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EFFICACY OF DIFFERENT GROUPS OF INSECTICIDES AGAINST DUSKY COTTON BUG, *OXYCARENUS LAETUS* KIRBY IN FIELD CONDITIONS OF PAKISTAN

[1*]S.I.A. Shah, [1]M.T. Jan, [1]M. Rafiq, [2]T.H. Malik, [1]I.R. Khan and [3]Z. Hussain

[1*]Syed Ishfaq Ali Shah (Scientific Officer) Entomology Section,

[1]Muhammad Tahir Jan (Senior Scientific Officer) Entomology Section,

[1]Muhammad Rafiq (Principal Scientific Officer) Entomology Section,

[2]Tassawar Hussain Malik (Director Research) R&D Wing,

[1]Imran Rafi Khan (Scientific Officer) Statistic Section and

[3]Zahid Hussain (Assistant Professor) Weeds Science Department

[1]Central Cotton Research Institute (CCRI), Multan, Punjab, Pakistan

[2]Pakistan Central Cotton Committee (PCCC), Multan, Punjab, Pakistan

[3] University of Agriculture, Peshawar, Khyber Paktun Khawa (KPK), Pakistan

*Corresponding author: sias337@yahoo.com, 0086-18101300619 and 0092-3339150857

ABSTRACT

To assess the efficacy against dusky cotton bug (*Oxycarenus laetus*) in field conditions, a total of 12 insecticides belonging to five different groups viz. Organophosphate, Pyrethroid, Neo-nicotinoid, Naturalyte and Insect Growth Regulator (IGRs) were tested at the Central Cotton Research Institute, Multan, Pakistan during 2014. Percent mortality was recorded after 24 and 72 hours of application. All tested insecticides were significantly different in relation to pest mortality than untreated check, while mortality ranged from 12.5 to 85.0% and 60.0 to 100% respectively after 24 and 72 hours of the application. Among the insecticides, Triazophos proved most effective and gave 85% mortality followed by Imidacloprid (79.2%), Profenofos (78.0%) and Dimethoate (75.0%) while Spinosad gave lowest pest mortality (12.5%) followed by Emamactin (16.7%), Pyriproxifen (25.0%) and Diafenthiuron (30.0%) after 24 hours of application. Efficacy of all the insecticides increased after 72 hours of the application and they gave 100% mortality except Pyriproxyfen (60.0%), Emamectin (62.5%), Diafenthiuron (80%) and Spinosad (83.3%). In untreated check 3.8 and 8.4% pest mortality was recorded respectively after 24 and 72 hours of application. Among the different insecticidal groups, Organophosphates proved most effective and gave 79.3% pest mortality followed by Pyrethroids (53.6%) and Neo-nicotinoids (53.4%) while Naturalite proved least effective and gave 14.6% mortality followed by Insect Growth Regulator (IGRs) (25.0%) after 24 hours of the application. Whereas, Organophosphates and Pyrethroids gave 100% pest mortality 72 hours of application followed by Neo-nicotinoids (93.3%) while, IGRs and Necotinoids proved least effective and gave 60.0 and 72.9% pest mortality respectively.

Keywords: Chemical control, cotton, dusky cotton bug, insecticides, *Oxycarenus laetus*

1. INTRODUCTION

The cotton having a share of 1.4% in GDP and 6.7% in agriculture value addition and is an important source of raw material to the textile industry. During 2013-14, the crop was cultivated on an area of 2,806,000 hectares, 2.5% less than last year's area (2,879,000 hectares). The production stood at 12.8 million bales during the period 2013-14 against the target of 14.1 million bales, showed decline of 9.2% against the target and decline of 2.0% over the last year production of 13.0 million bales (PEC, 2014). Insect pests are one of the most important factors responsible for low yields of cotton. These insects include major, minor, occasional or potential insect pests which cause 30-40% yield losses in cotton crop in Pakistan (CCRI, 2005).

