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EFFICACY OF DIFFERENT GROUPS OF INSECTICIDES AGAINST COTTON STAINER (*DYSDERCUS KOENIGII*) IN FIELD CONDITIONS

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ABSTRACT

A total of 18 insecticides belonging to organophosphate, carbamate, pyrethroid and neo-nicotinoid groups were evaluated for control of *Dysdercus koenigii* in cotton at the Central Cotton Research Institute, Multan, Pakistan during 2012. Experiments were conducted in a Randomized Complete Block Design (RCBD) with three replications. Adults and nymphs of *D. koenigii* were collected from different locations of Multan District and reared in muslin cloth cages of 2.1m X 0.91m X 0.91m in field conditions. All insecticides were significantly different in relation to *D. koenigii* mortality than untreated control. Among the insecticides, alphacypermethrin 5EC (Pyrethroid) proved most effective and gave 100% pest mortality followed by deltamethrin 2.5EC (93.8%), cypermetrin 10EC (78.7%) and lambdacyhalothrin 2.5EC (70%) 24 hours after treatment. While, dimathoate 40EC, chlorfenapyr 360SC and malathion 57EC proved least effective and gave less than 33% pest mortality. After 72 hours of the treatment, most of the insecticides gave 100% pest mortality except bifenthrin 10EC, chlorfenapyr 360SC, thiacloprid 48SC, malathion 57EC, gammacyhalothrin 60CS, acetamiprid 20SP, thiamethoxam 70WG and thiacloprid 48SC. Among the insecticidal groups, pyrethroids proved most effective followed by carbamates, neo-nicotinoids and organophosphates after 24 hours of application while, after 72 hours, carbamates gave maximum pest mortality followed by organophosphates, pyrethroids and neo-nicotinoids.

Keywords: Carbamates, Cotton stainer, *Dysdercus koenigii*, Neo-nicotinoids, Organophosphate Pyrethroids

INTRODUCTION

Agriculture is the backbone of Pakistan's economy and majority of the population is engaged in farming directly or indirectly through production, processing and distribution of major agricultural commodities. It contributes about 21% of our Gross Domestic Product (GDP), providing livelihood to almost 68% people living in rural areas and employing around 45% of the total national labour force (PBS, 2011). Cotton being among the major crops of the country is an important cash crop which significantly contributes to the national economy by providing raw material to the local textile industry, such as cotton lint as an export item. It accounts for 7.8% of value added in agriculture and 1.6% of the GDP. During 2011-12, the crop was cultivated on an area of 2.835 million ha with a production of 13.6 million bales (PES, 2012).

Before the introduction of genetically modified varieties (Bt-cotton), bollworms were effectively controlled through pyrethroid insecticides on conventional varieties. However, due to the reduced use of these insecticides on *Bt* cotton, incidence of secondary pest outbreaks increased and have subsequently become major pests of cotton. Previously, the cotton stainer (red cotton bug) was rarely observed on cotton during October onwards and the damage caused by it was of minor concern. Consequently, the farmers having adopted cotton varieties allowed the cotton stainer to become a potential pest of cotton. According to Greene and Turnipseed

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(1996) the reduced use of broad spectrum insecticides in cotton (specifically varieties producing protein from *Bacillus thuringiensis*) has allowed minor pest complex to become a major pest group of the crop.

A few years ago red cotton bug was considered a minor pest however this boll-feeding insect with piercing sucking mouthparts has now become a common pest of cotton. It is thought that major cause of cotton staining is *Dysdercus koenigii* (Anonymous, 2011b). Cotton stainer especially *D. koenigii* F., (Hemiptera: Pyrrhocoridae) has been found most destructive pests of cotton in the cotton zones of Pakistan during the 2011 (Jaleel *et al*., 2013). Its population flared up during the last four years, as before 2010 it was reported very nominal. *D. koenigii* has recently become an important insect pest of cotton crop in Pakistan having a key role in the facts and figures of the country's economy. This insect has caused substantial economic losses in cotton crop in the cotton growing areas of Pakistan (Shah, 2014). A national seminar was organized by Central Cotton Research Institute (CCRI), Multan on cotton stainer: an emerging serious threat for cotton production in Pakistan (Anonemous, 2011a).

