Life Science Journal

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Multidisciplinary Academic Journal Publisher

Toxicological Impact Of Different Insecticides On The Desert Locust (*Schistocerca Gregaria* Forsk.) (Acrididae)

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Abstract: The desert locust, *Schistocerca gregaria* F has become a serious issue of the south Asia including Pakistan. The Present study was designed to evaluate the toxicity of seven insecticide; Lambda cyhalothrin 2.5EC, Malathion 57EC, Deltamethrin 2.5EC, Chlorpyrifos 40EC, Pyriproxyfen 10.8EC, Metarhizium 100g/l, Buprofezin 25WP against five days old winged adult locusts in mesh mosquito nets and on 2nd and 5th instars locusts hoppers in glass cages (18x18x18 ft3) having mesh on three sides with layer of sand under field and controlled conditions (28±2C° & 60 ± 5%) at Entomological Research Institute Faisalabad Pakistan. It can be inferred from the results obtained that all insecticide caused significant mortality in adult locusts and hoppers but mortality percentage increased as the time after application lapse. Lambda cyhalothrin 2.5EC is more potent (79.83% and 84.57%) against adult locusts followed by Chlorpyrifos 40EC (77.50% and 83.90 %) and Deltamethrin 2.5EC (73.37% and 81.133%) under field conditions similarly toxicity against adults under lab conditions, Lambda cyhalothrin 2.5EC performed better (81.33% & 86.00%) than Chlorpyrifos 40EC (80.67% & 85.33%). Buprofezin 25WP was found to be the least effective insecticide (41.67% & 55.70%) against locust adults under same conditions in both conditions. In case of hoppers, it was observed that Lambda cyhalothrin 2.5EC is more lethal (96.667% & 89.333%) against 2nd and 5th instar hoppers of desert locust than other treatments followed by Chlorpyrifos 40EC (96.333% & 87.333%). Metarhizium 100g/l was least lethal (40.000 % & 36.000%) in hoppers after same time of application. Hoppers showed more response toward insecticides as compared to adult locusts. In case of lab conditions first four treatments Lambda cyhalothrin 2.5EC, Malathion 57EC, Deltamethrin 2.5EC and Chlorpyrifos 40EC caused 100 percent mortality in 2nd and 5th instar hopper followed by toxicity produced by Pyriproxyfen (87.237%). Buprofezin 25WP have very low residues in locust body and totally degrade after 3 days and chlorpyriphos was found most persistent and highest residues till day 10 after application while no residues were detected in Deltamethrin 2.5EC and Metarhizium 100g/l.

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Keywords: Bioassay, Desert Locust, Hoppers, Residues of Insecticides, Toxicity

1. Introduction

The desert locust (*Schistocerca gregaria* F.) belonged to family Acrididae is migratory pest of agricultural crops and found almost all over the world (Avanesyan and Culley, 2015). It has very high reproductive rate and increased in number very fast so it may cause the conditions of plague (Bateman *et al*., 1993). In modern era, these out breaks of locusts are fraught by disastrous management authorities of agricultural sector because it caused strongest effects on food safety (Lachininsky et al, 2003 & Kurishbaev and Azhbenov, 2013). The outbreaks of *S. gregaria* can be episodic e.g locusts may be chronic pest e.g it's outbreak can be alternative periods (invasion and recession) (Long Zhang et al., 2019) and considered as important economical pest of the world e.g Egypt as well as in other African and Asian countries (Guo, 1989; Maya et al., 2005; Capinera et al., 2004; Avanesyan and Culley, 2015).

The desert locust became serious pest during 1950, 1960 and 1990 in much area of Pakistan e.g desert areas of Punjab, Baluchistan and Sindh which covered the area of 300,000 square kilometer. Later on, the devastating large population of desert locust

was observed during 1993 and 1997. The females of locust like to lay eggs in sandy soil with abundant moisture. The development and multiplication of desert locust enhanced with availability of rain (easy egg lying) and vegetation (diet for the immature wingless stages) (I. katri, 2019). During 2019, Desert Locust spread in all frontline countries due to favorable environment created by cyclones in Arabian sea followed by rainfall and its undetected continuous breeding for three 3 generations in *Empty Quarter* (Yemen-Saudi Arabian Border) due to law and order situation. The immature Desert Locust swarms invaded Saudi Arabia which were migrated from the Red Sea coast of Sudan and Eritrea in January, 2019. It invaded Iran in February 2019 and subsequently Pakistan in March 2019 (FAO, 2019)