Khan *et al*, (2014) confirmed the species and stated that dusky cotton bug, *Oxycarenus laetus* Kirby (Hemiptera: Lygaeidae), is a serious threat to cotton due to early cultivation of *Bt.* cotton in Pakistan. Dusky cotton bug has become a highly risky pest which poses a significant economic threat (Peral, 2006; Smith and Brambila, 2008) and was considered to be the minor pest of cotton; however it is now going to become the great threat to the early and late cotton crop in Pakistan. This pest has recently become a wide spread and common pest of economic importance. Both nymphs and adults feed on immature seeds causing multiple types of injuries to the crop including reduction in cotton yield, seed weight and oil contents (Sewify and Semeada, 1993; Srinivas and Patil, 2004). Dusky cotton bug may also feed on the leaves and young stems of the host plants to obtain moisture (Ananthakrishan *et al*, 1982). It causes severe damage to the embryo, reduces seed viability (Kirkpatrick, 1923; Pearson, 1958; Srinivas and

Patil, 2004) and deteriorates quality of cotton by staining lint (Henry, 1997; Sweet, 2000) stated that dusky cotton bug (also called cotton seed bug) is a serious pest of cotton seeds. Sometime, the bugs are crushed in the ginning process, staining the lint. Greater damage is done to the seeds by reducing quality, germination and oil content.

With effective control of cotton pests, yield of cotton can be increased by 200-300 kg ha^{-1} (Khan *et al,* 1987). There are different pest control tactics, but the most common and quicker one is that of chemical control which is generally adopted by our farming community. 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). A common strategy preferred by farmers to protect cotton crop is the utilization of chemical pesticides as they are highly effective and often have knock down effect. It is reported that about 90% farmers protect crops from pests using chemical insecticides (Prayogo *et al,* 2005). Crop protection with chemicals is desirable and unavoidable part of integrated pest management (Mohyuddin *et al,* 1997). Even in the technologically advanced countries, about three percent of market value of agriculture crops is spent on toxic chemicals and their application.

A huge number of synthetic pesticides are used annually for insect pest control. No doubt agrochemicals have a major role in improving yields in food production; however, concern has arisen about the negative impact of such chemicals on human health and environment (Dinham, 1993). Indiscriminate use of insecticides has not only caused the resistance problem in these pests but it has also polluted the environment along with other health hazards (Raza and Afzal, 2000; Bashir *et al.,* 2001). Therefore, the judicious and effective use of chemicals at proper time is most important. Insecticides against the particular insects, continuously over a long period cause resistance in them (Wang *et al.* 2011).

It is clear from the above review that sucking behavior of dusky cotton bug disturbs the cotton crop at early (squares and flowers) as well as the late stages (open bolls) but most economic losses are caused in the late stage. It extracts the sap from the reproductive parts of plants and can also deteriorate the seed quality. Besides damaging the seeds and the reproductive parts, it worsens the lint quality resulting in poor ginning of cotton fibers. The lint is stained, the quality of which is lowered resulting in its price fall down in market. Secondly, dusky cotton bug can only be observed when majority of cotton bolls get opened, at this time neither any recommended insecticide is available nor is known a dose rate for controlling these bugs (see details in the discussion chapter). Third, environmentally safe plant protection is a major challenge for sustainable cotton production because producing high yield has always been an important part of farming. Chemical control is essential, unavoidable component to achieve high yield but, it is important to know the drawbacks of insecticides application. We can minimize the negative impacts on humans, animals and environment with better management strategy (BMS). In this context, before the chemical application it must be understood what to spray, when to spray, how to spray and why to spray?

Keeping the above four main highlighted issues, a study was conducted to find out the most specific and effective chemicals against dusky cotton bug when majority of mature bolls of cotton crop are opened which will minimize the risk of afore-mentioned drawbacks of pesticides efficiently.

2. MATERIALS AND METHODS

Twelve insecticides belonging to groups; Organophosphate, Pyrethroid, Neo-nicotinoid, Naturalyte and Insect Growth Regulators (IGRs) were tested against *O. laetus* in Central Cotton Research Institute (CCRI), Multan in 2014 (Table 1). Experiments were conducted in an acre field, with bed and rows crop pattern. Each treatment was replicated three times (each replication had two plants). Data were complied with Randomized Complete Block (RCB) design. In each replication, plant to plant space was kept 1.5 ft., while replication to replication distance was 3 ft., so that to avoid the chance of mixing of dusky cotton bug. Adults of dusky cotton bug were collected from different locations from early sown cotton fields of Multan district and were released carefully on leaves, squares, flowers, green and open bolls.

