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Performance of Different Botanical Against Pink Bollworm (*Pectinophora Gossypiella*) on Cotton Crop Under Field Conditions

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ABSTRACT

Cotton (*Gossypium hirsutum* L.) is an important cash crop, widely recognized as the “King of Fiber” and an essential component of human life across the globe. Over the past few decades, cotton production in Pakistan has declined due to several factors, including climate change, drought, and, most importantly severe infestations by insect pests. The high input cost of chemical control methods has further contributed to ecological disruption, destruction of natural enemies, and environmental hazards. Botanical extracts offer a comparatively safer alternative for the environment, human health, and the biodiversity of the ecosystem. Therefore, the present study was conducted to evaluate the performance of different botanicals against the pink bollworm in cotton crops. The results revealed that the highest reduction in infestation 57.2% after the first application was achieved with Neem (*Azadirachta indica*) extract, while the lowest reduction 34.95% was recorded with Safeda (*Eucalyptus*). Trooh (*Citrullus colocynthis*) and Akk (*Calotropis gigantea*) produced 48.32% and 41.13% reduction, respectively. After the second application, the infestation reduction percentages of Neem, Trooh, Akk, and Safeda were 62.7%, 55.63%, 49.5%, and 42.13%, respectively. A similar trend was observed in all treatments on the Koonj variety, though the level of reduction varied. In conclusion, Neem extract proved to be the most effective botanical against pink bollworm infestation, while the Koonj variety responded the best in terms of overall infestation reduction percentage.

Key words: *Pectinophora gossypiella*, performance, botanical pesticides, cotton

INTRODUCTION

Cotton, *Gossypium hirsutum* L., belongs to Malvaceae family known as an important cash and fiber crop of our country (Rauf *et al.*, 2019). It is considered as a King of natural source of fibre and it was known as a White Gold (Aslam *et al.*, 2004). Cotton is considered as a main source of food, feed, fiber and fuel for human population of world (Welch *et al.*, 2007). The many peoples of world depend upon cotton which give a support for livelihood of millions of people, who working in cotton industries such as ginning factories, textile mills, edible oil production, soap manufacture industries (Köll, 2003; Sutton & Olomi, 2012; Veit, 2019). The cotton crop grown more than hundred countries of the world, mostly trade in agricultural commodities with involve 150 countries of world for import and exports (Ali *et al.*, 2012). Among the cotton producing countries of the world Pakistan ranked 5th position after China, USA, India and Brazil (Khan *et al.*, 2020). Pakistan average yield of cotton is comparatively low with the other countries of the world (Aslam, 2016). The cotton contributes shares in GDP about 0.6 to 3.1 percentage and agriculture value

addition with annual production 7064 million bales for the year 2019-2020 (Abdul Kareem *et al.*, 2021). Cotton is an important fibre crop which being succulent, is observed to be attacked by various chewing and sucking insects. Some of these tiny creatures serve as notorious and serious pests of crops including cotton. Due to anthropogenic activities, climate on the earth is being changed since last century that leads to global warming (Naeem-Ullah, *et al.*, 2020). Cotton crop is damaged right from seedling stage by a number of pests, such as grasshoppers, thrips, aphids and jassids. Sap-sucking pests debilitate the early growth of the crop. Towards the bud-break stage of the cotton crop, the fruiting body (buds, flowers, bolls) feeders such as bollworms appear in the crop. Spiny bollworms, Spotted bollworms, American bollworms and Pink bollworms are the prominent amongst them (Rajendran, *et al.*, 2018). These insects are most important for decreasing the cotton yield about 30-40 percentage respectively (Tokel *et al.*, 2022).

Among these insect pests, the pink boll worm, *Pectinophora gossypiella*, is a serious threat for cotton production in Pakistan (Abbas, *et al.*, 2015). The main

damaged caused by larvae which infesting the bolls, flowers and seed of cotton (Bhute, *et al.*, 2023). After the introduction of *Bt* cotton varieties the use of pesticides minimized and the problem of bollworms was solved, but from last few years, pink bollworm has developed resistance against *Bt* toxins (Rao, *et al.*, 2021). The pink bollworm poses greater threat for cotton in recent years and has known to cause loss in normal opening of bolls, oil content and seed cotton yield (Bhute, *et al.*, 2023). Pink boll worm can damage the quality, quantity of cotton, which affecting the yield losses to both farmers and the textile industry (Fand *et al.*, 2019; Naik *et al.*, 2019). The effect of pink boll worm about 2.8% to 61.9% decrease the seed cotton production, about 2.1 to 47.1% reduce oil and 10.7 to 59.2% decrease the normal boll opening of cotton crop (Patil, 2003). The pink boll worm has become an increasing the threat for cotton growers of Pakistan, due to develop resistant against transgenic cotton varieties (Najork *et al.*, 2021; Rao *et al.*, 2022). The pink boll worm has significant challenges for cotton

growing areas, with early documents of its prejudicial effects on cotton production (Bhute *et al.*, 2023). The use pesticide chemical resulted in the interrupt the environment, destruction of predators, parasitoids and human health hazards (Ayaz *et al.*, 2020). The application of Botanical pesticides known as safe for environment, human health and there are no any side effects to human health and insect biodiversity. Therefore, the current study will be demonstrated on performance of various botanical insecticides against pink boll worm on cotton.

MATERIALS AND METHODS

Area of study: The three cotton varieties Bakhtawar, Koonj, Sindh-1, were sown in randomized complete block design (RCBD) with three replications in the month of April at Plant Protection Research Institute, Agriculture Research Center, Tandojam during the kharif season. The following treatments were applied through the spray, the infestation of pink boll.

T ₁ = Neem (<i>Azadirachta indica</i>)	2kg per acre (fresh leaves)
T ₂ = Troorh (<i>Citrullus colocynthis</i>)	2kg per acre (fresh leaves)
T ₃ = Akk (<i>Calotropis gigantea</i>)	2kg per acre (fresh leaves)
T ₄ = Safeda (<i>Eucalyptus</i>)	2kg per acre (fresh leaves)
T ₅ = Karate 25 EC (Lemdacyhalothrin)	250 ml per acre (Positive control)
T ₆ = Control (Negative control)	

Spray procedure and data observation: For preparation of botanical insecticides, the fresh plant material of Neem, Troorh, Akk and Eucalyptus were collected from the surrounding of Sindh Agriculture University Tandojam. The methods were used for preparation of extracts (Kunbhar, *et al.*, 2018). The synthetic pesticide Lambdacyhlothrins (Karate 25 EC) was also used for comparison with botanical pesticides. Total two sprays were applied after interval of 15 days at economic threshold level of Pink bollworm infestation. A total of 25 plans per plot from each treatment were randomly selected and tagged for observation. The infestation of pink boll worm on

cotton observed before the application of treatments. After the application of botanical pesticides, the data was taken after 24 hours, 48 hours, 72 hours and one week of spray (Kunbhar *et al.*, 2018).