Main damage of red cotton bug is the injection of fungal spores (Nematospora) into the boll and the developing fungus stains the lint (Hill and Waller, 1990). The insect feed mainly on the milky contents of seed kernels. Little damage is done to very young fruits but the perforation may cause bolls to fall. In green bolls less than 25 days old, the perforation induces a reaction which results in the formation of cankers (neoplasmic outgrowths) in the locules and numerous micro-organisms can enter through the perforation wound. This is a characteristic symptom of stigmatomycosis. In older bolls, which have not yet opened, there is no tissue reaction; the entry of germs causes internal boll to rot. In open bolls, cotton stainer feeds directly on the seed. Its excrement stains the fibers and reduces the germination power of the seeds by wounding the embryos. Shedding of very young boll, rotting in green bolls with or without internal cankers, stained cotton fibers, tight lock phenomenon of bolls and loss of seed viability are all caused by this insect species (Cauquil, 1988). This species reproduces rapidly in the field, has fast and efficient egg development (Venugopal *et al*., 1994).

Chemical control of the pests becomes imperative when all other control methods fail to control the target pests (Bashir *et al*., 2001; Raza and Afzal, 2000). It is reported that about 90% of the farmers use chemical insecticides (Prayogo *et al*., 2005). Crop protection with chemicals is desirable and an unavoidable part of integrated pest management (Mohyuddin *et al*., 1997). Even in the technologically advanced countries, about 3% market value of agriculture crops is spent on toxic chemicals and their application.

It is clear from the above review that environmentally safe plant protection is a major challenge for sustainable cotton production because, producing high yield products has always been an important part of farming. Chemical control is an essential and sometimes unavoidable component to achieve high yield but, it is important to know and understand the drawbacks of continuous insecticide applications. However, we can minimize the negative impacts on humans, animals and environment with better management strategy (BMS) programme. In this context, before the chemical application, it must be understood what, when, how and why to spray.

Due to current substantial economic losses of red cotton bug to cotton in the cotton growing areas of Pakistan, it was necessary to be screened out available insecticides against the pest. We have found very limited literature on cotton stainer except hematological study in laboratory conditions. Jaleel *et al.,* (2013) also mentioned in his recent study that in order to develop an effective pest management system for *D. koenigii*, the studies on life cycle, reproductive biology and bionomic of the pest are necessary. The information on these aspects of *D. koenigii* in Pakistan is very little. The main objective of this study was to find out the most effective chemicals for cotton stainer management and minimize the risk of resistance.

MATERIALS AND METHODS

Eighteen insecticides belonging to the groups: organophosphate, carbamate, pyrethroid and neo-nicotinoid were tested against *D. koenigii* in Central Cotton Research Institute (CCRI), Multan (Punjab), Pakistan at the end of October, 2012 (Table 1).

Cotton variety *Bt*-CIM-599 was sown on 16^{th} May in a Randomized Complete Block Design (RCBD) with three replications and the plot size of 6.6 m × 6.6 m. Plant to plant space was 0.4m while, replication to replication was 1.8m apart to avoid the chance of mixing of *D. koenigii* population after release.

Adults and nymphs of *D. koenigii* were collected from *Bombax ceiba* (red silk cotton tree) from various parts of Shujabad, CCRI, Multan and early sown cotton of Makhdoom Rasheed area. Okra, hollyhock and plants of family bombacaceae were recorded as alternate hosts of *D. koenigii* (Kohno and Ngan, 2004). Prior to conducting the screening trial, collected adults and nymphs were reared in cages, made of iron frame covering with thin white muslin cloth of 2.1 x 0.91 x 0.91 m size. One fifty (150) of the pest were released in each repeat of every treatment. After 48 hours of the releases, application done on crop at fruiting phase with hand knapsack sprayer with hollow cone nozzle. After spray, pest were collected along with vegetative and reproductive parts as feed in 0.6 x 0.6 x 0.6 m sized plastic rearing chambers and kept in the laboratory. Temperature and relative humidity (RH) were maintained 30-35 °C and 60-70% respectively. Percent insect mortality was recorded at 24 and 72 hours of treatment.