The variety of combat actions are done to save the agricultural important crops like making noise, drumming and other physical measures but chemical application is more effective and efficient mean to control desert locusts (Abou El_magd *et al*. 2011, Kurishbaev and Azhbenov, 2013). The prethroids and organophasporous insecticides are the used to control the desert locusts while organochlorides were banned in the world due its persisting long term harmful effects on environment and human beings (Lecoq, 2001). The non-judicial use of synthetic insecticides developed resistance issue and also increased hazards to environmental health (Garriga and Caballero, 2011) so appropriate size of droplets is required to minimize the drifting problems (Rachadi 2010). The hoppers cannot fly at all during their initial stages and easily chemically controlled but the main problem in combat action is non-approachable and unseen mass breeding sites of *S. gregaria* (Azhbenov *et al*., 2015).

The current studies are designed to evaluate the most effective, low resistance and environmental friendly insecticide against the *S. gregaria* and also aimed to determine the best time to adopt control measures.

2. Materials And Methods

In the study presented here seven insecticides viz. Lambda cyhalothrin 2.5EC, Malathion 57EC, Deltamethrin 2.5EC, Chlorpyrifos 40EC, Pyriproxyfen 10.8EC, Metarhizium 100g/l, Buprofezin 25WP were tested against desert locust adults and against 2nd and 5th instar hoppers.

2.1. Lab. Rearing

The eggs of desert locust were collected from three different districts i.e Bhakkar, Jhang and Rajanpur of Punjab. Collected eggs were placed under controlled conditions (28±2C° & 60 ± 5%) in glass cages (18x18x18 ft^3) having mesh on three sides with layer of sand at Bioassay Laboratory Entomological Research Institute Faisalabad. To keep the population homogeneous, neonate were collected and separated on daily basis for bioassays studies. Population was fed on branches of Brassica crop.

2.2. Bioassay

Homogenies population of hoppers at 2nd and 5th instars and adults were kept in glass cages under lab conditions and in mesh cages under fields conditions. Locust were treated with three puffs of above said insecticides at recommended doses by hand sprayer at 1 psi pressure. Two hundred hoppers/adults were treated in each repeat and the experiment was replicated thrice. Populations were provided brassica branches as food. After application of treatment, Percentage mortality was observed after 24 hours and 72hours in adults while in the case of hoppers, after 24 hours data was collected.

2.3. Statistical Analysis

The collected data was subjected to statistix 8.1 for Anova analysis and mean values of percentage mortality by LSD values

3. Results and Discussion

3.1. Field Experiment:

In current studies, Seven (07) Insecticides viz Lambda cyhalothrin 2.5EC, Malathion 57EC, Deltamethrin 2.5EC, Chlorpyrifos 40EC, Pyriproxyfen 10.8EC, Metarhizium 100g/l, Buprofezin 25WP were applied on healthy, fresh and uninfected winged adult desert locust and 2nd instars locusts hoppers under field while control was only water treatment without any insecticide. Percent mortality of adults were calculated after 24 and 72 hours of treatments. Similary many FAO studies were conducted on insecticide treatments particularly against locusts depended on judicial applications of pyrethroides like lambdacyhalothrin deltamethrin, fipronil, and different IGRs **(**FAO, 1998**)** so these insecticide groups were considered in current studies**.** It can be inferred from the results obtained that all insecticides cause significant mortality in adult locusts and mortality percentage increases as the time after application lapse. Generally, table 1 predicts that Lambda cyhalothrin 2.5EC is more potent against adult locusts than any other insecticide followed by Chlorpyrifos 40EC Deltamethrin 2.5EC and Malathion 57EC. The percent mortality induced by Lambda cyhalothrin 2.5EC was 79.83% and 84.57% after 24 and 72 hours of application respectively while toxicity caused by Chlorpyrifos 40EC was 77.50% and 83.90 % respectively. Deltamethrin was ranked as third on the basic of results obtained after experiment 73.37% and 81.133% mortality after same time of application. The results of FAO (2014) field experiment on efficacy of insecticides was in line with our research and concluded that Lambda cyhalothrin caused more an fast mortality in desert locust than

Deltamethrin and Chlorpyrifos but other researcher noted that chlorpyrifos was more toxic to adult locust then Lambda cyhalothrin 2.5EC (CERES 2004) when chlorpyrifos applied through aircraft applications at recommended doses (225 g a.i./ha). Buprofezin 25WP was found to be the least effective insecticide (41.67% & 55.70%) against locust adults as shown in the table 1.