Statistical analysis: The statistical software Statistix 8.1. was used to perform (ANOVA) to determine the difference between the different data set and the LSD was calculated to find out the least significant difference between different treatments used in the study. The, percentage reduction in pest infestation after the application of individual botanical pesticides was recorded and corrected mortality was found by using Abbots (1925) formula as given below:

$$\text{Corrected \%} = \left(1 - \frac{n \text{ in T after treatment}}{n \text{ in Co after treatment}} \right) * 100$$

n = number of live insects in control group

t = number of live insects in treated group

co= number (n) measured in the control group

RESULTS

Efficacy of various botanical pesticides against Pink boll worm in 1st spray on Bakhtawar variety: The results indicated (Table 1.) that there is no significant difference ($F = 0.24$, $P > 0.05$) was recorded in various treatments regarding the infestation of pink boll worm at pre-treatment observations with the highest population (15.10 ± 1.17 /plant) was recorded in Neem treatment, while the lowest infestation (13.23 ± 1.36

/plant) was recorded control plot. However, after the application of different botanical pesticides, the significant difference in the infestation of pink boll worm was recorded at different intervals of 24 hours ($F = 2.24$, $P < 0.05$), 48 hours ($F = 5.32$, $P < 0.05$), 96 hours ($F = 4.70$, $P < 0.05$), and one week ($F = 2.83$, $P < 0.05$). The maximum infestation of pink boll worm was recorded in all interval in control plot. Moreover, at 24hour time interval after treatments, the minimum infestation of pink boll worm was recorded in Karate

(4.93±1.12/ plant), followed by Neem (8.76±1.44/ plant) and Trooh (9.96±1.67/ plant). Similar trend was recorded in infestation of pink boll worm was observed as 48 hours after the application, the data showed that the highest infestation (15.73±1.38/plant) was observed on control treatment, while lowest infestation (5.16±1.07/plant) was found in Karate followed by Neem (6.73±1.30/plant), Trooh (8.13±1.67/plant), Akk (9.26±1.50/plant) and Eucalyptus (10.23±1.35/plant) respectively. The results after the 96 hours of application of botanical pesticides showed significant difference in all treatments. The results of Neem and trooh showed the minimum infestation of pink boll worm (7.80±1.52 and 9.10±1.35/ plant) 96 hours after the botanical pesticides application. Whereas the

infestation of pink boll worm in the Akk and Eucalyptus plot was found (10.86±1.56 and 11.73±1.67/ plant). While the results of synthetic pesticide Karate showed (7.3±1.21/plant) compare to control treatment (16.46±1.50/plant). After the one week of application, the infestation of pink boll worm slowly increased in first spray. The data indicated that the minimum infestation was recorded on Karate (8.53±1.13/plant) followed by Neem (9.73±1.86/plant), whereas the maximum infestation was observed (17.36±1.16/plant) on control. The results of other botanical pesticides showed the lowest infestation (10.53±1.78/plant) was recorded on Trooh, followed by Akk (11.50±1.92/plant) and Eucalyptus (12.66±1.70/plant) respectively.

Table 1. Efficacy of various botanical pesticides against Pink boll worm in 1st spray on Bakhtawar variety

Treatment	Dose/ acre	Pre- Observation	Post observation				Reduction Percentage %
			24 hours	48 hours	96 hours	one week	
Neem (<i>Azadirachta indica</i>)	2kg	15.10±1.17	8.76±1.44	6.73±1.30	7.80±1.52	9.73±1.86	48.66%
Trooh (<i>Citrullus colocynthis</i>)	2kg	14.20±1.14	9.96±1.67	8.13±1.67	9.10±1.35	10.53±1.78	41.31%
Akk (<i>Calotropis gigantea</i>)	2kg	14.43±1.54	10.86±1.56	9.26±1.50	10.16±1.55	11.50±1.92	34.97%
Safeda (<i>Eucalyptus</i>)	2kgc	14.43±1.37	11.73±1.67	10.23±1.35	11.30±1.28	12.66±1.70	28.56%
Karate (Lemdacynhalothrin)	250ml	14.16±1.39	4.93±1.12	5.16±1.07	7.3±1.21	8.53±1.13	59.67%
Control		13.23±1.36	14.73±1.28	15.73±1.38	16.46±1.50	17.36±1.16	

LSD= Pre-obs. 3.4538
24hr 3.8952
48hr 3.7726
96 hr 3.9179
One week 4.5036

The (figure 1.) showed the corrected percentage reduction in pink boll worm infestation using Abbot's formula after 1st application of the botanical pesticides. The data shows that the percentage of botanical pesticide reduction was recorded from all treatments. The maximum reduction (66.53%) was recorded in Karate followed by Neem (40.52%), while the minimum reduction (20.36% and 26.27%) was recorded in Eucalyptus and Akk after 24 hours of application. Similarly, the significant reduction was observed in different botanical pesticide after 48 hours. Among the botanicals the maximum reduction was recorded in Neem (57.2%) followed by Trooh (48.32%), Akk (41.13%) and Eucalyptus (34.95%) while the highest reduction (67.57%) was recorded in synthetic pesticide Karate. The maximum reduction of pink boll worm was recorded in Karate (55.65%) followed by Neem (52.61%), Trooh (44.71%), Akk (38.27%) and Eucalyptus (31.34%) after 96 hours of application. The data indicated after one week of spray the maximum reduction in infestation (50.86%) was observed in Karate, among the botanicals the highest reduction (43.95%) was found in Neem, followed by Trooh (39.34%), Akk (33.75%) and Eucalyptus (27.07%) in pink boll worm infestation on cotton crop respectively. Overall highest reduction in infestation of

pink boll worm (59.67%) was found in Karate followed by Neem (48.66%), Trooh (41.31%) and Akk (34.97%)

treatment, while the lowest reduction (28.56%) was observed in Eucalyptus respectively.