RESULTS

Percent mortality of *D. koenigii* by insecticides

After 24 hours of insecticides application

Most of the tested insecticides were statistically different from each other while 2.0% pest mortality was observed in check plots. Among the insecticides, alpha-cypermelthrin 5EC and deltamelthrin 2.5EC proved most effective and gave maximum mortality of *D. koenigii* (100 & 93.8%, respectively) followed by cypermethrin 10EC (78.7%) and lambdacyhalothrin 2.5EC (70%). Gamma-cyhalothrin 60CS, carbosulfan 500SC, triazophos 40EC and imidacloprid were statistically at par and gave 59.7-67.8% pest mortality. While diafenthiuron 50 SC, bifenthrin 10EC, thiamethoxam 70WG

Table 1

Groups and common names of insecticides tested against *Dysdercus koenigii*.

Group	Common name	Dose /100 liter water
Organophosphate	Triazophos 40EC	600 ml
	Profenofos 50EC	500 ml
	Dimethoate 40EC	400 ml
	Malathion 57EC	250 ml
	Acephate 75SP	250 g
Carbametes	Carbosulfan 500SC	500 ml
Pyrethroids	Deltamethrin 2.5EC	250 ml
	Lamdacyhalothrin 2.5EC	330 ml
	Alpha-cypermethrin 5EC	250 ml
	Bifenthrin 10EC	250 ml
	Cypermethrin 10EC	250 ml
	Gammacyhalothrin 60CS	100 ml
Neo-nicotinoids	Acetamiprid 20SP	125 g
	Imidacloprid 20SL	250 ml
	Diafenthiuron 50SC	200 ml
	Chlorfenapyr 360SC	225 ml
	Thiamethoxam 70WG	24.g
	Thiacloprid 48SC	25 ml

and acetamiprid 20SP showed moderate efficacy and gave 42-50% pest mortality. Thiacloprid 48SC, acephate 75SP and malathion 57 EC were statistically at par and gave low mortality (32.6-39.4%). Whereas, chlorfenapyr 360SC and diamethoate 40EC proved least effective against this pest after 24 hours of the spray and gave 16.3 and 17.4% mortality respectively followed by profenofos 50EC (28.8%) (Table 2).

After 72 hours of insecticides application

Statistical analysis showed that most of the tested insecticides were statistically at par and gave 100% pest mortality. Among the rest of the insecticides, thiamethoxam 70WG, malathion 57EC, gamma-cyhalothrin 60CS and acetamiprid gave more than 89.5% pest mortality and were significantly at par. Lowest pest mortality was observed by bifenthrin 10EC (72.9%) followed by chlorfenapyr 360SC (73.9%) and thiacloprid 48SC (80.7%) and proved least effective insecticides while only 4.0% mortality was recorded in untreated check (Table 2).

Fig. 1
Stained and locked lint

Fig. 2
Warts (callus tissue) on internal carpal wall

Fig. 3
Severe lesions and partially opened boll

Fig. 4
Severe bad opening of mature boll

Table 2

Percent mortality (Mean ± standard error) of *D. koenigii* caused by different insecticides after spray at 24 and 72 hours interval.

