}	28.42
non-Bt.	Tobacco	15.50	11.81±1.11^{c}	12.69±0.77^{c}	14.44±0.47^{c}	16.13±0.74^{c}	13.76
	Neem	16.37	12.50±0.44^{b}c	13.50±0.36^{bc}	15.13±0.55^{b}c	16.25±0.69^{c}	14.34
	Datura	16.37	13.44±0.44^{b}	15.06±0.44^{b}	16.00±0.84^{b}	17.56±0.89^{c}	15.51
	Control	18.76	24.19±0.12^{a}	29.94±0.95^{a}	33.25±1.20^{a}	36.56±1.20^{a}	29.19

Table 2: *Overall mean larval population of P. gossypiella after application of different plant extracts at variable intervals in 2016.*

Cotton	Treatments	Pre treatment	Post treatments				Mean
			48hrs	96hrs	1st week	2nd week	
Bt.	Tobacco	15.81	11.44±0.64^{c}	12.56±0.75^{c}	13.50±0.74^{c}	14.81±0.79^{c}	9.37
	Neem	16.31	12.31±0.57^{b}	13.44±0.71^{bc}	14.88±0.72^{bc}	16.06±0.80^{bc}	14.17
	Datura	16.06	12.25±0.46^{b}	14.06±0.69^{b}	15.81±0.88^{b}	17.00±0.98^{b}	14.78
	Control	17.32	18.75±1.84^{a}	20.63±2.38^{a}	24.81±1.63^{a}	29.50±1.03^{a}	23.42
non-Bt.	Tobacco	15.56	11.44±0.51^{c}	12.63±0.36^{c}	14.19±0.43^{c}	15.81±0.50^{c}	13.51
	Neem	15.75	12.56±0.32^{bc}	13.50±0.35^{bc}	15.06±0.44^{bc}	16.25±0.72^{b}c	14.34
	Datura	17.06	13.69±0.11^{b}	14.56±0.34^{b}	16.44±0.53^{b}	17.31±0.86^{b}	15.05
	Control	18.72	20.75±2.06^{a}	23.69±1.72^{a}	27.63±1.06^{a}	29.13±1.72^{a}	24.55

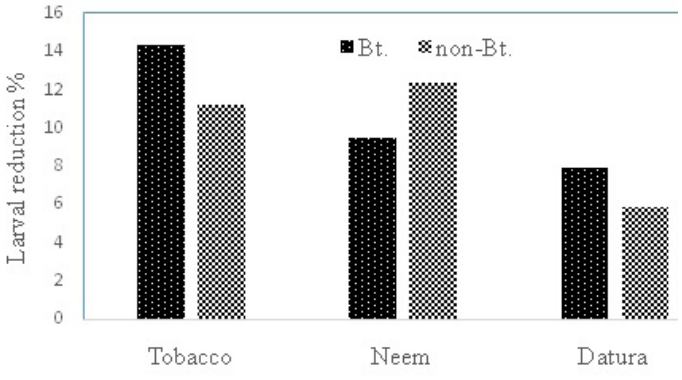

Figure 3: *Reduction percentage in mean larval population of P. gossypiella on Bt. and non-Bt. cotton crops for 2015.*

13.44±0.44at 48 hrs, 12.69±0.77 to 13.50±0.36 at 96 hrs, 14.44±0.47 to 16.00±0.84 at 1st week and 16.13±0.74 to 17.56±0.89) at 2nd week after plant extracts spray was recorded on tobacco and datura.

A maximum mean larval population of 14.46 on neem in Bt. and 15.09 on datura in non-Bt. crops; however, it was from 26.42 to 30.19 in control plots was recorded. In control plot, the larval population as compared to all treated plot was much higher that displayed influence of all these botanical extracts. Among selected botanical pesticides, tobacco was observed much effective as minimum mean larval population of 13.10 in Bt. and 12.57 in non-Bt. cotton crops were observed. Similar, findings were also noticed in next (2016) of experimentation. The highest reduction percentage of 14.36% was recorded in Bt. cotton with bio-extracts application of tobacco followed by neem 9.45% and datura 7.94%. However, the similar effects were also found in non-Bt. cotton with less reduction percentage as compared to Bt. cotton; whereas, the maximum mean reduction population of 12.40% was recorded at neem followed by tobacco 11.22% and datura 5.85%, respectively in 2015 (Figure 3).

The results were observed almost same in consecutive year (2016) that showed the larval population ranged from 15.81 to 16.31 per cotton bolls before the application of selected bio-pesticides on Bt. cotton (tobacco and neem). The mean larval population ranged of 11.44±0.64 to 12.31±0.57% was recorded from tobacco and neem at 48 hrs, 12.56±0.75to 14.06±0.69 at 96 hrs, 13.50±0.74 to 15.81±0.88 at 1st week and 14.81±0.79 to 17.00±0.98 at 2nd week tobacco and datura in Bt. cotton crop. However, in non-Bt. cotton crop the larval population was ranged of 15.56 to 17.06 before the application of spraying from the plot of tobacco and datura bio-pesticides. The larval population of 11.44±0.51 to 13.69±0.11 at 48 hrs, 12.63±0.36 to 14.56±0.34 at 96 hrs, 14.19±0.43 to 16.44±0.53 at 1st week and 15.81±0.50 to 17.31±0.86 at 2nd week was recorded in tobacco and datura in Table 2.