Efficacy of various botanical pesticides against Pink boll worm in 2nd spray on Bakhtawar variety: Table 2 presents the effect of various botanical pesticides on the reduction of pink bollworm infestation after the second spray. The pre-treatment observations recorded prior to the application of botanical pesticides showed no significant difference among treatments ($F = 0.38$, $P > 0.05$). The highest pre-treatment infestation (11.66 ± 1.30 insects/plant) was observed in the Akk treatment, while the lowest (9.53 ± 1.12 i/plant) was recorded in the Neem treatment. Following treatment application, significant differences were observed among all treatments. After 24 hours, the lowest infestation (2.56 ± 1.0 insects/plant) was recorded in the Karate treatment, followed by Neem (4.83 ± 1.07 insects/plant). In contrast, the highest infestation among botanical pesticides was observed in Akk and Eucalyptus (5.93 ± 1.04 and 6.83 ± 1.19 insects/plant) respectively, compared to the control (12.30 ± 1.04 insects/plant). After 96 hours of application, the control again showed the highest infestation (14.10 ± 1.15 insects/plant). The lowest infestation (5.66 ± 1.15 insects/plant) was observed in the Karate treatment.

Among botanical pesticides, Neem recorded the minimum infestation (4.43 ± 1.07 insects/plant), followed by Trooh (5.53 ± 1.13 insects/plant), Akk (6.63 ± 1.23 insects/plant), and Eucalyptus (7.36 ± 1.18 insects/plant). One week after application, pink bollworm infestation increased gradually across treatments. No significant difference was observed between Karate and Neem at this stage. The minimum

infestation (6.86 ± 1.12 insects/plant) was recorded in Karate, followed closely by Neem (6.66 ± 1.20 insects/plant), compared with the control (15.40 ± 1.12 insects/plant). Among botanical treatments, Trooh again showed the lowest infestation (7.06 ± 1.08 insects/plant), followed by Akk (8.16 ± 1.17 insects/plant) and Eucalyptus (9.13 ± 1.16 insects/plant)

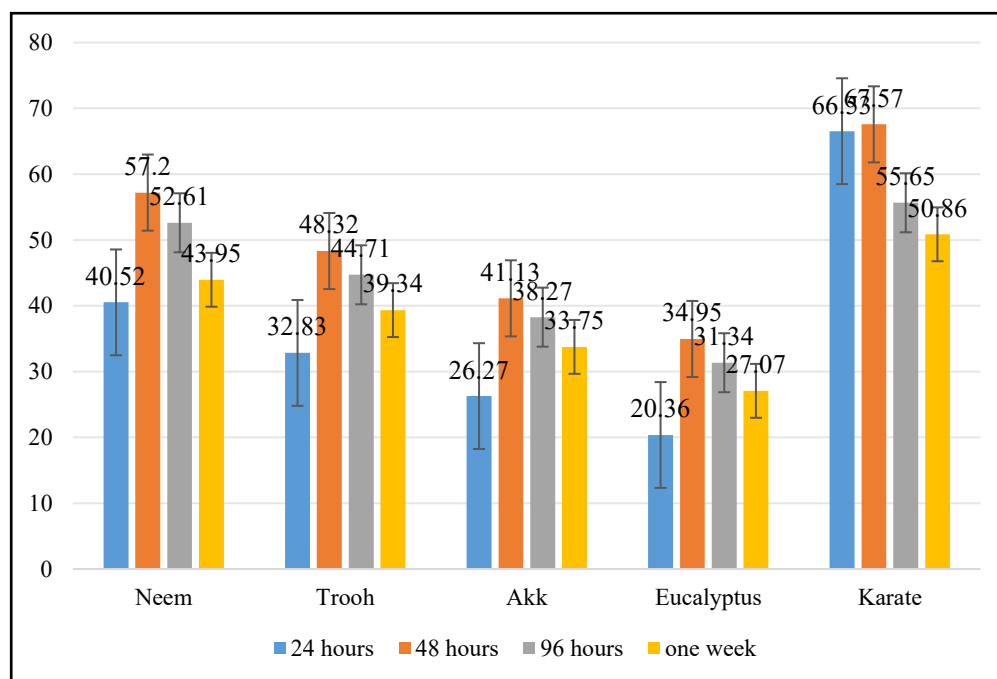


Figure. 1. Reduction percentage of botanicals against pink boll worm on Bakhtawar during 1st spray

Table 2. Efficacy of various botanical pesticides against Pink boll worm in 2nd spray on Bakhtawar variety

Treatment	Dose/ acre	Pre- Treatment	Post Treatment				Reduction Percentage %
			24 hours	48 hours	96 hours	one week	
Neem (<i>Azadirachta indica</i>)	2kg	9.53±1.12	4.83±1.07	3.80±1.07	4.43±1.07	6.66±1.20	62.7%
Trooh (<i>Citrullus colocynthis</i>)	2kg	10.26±1.23	5.93±1.04	4.73±1.01	5.53±1.13	7.06±1.08	55.63%
Akk (<i>Calotropis gigantea</i>)	2kg	11.66±1.30	6.83±1.19	5.46±1.15	6.63±1.23	8.16±1.17	49.54%
Safeda (<i>Eucalyptus</i>)	2kg	10.20±1.26	7.83±1.18	6.30±1.14	7.36±1.18	9.13±1.16	42.13%
Karate (<i>Lemdacynhalothrin</i>)	250ml	10.26±1.13	2.56±1.0	4.06±1.04	5.66±1.15	6.86±1.12	64.97%
Control		10.13±1.19	11.1±1.04	12.30±1.04	14.10±1.15	15.40±1.12	--

LSD= Pre-obs. 3.1795
24hr 3.1217
48hr 3.0319
96hr 3.1953
One week 2.9337

The corrected percentage of reduction showed in (figure 2.) in pink boll worm infestation during the 2nd application of the botanical pesticides. The data indicated the maximum reduction (65.49%) was recorded in Karate treatment followed by neem (56.48%), Trooh (46.57%), Akk (38.46%) and Eucalyptus (29.45%) respectively. The data showed that maximum (66.99%) reduction was recorded for Karate followed by Neem (69.10%) after 48 hours of

spray, among the other botanical the minimum reduction was observed in Akk (48.78%) followed by Eucalyptus (55.6%) respectively. The infestation reduction of pink boll worm reduction was recorded in all the treatments of botanical pesticide application. According to results, the reduction of pink boll worm infestation after one week of the application, of Karate showed the highest infestation reduction (55.45 %) than botanical pesticides, whereas, among the

application of botanicals pesticides, the maximum reduction of pink boll worm infestation was recorded in Neem (56.48%) and minimum reduction (29.45%) was observed in Eucalyptus followed by Akk (38.46%) and Trooh (46.57%) treatments. Afterwards, overall

maximum reduction (64.97%) was recorded in Karate treatment, followed by Neem (62.7%), Trooh (55.63%), Akk (49.54%) and Eucalyptus (42.13%) after application respectively.