A hundred and fifty (150) adults of dusky cotton bug per tagged replication were released and then plants were sprayed. One hundred (100) sprayed adults of dusky cotton bug out of the 150 from each replication were collected carefully along the vegetative and reproductive bodies of the sprayed plants in large sized plastic chambers and brought to laboratory. Temperature and R.H. were maintained as 30-35 °C and 60-70%, respectively. Percent mortality after 24 and 72 hours of application was recorded. However, percent mortality after one week of spray was avoided to record because natural mortality in the control check was observed more than 10%. Vegetative as well as reproductive sprayed bodies of cotton plants were observed when dried.

Table 1. Groups and common names of insecticides tested against *Oxycarenus laetus*

Group	Common name	Dose/100 liter water
Organophosphates	Triazophos 40 EC	600 ml
	Profenofos 50 EC	500 ml
	Dimethoate 40 EC	400 ml
Pyrethroids	Deltamethrin 2.5 EC	250 ml
	Lambdacyhalothrin 2.5 EC	330 ml
	Bifenthrin10 EC	250 ml
Neo-nicotinoids	Acetamiprid 20 EC	150 ml
	Imidacloprid 25 WP	250 g
	Diafenthiuron 50 SC	200 ml
Naturalyte	Spinosad 240 SC	80 ml
	Emamectin1.9 EC	200 ml
Insect Growth Regulators (IGRs)	Pyriproxyfen 10.8 EC	500 ml

3. RESULTS

The percent mortality caused by the 12 insecticides belonging to five different chemical groups was recorded against *Oxycarenus laetus* after 24 and 72 hours after spray.

3.1 Percent mortality by the insecticides

After 24 hours of the application, most of the tested insecticides were statistically different from each other while 3.8% pest mortality was observed in check plots. Among the insecticides, Triazophos proved most effective and gave 85% mortality of *O. laetus* followed by Imidacloprid (79.2%, Profenofos (75.0%) and Deltamethrin (70.0%) which all three were statistically at par while Acetamiprid, Bifenthrin and Lambda-cyhalothrin were non significant to each other and showed moderate efficacy with 45.0 – 50.9% pest mortality. Diafenthiuron and Pyriproxyfen were statistically similar and gave low mortality (30 & 25% respectively). Whereas, Spinosad and Emamectin proved least effective against this pest after 24 hours of the spray and gave 12.5 & 16.7% pest mortality respectively.

All the insecticides enhanced their efficacy after 72 hours of spray and most of the tested insecticides gave 100% pest mortality. Among the rest of the insecticides, Diafenthiuron 50 EC and Spinosad 240 SC gave respectively. 80 & 83.3% pest mortality and were significantly at par. Lowest pest mortality was found by Pyriproxyfen 10.8 EC (60.0%) and Emamectin 1.9 EC (62.5%) and proved least effective. While only 8.4% mortality was recorded in untreated check (Table-2).

Table 2. Percent mortality (Mean ± standard errors) of *O. laetus* caused by different insecticides after spray at 24 and 72 hours intervals

Insecticides	% mortality ± S.E.M. at	
	24 hours	72 hours
Triazophos 40 EC	85.0 ± 3.23 a	100.0 ± 0.00 a
Profenofos 50 EC	78.0 ± 3.30 ab	100.0 ± 0.00 a
Dimethoate 40 EC	75.0 ± 3.32 ab	100.0 ± 0.00 a
Deltamethrin 2.5 EC	70.0 ± 4.06 b	100.0 ± 3.49 a
Lambdacyhalothrin 2.5 EC	45.0 ± 4.48 c	100.0 ± 0.00 a
Bifenthrin10 EC	45.8 ± 4.20 c	100.0 ± 0.00 a
Acetamiprid 20 EC	50.9 ± 3.40 c	100.0 ± 0.00 a
Imidacloprid 25 WP	79.2 ± 4.08 ab	100.0 ± 0.00 a
Diafenthiuron 50 SC	30.0 ± 3.35 d	80.0 ± 4.51 b
Spinosad 240 SC	12.5 ± 2.02 e	83.3 ± 3.91 b
Emamectin1.9 EC	16.7 ± 2.10de	62.5 ± 3.76 c
Pyriproxyfen 10.8 EC	25.0 ± 3.98 de	60.0 ± 2.87 c
Untreated check	03.8 ± 0.75 f	08.4 ± 1.22 d