Insecticides	% mortality ± S.E.M. of *D. koenigii* after Treatment	
	24 hours	72 hours
Triazophos 40EC	61.2±2.98 d	100.0±0.00 a
Profenofos 50EC	28.8±1.72 h	100.0±0.00 a
Dimethoate 40EC	16.3±1.08 I	100.0±0.00 a
Malathion 57EC	32.6±1.78 gh	91.3±3.49 b
Acephate 75SP	38.5±1.63 fg	100.0±0.00 a
Carbosulfan 500SC	62.7±2.52 cd	100.0±0.00 a
Deltamethrin 2.5EC	93.8±1.58 a	100.0±0.00 a
Lambdacyhalothrin 2.5EC	70.0±2.54 c	100.0±0.00 a
Alpha-cypermethrin 5EC	100.0±0.00 a	100.0±0.00 a
Bifenthrin 10EC	50.0±2.82 e	72.9±2.00 d
Cypermethrin 10EC	78.7±1.76 b	100.0±0.00 a
Gammacyhalothrin 60CS	67.8±2.77 cd	89.8±2.24 b
Acetamiprid 20SP	42.1±1.92 ef	89.5±2.20 b
Imidacloprid 20SL	59.7±2.51 d	100.0±0.00 a
Diafenthiuron 50SC	50.0±1.24 e	100.0±0.00 a
Chlorfenapyr 360SC	17.4±1.25 I	73.9±2.58 d
Thiamethoxam 70WG	44.0±4.00 ef	94.8±1.35 ab
Thiacloprid 48SC	39.4±2.75 fg	80.7±2.24 c
Untreated check	2.0 ± 0.32 j	4.0 ± 0.33 e

Values sharing same letters differ non-significantly ($P > 0.01$). CV (Coefficient of variance) values at 24 hours and 72 hours were 7.55 and 2.77, respectively.

The *D. koenigii* were reared after collection from different locations of Multan. The cotton stainer mostly attacks cotton on boll formation stage by piercing the fruit wall and feeding on immature seeds (Fig. 1-4). Feeding on small bolls resulted indirect yield losses by causing them to abscise from the plant and bad opening of mature bolls. While piercing in to seed it inserts bacteria, *Pantoa agglomaraus* inside the boll which ultimately result into fibre staining and boll rottening (Anonymous, 2011a). It usually sucks the moisture contents from the cotton seeds and stains the lint by its excreta (Rab *et al*., 1983). The hemipteran pests have piercing-sucking type of mouth parts with the segmented beak arising from the anterior portion of the head. Such type of mouth parts may have enzymes that internally deteriorate the quality of the developing lint (Elzinga, 1997). *D. cingulatus* insert proboscis into the soft tissues of cotton boll, produces an abnormal out-growth (warts) into the internal carpel wall of the boll, resulting in occurrence of lesions on the respective locule lint (Wilson *et al*., 2004; Cauquil, 1988).

Percent mortality of *D. koenigii* by different insecticidal groups

After 24 hours of insecticides application

Among the efficacy of different insecticidal groups against *D. koenigii*, all the groups were significantly different (P<0.01) from each other. Pyrethroids proved most effective and gave knock down results against the pest. Pyrethroids gave 76.72% pest mortality which was significantly different from other groups followed by carbamates (62.7%). Whereas, neo-nicotinoids and organophosphates were statistically at par and gave 42.1 and 35.5% pest mortality, respectively. On the other hand, 2.0% mortality of *D. koenigii* was observed in untreated check plots (Table 3).

After 72 hours of insecticides application

The efficacy of all the tested insecticidal groups increased after 72 hours of the treatment and increasing trend was observed in pest mortality as compared to 24 hours observations. These groups showed significantly ($P<0.01$) different results from each other but caused more than 89% pest mortality. However, carbamates and organophosphate were statistically similar and most effective against the pest with 100 and 98.26% pest mortality, respectively. On other hand neo-nicotinoids proved less effective as compared to other groups and caused 89.8% mortality. Pyrethroids demonstrated 93.8% mortality while 4.0% mortality was recorded in check plots (Table 3).

Table 3

Percent mortality (Mean ± standard error) of *D. koenigii* caused by different insecticides groups after spray at 24 and 72 hours interval.