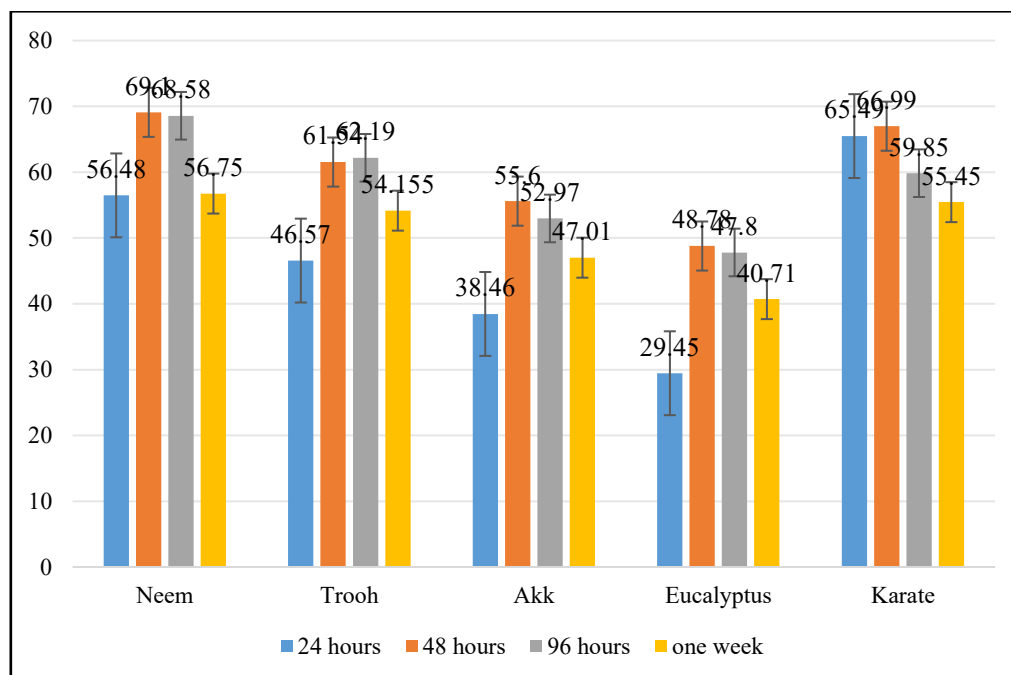


Figure. 2. Reduction percentages of botanicals against pink boll worm on Bakhtawar during 2nd spray

Efficacy of various botanical pesticides against Pink boll worm in 1st spray on Koonj variety: Similarly, the various botanical such as Neem Trooh, Akk and Eucalyptus were use against pink boll worm infestation on cotton variety Koonj. The results showed non-significant difference ($F=0.28$; $P>0.05$) was recorded in infestation of pink boll worm in all treatments. The results indicated (Table 3.) that the maximum pest infestation before first spray 8.90 ± 1.06 / plant was recorded on Akk and minimum infestation 7.40 ± 1.19 / plant was found on Trooh. However, the pest infestation was reduced after 24-hours of spray and a significant ($F=5.30$; $P<0.05$) difference in pest infestation was found in different treatments. The minimum infestation percentage was observed in treatment of Karate (1.70 ± 0.96 / plant) followed by

Neem (3.73 ± 1.12 / plant) and Trooh (4.76 ± 1.06 / plant). Whereas the maximum pest infestation percentage (9.96 ± 1.20 / plant) was observed in control and among other botanical treatments of Akk and Eucalyptus 5.70 ± 1.20 / plant and 6.46 ± 1.11 respectively. Similarly, reduction in pest infestation after 96-hours of botanical pesticides insecticide application was observed in all treatments. A highly significant difference ($F=5.06$; $P<0.05$) was observed among the all treatments of botanical. Lowest infestation 3.53 ± 0.98 / plant was recorded in Karate treatments followed by Neem 4.96 ± 1.02 / plant treatments. Besides, 5.76 ± 1.03 , 6.56 ± 1.15 , 7.53 ± 1.14 /plant infestation percent was observed in Trooh, Akk and Eucalyptus. While the highest infestation (12.50 ± 1.03 / plant) was found in control treatment respectively.

Table. 3. Efficacy of various botanical pesticides against Pink boll worm in 1st spray on Koonj variety

Treatment	Dose/ acer	Pre-Observation	Post observation				Reduction Percentage %
			24 hours	48 hours	96 hours	one week	
Neem (<i>Azadirachta indica</i>)	2kg	7.96+1.14	3.73+1.12	2.96+0.89	4.96+1.02	6.90+1.20	61.77%
Trooh (<i>Citrullus colocynthis</i>)	2kg	7.40+1.19	4.76+1.06	3.73+1.03	5.76+1.03	7.66+1.04	54.85%
Akk (<i>Calotropis gigantea</i>)	2kg	8.90+1.06	5.70+1.2	4.73+1.13	6.56+1.15	8.73+1.17	47.03%
Safeda (<i>Eucalyptus</i>)	2kg	8.63+1.00	6.46+1.11	5.73+1.09	7.53+1.14	9.80+1.22	39.2%
Karate (Lemdacyhalothrin)	250ml	7.80+1.25	1.70+0.96	2.73+0.95	3.53+0.98	4.76+1.09	73.8%
Control		8.76+1.27	9.96+1.20	10.73+1.27	12.50+1.03	15.40+1.26	----

LSD= Pre-Obs.	3.2039
24hr	3.0450
48hr	3.0744
96hr	3.0165
One week	3.0173

The results showed the corrected percentage reduction in pink boll worm infestation after 1st application of the botanical pesticides on cotton variety Bakhtawar as calculated by using Abbot's formula is given in (Figure 3). According to results, after 24-hours of the application, Karate showed the highest infestation reduction (82.93%), followed by Neem (62.92%) and Trooh (52.2%) treatments. The lowest infestation reduction of pink boll worm was calculated in Eucalyptus (33.33%) and Akk (42.77%) treatments. After one week of the application of botanicals, the

maximum reduction in pink boll worm infestation was recorded in Karat (69.09%) followed by neem (55.19%) and minimum reduction was found in Eucalyptus (36.35%) followed by Akk (43.31%) and Trooh (50.25%) treatment. The overall mean infestation of pink boll worm reduction percentage of botanical pesticides showed that maximum reduction percentage (73.8%) was found in Karate, followed by Neem (61.77%), Trooh (54.85%), Akk (47.03%) and Eucalyptus (39.2%) respectively.