Table 1: percentage mortality of five day old winged adult desert locusts under Field Conditions.

Sr. NO	Insecticides	Dose/liter of water	Mortality (%) after 24 hours	Mortality (%) after 72 hours
1.	Lambda cyhalothrin 2.5EC	3ml	79.833 A	84.567 A
2.	Malathion 57EC	6ml	70.833 B	77.167 B
3.	Deltamethrin 2.5EC	3ml	73.367 AB	81.133 AB
4.	Chlorpyrifos 40EC	10ml	77.500 A	83.933 A
5.	Pyriproxyfen 10.8EC	5ml	59.167 C	68.900 C
6.	Metarhizium 100g/l	6.6ml	45.100 D	57.100 D
7.	Buprofezin 25WP	5gm	41.667 D	55.700 D

Table 2: Percentage Mortality of 2nd Instars Hoppers of Desert Locust Under Field Conditions.

Sr. NO	Insecticides	Dose/liter of water	Mortality (%) after 24 hours
1.	Lambda cyhalothrin 2.5EC	3ml	96.667 A
2.	Malathion 57EC	6ml	86.000 AB
3.	Deltamethrin 2.5EC	3ml	94.333 A
4.	Chlorpyrifos 40EC	10ml	96.333 A
5.	Pyriproxyfen 10.8EC	5ml	75.333 C
6. .	Metarhizium 100g/l	6.6ml	40.000 E
7.	Buprofezin 25WP	5gm	58.000 D

Table 3: Percentage Mortality of 5th Instars Hoppers of Desert Locust Under Field Conditions.

Sr. NO	Insecticides	Dose/liter of water	Mortality (%) after 24 hours
1.	Lambda cyhalothrin 2.5EC	3ml	89.333 A
2.	Malathion 57EC	6ml	74.667 C
3.	Deltamethrin 2.5EC	3ml	82.667 B
4.	Chlorpyrifos 40EC	10ml	87.333 A
5.	Pyriproxyfen 10.8EC	5ml	65.000 C
6. .	Metarhizium 100g/l	6.6ml	36.000 E
7.	Buprofezin 25WP	5gm	47.333 D

These treatments belonged to different insecticidal groups and have different mode of action were also applied against 2nd and 5th instar hoppers of desert locusts under field conditions. It is concluded from observations that all treatments caused significant mortality in hoppers of desert locusts and hoppers showed more response toward insecticides compared to adult locusts. Similarly Holt and Copper (2006) also conclude the results that early instars of *S. gregaria* was the best target for chemical control. it was observed that Lambda cyhalothrin 2.5EC is more potent against 2nd and 5th instar hoppers of desert locust than other treatments followed by Chlorpyrifos 40EC. The percent mortality induced by Lambda cyhalothrin 2.5EC was 96.67% and 89.33% in 2nd and 5th instars respectively while lethal effect caused by Chlorpyrifos 40EC was 96.333% and 87.333 in 2nd and 5th instars respectively after 24 hours of application of insecticides as mentioned in table 2 & 3 but the Metarhizium 100g/l was least lethal (40.000 % & 36.000%) in hoppers after same time of application. Pyriproxyfen was found more effective in immature stage due to its mode action and it inhibit the larval development because it effect the juvenile hormone of the target pest. Similar results was observed by Vennard et al., 1998 that Pyriproxyfen inhibit the supernumerary characteristics in 4th instars and it also effect the 5th instar locusts hoppers as well.

3.2. Lab experiments

The bioassay conducted under controlled conditions showed in table 4 that similarly all insecticides showed significant mortality in adult locust but higher than the field conditions. The results showed that among these insecticides Lambda cyhalothrin 2.5EC caused more mortality in adult locusts under laboratory conditions followed by Chlorpyrifos 40EC and Deltamethrin 2.5EC (table 4). The toxicity of Lambda cyhalothrin 2.5EC was

81.33% and 86.00% after 24 and 72 hours of treatments while Chlorpyrifos 40EC caused 80.667% and 85.333% mortality. But Sittg (1980) did not observe the similar results as he found that Malathion is slight toxic to locust as compared to Deltamethrin. Buprofezin 25WP showed least effective results (43.33% & 57.33%) against locust adults under controlled environmental conditions as shown in the table 4 while table 5 & 6 predicts under laboratory conditions that first four treatments Lambda cyhalothrin 2.5EC, Malathion 57EC, Chlorpyrifos 40EC and Chlorpyrifos 40EC caused 100 percent mortality in 2nd instar and 5th instar hopper followed by toxicity produced by Pyriproxyfen 10.8EC was 87.23% and 84.33 after 24 hours of application of insecticides whereas Buprofezin 25WP showed least mortality (22.79% & 54.33%) after 24hours of treatment as shown in table 5 & 6. Our results are in line with Metaweh (2001) and Metaweh and Ali (1999), They all found that lambdacyhalothrin is more potent to adult locusts and pest respond more under control conditions as compared to field conditions.