Mean ± standard error. Values sharing same letters differ non-significantly (P>0.01).
CV% values at 24 and 72 hours are 12.28 and 4.55 respectively

3.2 Percent mortality by different insecticidal groups

Among the five tested groups, Organophosphate proved most effective and gave 79.3% *O. laetus* mortality which was statistically different from others. Pyrethroids and Neo-nicotinoids showed moderate efficacy and gave 53.6 & 53.4% pest mortality respectively while both groups were non-significant to each other. Naturalytes proved least effective and gave only 14.6% pest mortality followed by IGRs with 25% mortality. These both groups are statistically at par.

After 72 hours of the application, efficacy of all the insecticidal groups increased and found much higher than of 24 hours. Organophosphates and Pyrethroids proved most effective and gave 100% pest mortality followed by Neo-nicotinoids with 93.3% mortality but statistically all these groups were non significant to each other. IGRs proved least effective and gave 60% pest mortality followed by Naturalytes with 72.9% mortality while both groups were statistically different to each other (Table-3).

Table 3. Percent mortality of *O. laetus* caused by various insecticides groups after spray at 24 and 72 hours interval

Groups of insecticide	**% mortality ± S.E.M. at**	
	24 hours	**72 hours**
Organophosphate	79.3 ± 2.39 a	100.0 ± 0.00 a
Pyrethroids	53.6 ± 2.46 b	100.0 ±0.00 a
Neo-nicotinoids	53.4 ± 1.41 b	93.3 ± 1.50 a
Naturalyte	14.6 ± 0.58 c	72.9 ± 3.46 b
Insect Growth Regulator	25.0 ± 3.97 c	60.0 ± 2.87 c

Mean ± standard error. Values sharing same letters differ non-significantly (P>0.01).
CV% values at 24 and 72 hours are 8.48, and 4.70 respectively.

4. Discussion

Before the wide adaptation of genetically modified cotton varieties, mostly attack of bollworms was effectively controlled through some conventional and synthetic pyrethroid insecticides on conventional cotton varieties. Now reduction in the use of these insecticides on transgenic cotton increased the incidence of minor pest's damage and eventually such minor pests have become major pests of cotton. In past, dusky cotton bug was reported below 5% damage on conventional varieties at the time when most of the cotton bolls got opened, therefore, the damage caused by the bugs was negligible. When farmers abandoned conventional varieties and started sowing *Bt*. cotton very early; this bug became a serious threat for cotton crop. Patil and Rajanikanth (2005) mentioned that incidence of dusky cotton bug is increasing on *Bt.* cotton compared to non *Bt.* cotton because of reduction in insecticides application for bollworm management. Insecticides that applied against bollworms typically in non transgenic *Bt.*-cotton varieties during the mid to late seasons successfully minimize the population of these bugs.