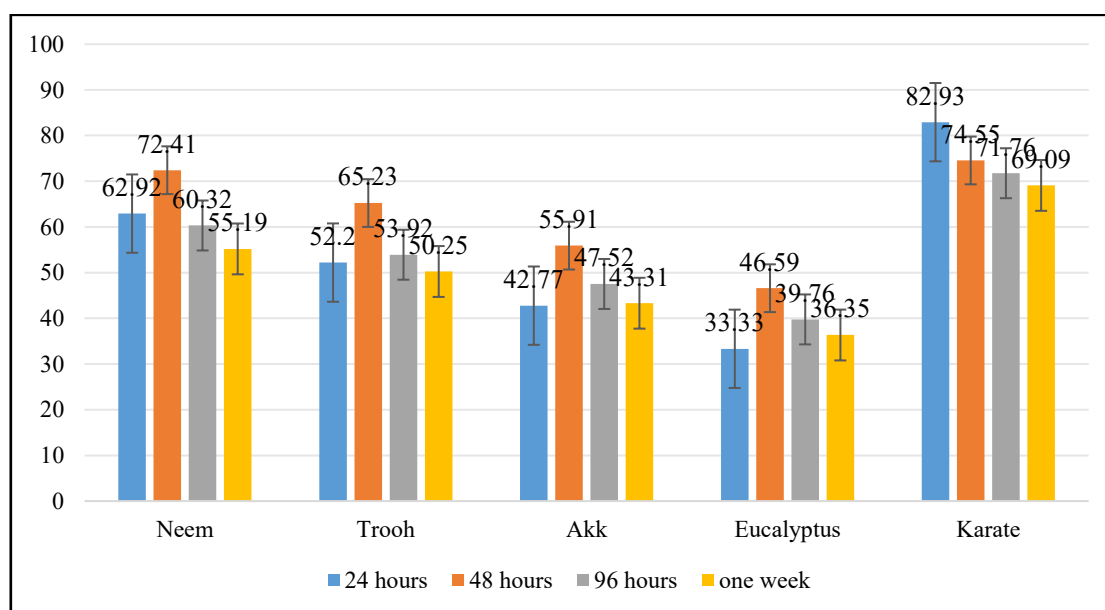


Figure 3. Reduction percentage of botanicals against pink boll worm on Koonj during 1st spray

Efficacy of various botanical pesticides against Pink boll worm in 2nd spray on Koonj variety: The data showed (Table 4.) that the application of 2nd spray of different botanicals against pink boll worm pre-treatment observation was obtained before spray, which showed no significant ($F = 0.31$; $P > 0.05$) difference in infestation of pink boll worm in all treatments. The range of pre-treatment infestation was 8.93 ± 1.43 to 10.33 ± 1.50 / plant infestation in all treatment's plots. The infestation pink boll worm was reduced when botanicals (Neem, Trooh, Akk, and Eucalyptus) were applied with a synthetic insecticide (Karate) after 24-hours of spray. The data showed that significant ($F = 7.27$; $P < 0.05$) difference in pest infestation was found in various treatments. The minimum infestation was observed in Karate

(1.70 ± 1.00 / plant) followed by Neem (4.93 ± 1.19 / plant) and Trooh (5.93 ± 1.44 / plant). Whereas the maximum pink boll worm infestation (12.30 ± 1.35 / plant) was observed in control and among treatments of Akk, and Eucalyptus 6.90 ± 1.6 and 8.36 ± 1.43 / plant respectively. The infestation of pink boll worm was observed after 96-hours of botanical insecticide application in all treatments and a highly significant difference ($F = 12.84$; $P < 0.05$) was observed among the treatments of botanicals. The lowest infestation percentage 3.53 ± 1.13 / plant was found in treatment of Karate. Similarly, in terms of minimum infestation in botanicals 4.96 ± 1.02 / plant was observed in Neem followed by Trooh 5.73 ± 1.02 / plant than other treatments. Whereas the highest infestation 14.13 ± 1.2 was found in control plots.

Tables. 4. Efficacy of various botanical pesticides against Pink boll worm in 2nd spray on Koonj variety

Treatment	Dose// acre	Pre- Observation	Post observation				Reduction Percentage %
			24 hours	48 hours	96 hours	one week	
Neem (<i>Azadirachta indica</i>)	2kgc	9.00±1.08	4.93±1.19	3.33±0.87	4.96±1.02	7.40±1.38	63.93%
Trooh (<i>Citrullus colocynthis</i>)	2kg	8.93±1.43	5.93±1.44	4.03±1.12	5.73±1.02	9.53±1.50	55.88%
Akk (<i>Calotropis gigantea</i>)	2kg	10.36±1.13	6.90±1.6	5.33±1.11	6.56±1.15	10.83±1.76	48.18%
Safeda (<i>Eucalyptus</i>)	2kg	10.43±1.15	8.36±1.43	7.23±1.20	8.43±1.22	11.33±1.65	38.16%
Karate (Lemdacyhalothrin)	250ml	9.26±1.43	1.70±1.00	2.73±1.09	3.53±1.13	4.73±1.09	77.80%
Control	--	10.33±1.50	12.30±1.35	13.70±1.52	14.13±1.2	17.03±1.08	---

LSD= Pre-obs. 3.2039
24hr 3.0450
48hr 3.0744
96hr 3.0165
One week 3.0173

According to results, after 24-hours of the application, Karate showed the highest infestation reduction (86.21%), followed by Neem (59.92%) and Trooh (51.79%) treatments. The lowest infestation reduction of pink boll worm was calculated in Eucalyptus (32.03%) and Akk (43.9%) treatments. After one week of the application of botanicals, the maximum reduction in pink boll worm infestation was recorded in Karat (72.23%) and minimum reduction was found

in Eucalyptus (33.47%) followed by Akk (36.41%) and Trooh (44.03%) treatment. Overall infestation reduction percentage of the pest demonstrated that the maximum reduction percentage (77.80%) was found in Karate, followed by Neem (63.93%) and Trooh (55.88%). The minimum reduction percentage (38.16%) was observed in Eucalyptus, followed by Akk (48.18%) respective