Groups of insecticide	% mortality ± S.E.M. of *D. koenigii* after Treatment	
	24 hours	72 hours
Organophosphate	35.5±0.39 c	98.3±0.70 a
Carbametes	62.7±2.52 b	100.0±0.00 a
Pyrethroids	76.7±0.51 a	93.8±0.69 b
Neo-nicotinoids	42.1±1.20 c	89.8±0.85 c
Untreated check	2.0 ± 0.32 d	4.0 ± 0.33 d

Values sharing same letters differ non-significantly (P>0.01). CV (Coefficient of variance) values at 24 and 72 hours were 5.21 and 1.20, respectively.

DISCUSSION

Due to its substantial economic losses to cotton, in the cotton growing areas of Pakistan, it was necessary to screen out available insecticides against the cotton stainer. We found very limited literature on cotton stainer studies except hematological study in laboratory conditions. Jaleel *et al.* (2013) recently conducted a study on cotton stainer to develop an effective pest management system for *D. koenigii*. The studies on life cycle, reproductive biology and bionomics of the pest are necessary. The information on these aspects of *D. koenigii* in Pakistan is very little.

Darvas *et al*. (1997) reported that the extracts of *Ajuga reptans* were effective on larvae of *D. cingulatus*. They reported that among the synthetic pyrethroids, the lambdacyhalothrin and gammacyhalothrin were effective against the cotton stainer. It may be incidentally controlled when carbamates such as carbaryl or organophosphates such as dimethoate are used (Ahmad *et al.* 1996; Qamar and Jamal, 2005). Saradamma, 1989; Misbahuddin and Ehteshamuddin, 2000 reported that synthetic chemical insecticides can efficiently control *D. cingulatus* Fabr. Knutson and Smith (1999) revealed that acephate and dimethoate are very effective against plant bugs. Jawale (2010) obtained best results with spraying of malathion 57 EC and endosulfan 35% EC for control of the cotton stainer. Rejesus *et al.* (1995) also reported similar results for cotton stainer control.

Wilson *et al*. (2004) termed cotton stainer *(D. cingulatus*) as an occasional pest due to which very few products have been registered for its control. Crude extract of *Lantana camara* L. flowers has been reported toxic against the cotton stainer by Rejesus *et al.* (1986) showing that the insect is vulnerable to phytotoxicity or allelopathy. Similar to our results, Rosaiah *et al.* (1980) reported the cypermethrin as an effective insecticide against *D. cingulatus*. Willrich *et al.* (2000) stated that insecticides representing the neonicotinoid class (imidacloprid, thiamethoxam, acetamiprid) have been evaluated against stink bugs. Jeremy *et al.* (2006) stated that there is an extensive list of commercial insecticides (primarily organophosphates and pyrethroids) recommended against boll-feeding bugs that consistently provide satisfactory control. In organophosphates, acephate, dicrotophos and methyl parathion are most effective; whereas, in the pyrethroids, bifenthrin, cyfluthrin, deltamethrin, gamma-cyhalothrin, lambda-cyhalothrin, tralomethrin, and zeta-cypermethrin are the best choices.

Sharma *et al.* (2010) tested efficacy of *Azadirachta indica* (neem) leaves, green seed coat, yellow seed coat and seed kernel against *D. cingulatus* in the lab. at 0.005%, 0.01%, 0.025%, 0.05%, 0.1%, 0.25%, 0.5% and 1.0% (v/v) concentration respectively. It was observed that *D. cingulatus* adults showed highest mortality (75%) at 1.0% concentration of the neem seed kernel, whereas, the least mortality was (5%) recorded with yellow neem seed coat at 0.005%. Padhi *et al*. (2012) conducted field experiments on cotton to test infrared thermography can distinguish systematic variation in deficit irrigation applied to various parts of the field over time. During the experiment, they had controlled pale cotton stainer by applying deltamethrin belong to pyrethroids group at a rate of 200 ml ha^{-1} and got efficient control. Occasionally, resurgence of cotton stainers can be suppressed with lindane and dimethoat, respectively (Bournier and Vaissayre 1977).

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