However, the maximum mean reduction population of 40.73 percent was observed from tobacco followed by neem 13.12% and datura 7.49% in Bt. cotton crop. Whereas, in non-Bt. cotton the maximum mean reduction population of 13.17 percent was also recorded from tobacco followed by neem 8.76% and datura 5.85%. In both years, the reduction in larval population was higher on application of tobacco extracts as compared to other botanical pesticides. However, such reduction was observed highest on Bt. cotton than non-Bt. cotton crop that showed somewhat dual effect of Bt. and tobacco extracts on larval population of *P. gossypiella* (Figure 4).

The pink bollworm is one of the most destructive pests

of cotton crop in the world. A significant attack has been indicated in local and imported Bt. cotton varieties due to lose of their resistance against bollworm complex in Pakistan. Organic pesticides are effective and cheaper for the controlling the pest populations than synthetic pesticide. The natural plants from which these bio-pesticides are prepared commonly available on agriculture field of the country (Khuhro et al., 2014). Keeping in the mind, the present study was devised to observe the efficacy of all botanical extracts on both cotton varieties (Bt. and non-Bt.). The consequences displayed that the tobacco suppressed well the pest of *P. gossypiella* in initial year of the study (2015) as compared to other bio-pesticides. There were overall similar population of pest on both varieties in control plot that indicated excellent response/resistance of conventional cotton variety (FH-1000) as compared to Bt. cotton variety (MNH-886). In selected intervals (48 hrs, 96 hrs, 1st week and 2nd week), the effect of these bio extracts were maximum at 48 hrs that steady raised again until 2nd week. These findings did not show much effect of bio-extracts in relation to cotton varietal difference in the present study. Similar trend was also observed in the second (2016) year of the study that further confirmed the maximum effect of tobacco on *P. gossypiella* larvae.

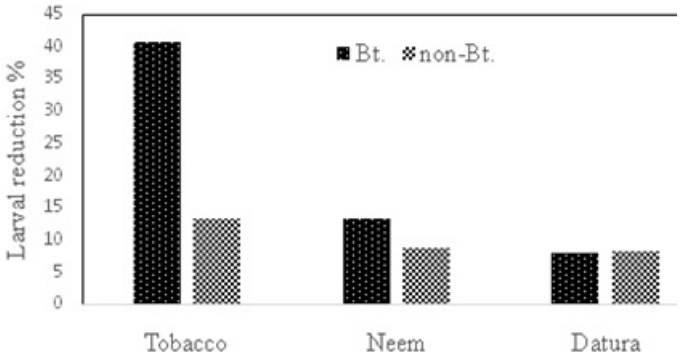

Figure 4: *Reduction percentage in mean larval population of P. gossypiella on Bt. and non-Bt. cotton crops for 2016.*

In addition, where other extracts maintained the similar pest population but tobacco did not allow the pest population of *P. gossypiella* larvae to develop particularly on Bt. cotton variety. It could be possible that it occurred due to dual action mode of Bt. cotton variety. Khan et al. (2000) also reported that the tobacco extracts showed significant effects on pink bollworm larvae of cotton crop to eradicate their population. Oruonye and Okrikata (2010) have also previously reported the botanical values of tobacoo and garlic and their supreme use against many pests. Various field experiments around the world using plant extracts including neem, tobacco and datura have been reported successfully implemented in agriculture field against pests population (Ahmed et al., 2009; Kumar et al., 2009; Khuhro, 2014). The differences in regard to yield and plant quality between cotton varieties was obvious using different plant extracts that helped to remove the bollworm larvae from cotton field and similar findings were also reported by many researchers (Kumawat and Jheeba, 1999; Deling et al., 2000; Manjunath, 2004; Bronkhorst, 2005; Phillips, 2005; Dutt, 2007; Bardin et al., 2008; Rafiq et al., 2012).

Conclusions

It is concluded through present investigation that the population of *P. gossypiella* was effected by using different plant-extract on Bt. cotton and non-Bt. cotton. There was no varietal different on pest population was noticed. In plant extracts, tobacco was observed much effective and such effect was observed maximum until 48 hrs after its application. Therefore, it is strongly suggested regarding use of these local bio products, which are not only cheaper but also effective. Further, they will also play a crucial role being safe bio pesticides for human, birds and natural enemies.

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Authors' Contributions

I.A Rajput conceived the idea data collection and overall management of the article, T.S Syed Technical input at every step, G.H Abro Review manuscript, I. Khatri and A.M Lodhi Data analysis and plagiarism.

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