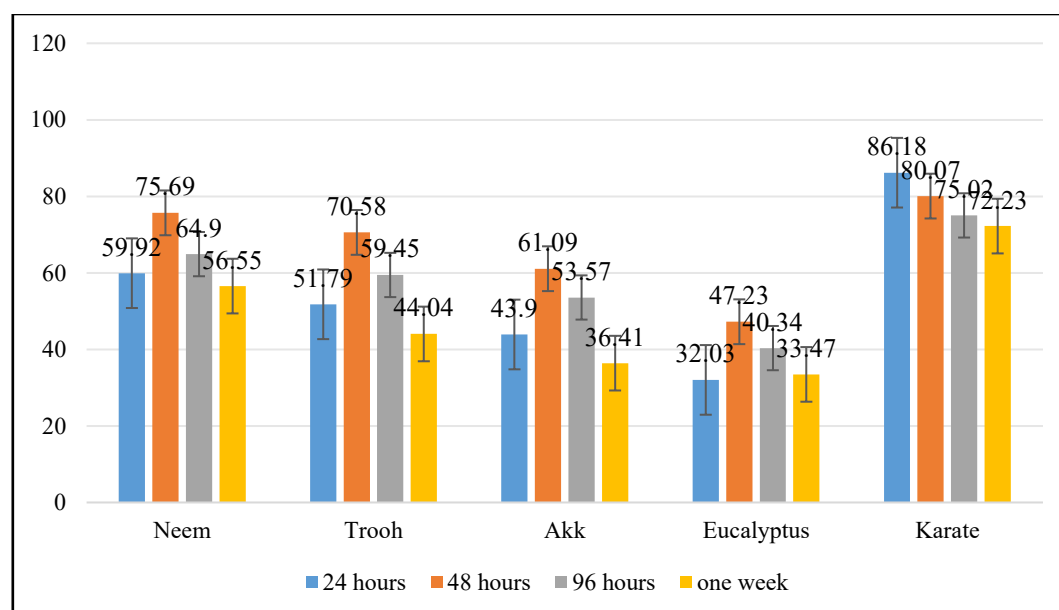


Figure 4. Reduction percentage of botanicals against pink boll worm on Koonj during 2nd spray

Efficacy of various botanical pesticides against Pink boll worm in 1st spray on Sindh-1 Variety: Similar the application of botanical pesticides on cotton Sindh-1 during 1st spray, the results of botanical pesticides pre-treatment observation of pink boll worm exhibited a non-significant difference ($F = 1.30$; $P > 0.05$) as the infestation ranged between 9.76 ± 1.85 / per plant was in control treatment to 12.60 ± 1.58 per plant in Karate

synthetic insecticide treatment (Table 5). However, the application of botanical and synthetic pesticide (Karate) reduced the infestation of pink boll worm considerable at 24-hours of the application and showed a highly significant ($F = 6.72$; $P < 0.05$) difference in the infestation of Pink boll worm recorded in various treatments. The lowest population of pink boll worm was recorded after 24-hours in Karate (3.46 ± 1.05 / plant), followed by Neem (6.56 ± 1.59 / plant), and Trooh (7.43 ± 1.74 / plant). After 24-hours of the

application of botanicals, the highest mean infestation was recorded in control (10.96 ± 1.96 / plant), but among botanicals treatments, Akk and Eucalyptus showed relatively higher infestation of pink boll worm i.e., 8.60 ± 1.49 and 9.50 ± 1.75 / plant, respectively. A further

reduction in infestation of pink boll worm was recorded in all the treatments.

Table 5. Efficacy of various botanical pesticides against Pink boll worm in 1st spray on Sindh-1 Variety

Treatment	Dose/ acre	Pre-Observation	Post observation				Reduction Percentage %
			24 hours	48 hours	96 hours	one week	
Neem (<i>Azadirachta indica</i>)	2kg	9.90 ± 1.44	6.56 ± 1.59	7.00 ± 1.53	8.03 ± 1.58	11.53 ± 1.91	34.39 %
Trooh (<i>Citrullus colocynthis</i>)	2kg	10.06 ± 1.38	7.43 ± 1.74	8.60 ± 1.92	9.76 ± 1.61	12.20 ± 1.82	24.75 %
Akk (<i>Calotropis gigantea</i>)	2kg	9.80 ± 1.57	8.60 ± 1.49	9.20 ± 1.65	10.63 ± 1.59	13.93 ± 2.03	16.11 %
Safeda (<i>Eucalyptus</i>)	2kg	11.00 ± 1.64	9.50 ± 1.75	10.20 ± 1.51	11.36 ± 1.56	14.53 ± 1.65	9.70 %
Karate (Lemdacylhalothrin)	250ml	12.60 ± 1.58	3.46 ± 1.05	4.90 ± 1.14	5.83 ± 1.31	8.66 ± 1.18	54.72 %
Control		9.76 ± 1.85	10.96 ± 1.96	11.86 ± 1.85	12.23 ± 2.06	15.43 ± 2.00	

LSD= Pre-obs.4.4288

24hr 4.460

48hr 4.4174

96hr 4.4746

One week 4.7214

The results showed (figure 5) that according to results, after 24-hours of the application, Karate showed the highest infestation reduction (68.39%), followed by Neem (40.01%) and Trooh (32.22%) treatments. The lowest infestation reduction of pink boll worm was calculated in Eucalyptus (13.33%) and Akk (21.53%) treatments. After one week of the application of botanicals, the maximum reduction in pink boll worm infestation was recorded in Karat (43.83%) and

minimum reduction was found in Eucalyptus (5.83%) followed by Akk (9.72%) and Trooh (20.95%) treatment. Overall maximum reduction percentage (54.72 %) was recorded Karate treatment, followed by the application of botanical pesticides, as the lowest pink boll worm infestation was observed in Neem (34.39%), followed by Trooh (24.75%), Akk (16.11%) and Eucalyptus (9.70%) during the first spray on cotton variety Sindh-1 respectively.