Table 4: percentage mortality of five day old winged adult desert locusts under Lab. Conditions.

Sr. NO	Insecticides	Dose/liter of water	Mortality (%) after 24 hours	Mortality (%) after 72 hours
1.	Lambda cyhalothrin 2.5EC	3ml	81.333 A	86.000 A
2.	Malathion 57EC	6ml	71.333 B	78.667 BC
3.	Deltamethrin 2.5EC	3ml	74.667 AB	83.333 AB
4.	Chlorpyrifos 40EC	10ml	80.667 A	85.333 A
5.	Pyriproxyfen 10.8EC	5ml	61.333 C	70.667 D
6.	Metarhizium 100g/l	6.6ml	47.333 D	60.333 E
7.	Buprofezin 25WP	5gm	43.333 D	57.333 E

Table 5: Percentage Mortality of 2nd Instars Hoppers of Desert Locust Under Lab Conditions.

Sr. NO	Insecticides	Dose/liter of water	Mortality (%) after 24 hours
1.	Lambda cyhalothrin 2.5EC	3ml	100.00 A
2.	Malathion 57EC	6ml	100.00 A
3.	Deltamethrin 2.5EC	3ml	100.00 A
4.	Chlorpyrifos 40EC	10ml	100.00 A
5.	Pyriproxyfen 10.8EC	5ml	87.237 B
6. .	Metarhizium 100g/l	6.6ml	73.170 C
7.	Buprofezin 25WP	5gm	60.790 D

Table 6: Percentage Mortality of 5th Instars Hoppers of Desert Locust Under Lab Conditions.

Sr. NO	Insecticides	Dose/liter of water	Mortality (%) after 24 hours
1.	Lambda cyhalothrin 2.5EC	3ml	100.00 A
2.	Malathion 57EC	6ml	100.00 A
3.	Deltamethrin 2.5EC	3ml	100.00 A
4.	Chlorpyrifos 40EC	10ml	100.00 A
5.	Pyriproxyfen 10.8EC	5ml	84.33 B
6. .	Metarhizium 100g/l	6.6ml	67.66 C
7.	Buprofezin 25WP	5gm	54.33 D

3.3. Residual analysis

Seven (07) insecticides were treated with adult locust at recommended dose, the results of pesticide report described that Lambda cyhalothrin 2.5EC and Buprofezin 25WP have very low residues in locust body and totally degrade after 3 days and chlorpyriphos was found most persistent and highest residues till day 10 after application while no residues were detected in Deltamethrin 2.5EC and Carbaryl 85WP as mentioned in table 7. These results are in line to results of Paul et al., 2013 as he detected that Deltamethrin 2.5 EC and Pyriproxyfen 10.8 EC have very low residues in the body of locust and according to Castro et al., 2002 chlorpyriphos was found most persistent.

Table 7: Residues of insecticides used on Five day old winged adult locust.

Sr #	Insecticides	Result (ppm) days after application						
		Day1	Day2	Day3	Day7	Day10	Day15	Day20
1.	Chlorpyrifos 40EC	21.3	20	20	0.27	0.18	ND	ND
2.	Deltamethrin 2.5EC	ND	ND	ND	ND	ND	ND	ND
3.	Lambda cyhalothrin 2.5EC	2.95	2	1.8	ND	ND	ND	ND
4.	Malathion 57EC	2.03	1.9	1.7	1.14	0.53	ND	ND
5.	Metarhizium 100g/l	ND	ND	ND	ND	ND	ND	ND
6.	Buprofezin 25WP	0.46	0.44	0.38	0.09	0.07	ND	ND
7.	Pyriproxyfen 10.8EC	ND	ND	ND	ND	ND	ND	ND

4. Conclusion

It is concluded that Lambda cyhalothrin 2.5EC and Chlorpyrifos 40EC are recommended for use against adult and immature stages. Pyriproxyfen 10.8EC is only effective for immature hopper stage. Locusts Hoppers are controlled easier as compared to matured winged adult locusts.

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7/25/2020