The best performance by Triazophos, Imidacloprid, Profenofos and dimethoate among the insecticides could be due to their desirable mode of action that effectively blocked a physiological mechanism in the target insect right 24 hours of application and after 72 hours mortality reached upto 100%. Triazophos mainly controls the chewing and sucking insects in crops like cotton, rice, vegetables, and fruits etc. Though it is non-systemic but it can penetrate deeply into the plant tissues due to its translaminar properties. The mode of action of Imidacloprid is based on interference of the transmission of impulses in the nerve system of insects. It is a systemic insecticide that stimulates certain nerve cells by acting on a receptor protein. It is inactivated either very slowly or not at all and has both contact and ingestion activity. The target pest's feeding activity ceases within minutes to hours, and death occurs usually within 24-48 hours but can take up to 7 days depending on the mode of application. The reason for its reliable insect control is long residual activity and highest selectivity. Profenofos is a non-systemic insecticide inhibiting biosynthesis of acetylcholinesterase with contact and stomach action. It exhibits a translaminar effect, has ovicidal properties and controls insects (particularly Lepidoptera) on cotton, maize, sugar beet, potatoes, vegetables, tobacco, and other crops, at 250-1000 g ha^{-1}. However, phytotoxicity may occur at higher doses and slight reddening of cotton may take place. Dimethoate is a widely used Organophosphate insecticide used to kill insects on contact. Dimethoate is also an acetyl-cholinesterase inhibitor which disables cholinesterase, an enzyme essential for central nervous system function. The values of co-efficient of variation (CV) were quite reliable and valid as obvious from the Table-2.

Looking at the average mortality of *O. laetus* all the five insecticides groups had a significant impact (Table 3). The highest mortality caused by Organophosphate group (the general name for esters of phosphoric acid) could be due to the fact that these are the most pervasive compounds. Organophosphates are the basis of many insecticides, herbicides, and nerve agents. However, they are of concern to both scientists and regulators because they work by irreversibly blocking an enzyme that's critical to nerve function in both insects and humans. Neo-nicotinoid and pyrethroid groups caused less mortality than Organophosphate group but more than Naturalyte group. Neonicotinoids are a class of neuro-active insecticides chemically similar to nicotine. However, their toxicity to human health is less than Organophosphate group. Pyrethroids group has insect repellent properties and are generally harmless to human beings in low doses but can harm sensitive individuals. The lowest mortality by Naturalyte group and IGR group could be attributed to the fact that they only target the juvenile harmful insect populations while causing less detrimental effects to the beneficial insects. Unlike classic insecticides, IGRs do not affect an insect's nervous system and are thus more worker-friendly within closed environments.

The mortality of *O. laetus* was higher after 72 hours of insecticidal application as compared with 24 hours because of the fatal influence gradually influenced the insect physiology which culminated in the highest control. Smith and Brembila (2008) tested four mixtures of IGRs and four synthetic Pyrethroids in cotton fields and found that all tested insecticides effectively reduced adult and nymph population levels of dusky cotton bug by more than 80%. In other areas of its distribution, effective control of the dusky cotton bug has been achieved through the use of a combination of chemicals with both contact and systemic properties. Sprays or dusts may be applied when the bugs are seen on newly opened bolls (Hill, 1983). Ibrahim *et al*, (1993) investigated insect growth regulators, Pyrethroids and insecticide mixtures and observed that all insecticides proved highly effective against adult and nymph population of dusky cotton bug in cotton fields. Similarly, Roger *et al*, (1997) found many Pyrethroids and Organophosphates effective against dusky cotton bugs i.e. *Oxycarenus lavaterae* with tralomethrin having more profound effects. Chemical control using various insecticides is effective against dusky cotton bug, for minimizing yield losses of the crop (Chin *et al*, 2009). Chemical insecticides may be applied in the form of sprays or dusts when the dusky cotton bugs are seen on newly opened bolls (Hill, 1983). Effective control of the dusky cotton bug can be achieved through the use of a mixture of different insecticides with both contact and systemic action (Ibrahim *et al*, 1993; Smith and Brambila, 2008). The results of Akram *et* *al*, (2013) proved that deltamethrin 2.5EC is effective against both adults and nymphs of dusky cotton bug. Triazophos 40EC, Nurelle-D 505EC, Curacron 500EC, Fiprox 5SC, Adder plus 360EC and mixture of Lancer 2.5EC and Triazophos 40EC were significantly effective in reducing dusky cotton bug population at 72 hours (23.75 to 55.85%) and even 168 hours (27.49 to 54.02%) post treatment under field conditions in *Bt.* cotton ecosystem. These chemical insecticides may be considered to be appropriate for field use against the investigated pest.

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