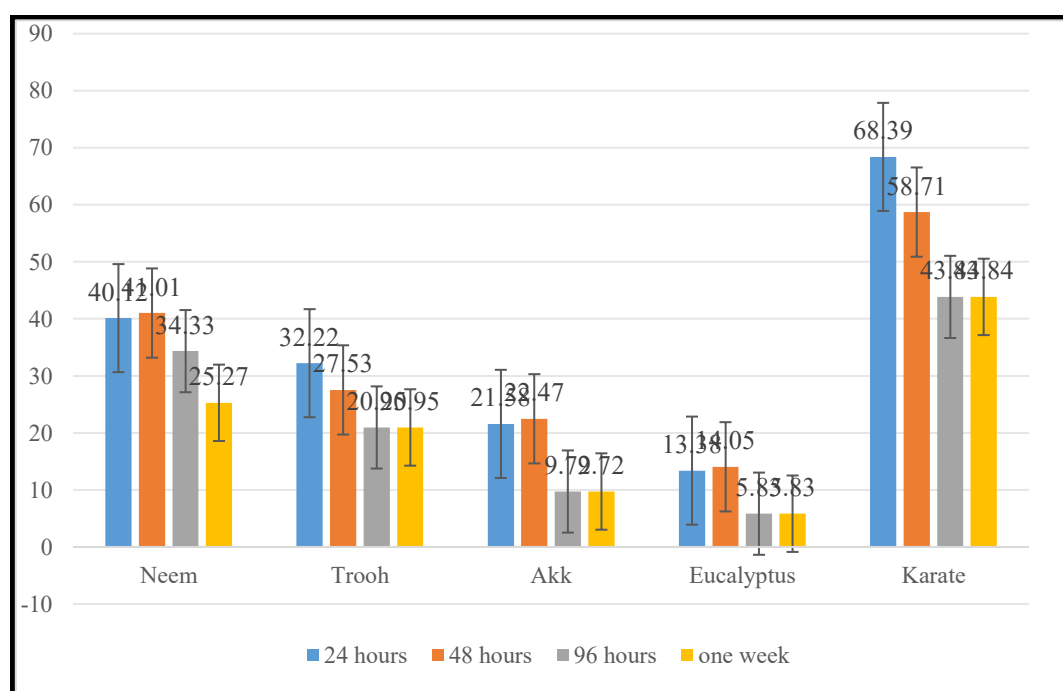


Figure 5. Reduction percentage of botanicals against pink boll worm on Sindh-1 during 1st spray

Efficacy of various botanical pesticides against Pink boll worm in 2nd spray on Sindh-1 Variety: The results of 2nd spray of various botanical pesticides on cotton variety Sindh-1 against pink boll worm. The results indicated (Table 6) show the performance of different botanicals and Karate before spray showed no significant ($F=0.50$; $P>0.05$) difference among the infestation percentage of pink boll worm in all treatments. The range of pre-treatment infestation percentage 11.06 ± 1.39 to 15.06 ± 1.55 / plant was recorded in all treatment's plots. The data showed after

24-hours of spray and a highly significant difference ($F=2.66$; $P<0.05$) in pink boll worm infestation was found in various treatments. The minimum infestation was observed in treatment of Karate (4.80 ± 1.2 / plant) while the maximum (16.13 ± 1.45) infestation was recorded in control, followed by Eucalyptus (10.76 ± 1.66 / plant), Akk (8.60 ± 1.49 / plant) and Trooh (9.96 ± 1.68 / plant), whereas, the Neem found lowest infestation (7.73 ± 1.53 / plant) compared with other botanical pesticides against pink boll worm on cotton

Table. 6. Efficacy of various botanical pesticides against Pink boll worm in 2nd spray on Sindh-1 Variety

Treatment	Dose/acre	Pre-Observation	Post observation				Reduction Percentage %
			24 hours	48 hours	96 hours	one week	
Neem (<i>Azadirachta indica</i>)	2kg	11.06 ± 1.39	7.73 ± 1.53	8.26 ± 1.59	9.23 ± 1.60	10.76 ± 1.91	49.56%
Trooh (<i>Citrullus colocynthis</i>)	2kg	11.93 ± 1.21	9.96 ± 1.68	10.43 ± 1.93	11.06 ± 1.50	11.46 ± 1.84	39.84 %
Akk (<i>Calotropis gigantea</i>)	2kg	12.56 ± 1.51	8.60 ± 1.49	9.60 ± 1.62	10.63 ± 1.59	11.23 ± 1.95	43.86 %
Safeda (<i>Eucalyptus</i>)	2kg	13.16 ± 1.41	10.76 ± 1.66	11.46 ± 1.48	12.10 ± 1.55	13.03 ± 1.73	33.63 %
Karate (<i>Lemdacyhalothrin</i>)	250ml	14.83 ± 1.45	4.80 ± 1.28	5.43 ± 1.19	6.53 ± 1.30	7.96 ± 1.13	65.34 %
Control		15.06 ± 1.55	16.13 ± 1.45	17.36 ± 1.48	18.20 ± 1.58	19.66 ± 1.36	---

LSD= Pre-obs. 3.8996
24hr 4.0756
48hr 4.0980
96hr 4.0994
One week 4.5365

The overall infestation reduction percentage showed (Figure 6) that the pink boll worm demonstrated that the maximum reduction percentage was recorded after 24-hours of the application, Karate showed the highest infestation reduction (70.25%), followed by Neem (52.05%) and Trooh (38.30%) treatments. The lowest infestation reduction of pink boll worm was calculated in Eucalyptus (33.20%) and Akk (46.64%) treatments. After one week of the application of botanicals, the maximum reduction in pink boll worm infestation was

recorded in Karat (59.49%) followed by neem (45.40) and minimum reduction was found in Eucalyptus (33.73%) followed by Akk (42.88%) and Trooh (41.59%) treatment respectively. Overall infestation reduction percentage showed that the pink boll worm demonstrated that the maximum reduction percentage (65.34 %) was found in Karate, followed by Neem (49.56%), while the minimum reduction percentage (33.63 %) was observed in Eucalyptus respectively.

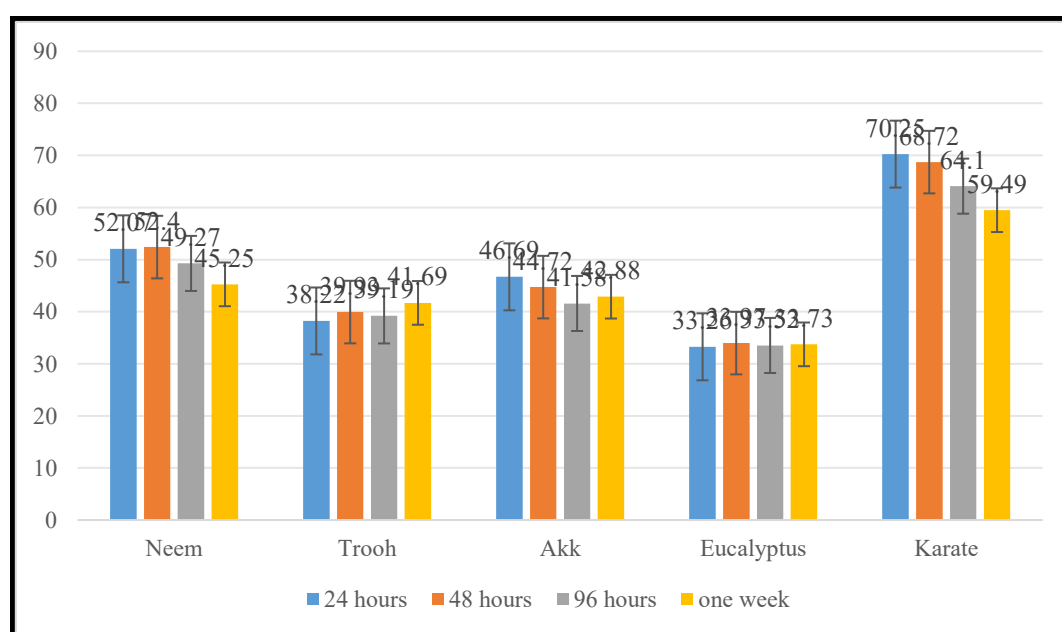


Figure. 6. Reduction percentage of botanicals against pink boll worm on Sindh-1 during 2nd spray

DISCUSSION

Botanical pesticides are effective because they contain natural compounds that disrupt insect feeding, growth, or reproduction. Neem-based formulations act as antifeedants and growth regulators, controlling a wide range of pests. Extracts from *Nicotiana* spp., *Phytolacca dodecandra*, and *Securidaca longipedunculata* interfere with pest physiology and behavior. These natural pesticides reduce pest populations while being environmentally safe and less harmful compared to synthetic pesticides.

The results of the current study indicated that larval damage by pink bollworm on green cotton bolls was significantly lower in all treated plots compared to the control. During the first spray on cotton variety Bakhtawar, the synthetic insecticide Karate recorded the lowest overall infestation (67.57%) among all treatments. Among botanical pesticides, neem was the most effective (57.2%), followed by Trooh (48.3%), Akk (41.3%), and Eucalyptus (34.12%), while the highest infestation occurred in control plots. After the second application, the same trend was observed, with Karate maintaining the lowest infestation (71.80%), followed by neem (56.48%), Trooh (46.57%), Akk (38.46%), and Eucalyptus (29.45%) (Bajya *et al.*, 2015; Mamoon-ur-Rashid *et al.*, 2012). Laboratory bioassays further confirmed that conventional insecticides, particularly lambda-cyhalothrin, were more efficacious than newer chemistries such as thiamethoxam and buprofezin against hatched pink bollworm larvae (Sabry, 2013). Among botanical options, 5% NSKE was highly effective, reducing infestation by 58.06%, followed by neem formulation at 1500 ppm (50.54%) (Shree *et al.*, 2024). Previous studies have similarly reported that botanical pesticides, including NSE 5% and Azadirachtin 1500 ppm, significantly reduced larval infestation and egg laying of American bollworm (*Helicoverpa armigera*), with efficacy comparable to synthetic insecticides such as Spinosad 45 SC and HaNPV 250 LE/ha (Borkar & Sarode, 2011). Overall, while synthetic insecticides provided rapid and high suppression, botanical formulations offered sustainable and effective control of pink bollworm, highlighting their potential role in integrated pest management strategies for cotton.

Similarly, the results regarding the first spray on cotton variety Koonj, observed the highest reduction in infestation of pink boll worm was found in synthetic chemical pesticides in Karat (69.09%) and minimum infestation reduction was recorded in botanical pesticides Eucalyptus (36.35%) after the Akk (43.31%) and Trooh (50.25%) give good results. Moreover, the overall infestation reduction percentage after 2nd spray of the pest demonstrated that the maximum reduction percentage (77.80%) was found in Karate, followed by Neem (63.93%) and Trooh (55.88%). The minimum reduction percentage (38.16%) was observed in Eucalyptus, followed by Akk (48.18%) respectively. The synthetic insecticide is indicated more toxicant

against the all-test insect's pest compare than neem extract-based treatments at any interval. All the Neem derivatives of all concentrations seriously affected the infestation of Spotted boll worm, the higher concentrations were adversely affected of the attack of pink boll worms up to 12 days after application of insecticides. The experimental plots were treated with different concentration's such as 1.5% and 2% neem oil and 3% neem seed of water extract data showed the significant higher in production as compared with control treatment. The chemical pesticides Polytrin C® 440 EC observed in all treatments was found highly toxic to the test organism insects as compared to with any other treatment of pesticides (Mamoon-ur-Rashid, *et al.*, 2012). Thavkar, *et al.* (2025) reported regarding the performance of the entomopathogenic fungi such as *Metarhizium anisopliae* strain (TMBMA1) used against the pink bollworm of cotton and it assesses the compatibility with major insecticides on cotton crop. In-addition, to understand the dynamics of colonization and infection processes of entomopathogenic fungi (EPF), scanning electron microscopy (SEM) of infected larvae was carried out.

Moreover, the results of first spray on Sindh-1, the highest reduction of treatment against pink boll worm infestation was recorded in synthetic pesticides overall maximum reduction percentage (54.72 %) was recorded Karate treatment, followed by the application of botanical pesticides, as the lowest pink boll worm infestation was observed in Neem (34.39 %), followed by Trooh (24.75 %), Akk (16.11 %) and Eucalyptus (9.70 %) during the first spray on cotton variety Sindh-1 respectively. Sabry, (2013) reported that the results of chemical pesticides lambda-cyhalothrin is more effective against cotton pink boll worm caterpillar, besides the lambda-cyhalothrin the results of buprofezin reported a good result in the incidence disturbance of pink boll worm during developmental process of larvae. Additionally, use of insecticides synergistic agent of PBO found a better results in exploding the toxicity of all the tested insecticides specially with the thiamethoxam new insecticides on cotton crop. According to Rajput, *et al* (2017) revealed that the three local plant extracts such as *Nicotiana tabacum*, *Azadirachtin indica* and *Datura stramonium* were observed on traditional method. The overall mean data indicated that the application of different interval showed that the maximum reduction in the pest population on 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 respectively.

CONCLUSION

It is concluded that among the botanical pesticides the neem showed comparatively more effective against the pink boll worm, followed by Trooh and Akk. All the botanicals were found less persistent especially Neem, followed by Tobacco and Trooh.

AUTHORS' CONTRIBUTION

Perwaiz Paryal and Sajjad Hussain Rind designed the experiment and collect the data, Sohail Ahmed Otho supervise the research, Imtiaz Ahmed Nizamani critically review the manuscript and Paras Paryal and Nadia Mangrio statistically analyze the data.

CONFLICT OF INTEREST

The manuscript has been reviewed by all authors, and it has been confirmed that no conflicts of interest exist.

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