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Studies on the toxic effect of thiamethoxam against the nymphal stage of *Dysdercus koenigii* fabricius (Hemiptera: pyrrhocoridae)

*** Mohd Jameel, Khowaja Jamal**
Department of Zoology, Faculty of Life Sciences, Aligarh Muslim University, Aligarh, Uttar Pradesh, India

Abstract
Toxicity of topically applied different sub lethal concentrations (0.002, 0.004, 0.006 and 0.008%) of thiamethoxam on the 4th instar nymphs of *Dysdercus koenigii* was studied in the controlled laboratory condition. With increase in the sub lethal concentration nymphal mortality, nymphal and adults longevity increases significantly in the dose dependent manner, However fecundity and fertility of the affected female decreases significantly as compare to the untreated control. A significant decline in the adults emergence were also observed with increase in the sub lethal concentrations of thiamethoxam. Therefore from the current study it is concluded that thiamethoxam is very potent insecticide against the nymphs of *Dysdercus koenigii* under the laboratory condition.

Keywords: *dysdercus koenigii*, mortality, fecundity, fertility, longevity

1. Introduction

Cotton is a crop which is cultivated throughout the world and considered as one of the important source of fiber and oil (Jaleel *et al.*, 2013) [17]. In the developing nations it is not the only source of major foreign exchange earner but it is the one of the source of world's leading textile fibers (Sinzogan, 2006) [36]. It is also considered as an excellent source of natural fiber and edible oil (Aslam *et al*., 2004) [2]. It is one of the major cash crop of the india, and is cultivated on a large scale in its different part including Karnatka, Maharastra, Punjab, Rasjasthan, Haryana, Madhya Pradesh, Andra Pradesh, Tamil Nadu, and Uttar Pradesh (Sammaiah *et al.*, 2012) [33]. India holds second position in cotton production in the world after China and contributed 18% of the total cotton production of the world. India is known for the largest area under the cultivation of cotton in the world, ranges between 12.2 million hectares which comprises about 25% of the total land of the world (The cotton corporation of the India Ltd., 2011) [11]. It has been reported that more than 1326 species of insects and mites are attacking cotton crop throughout the world (Balakrishnan *et al*., 2010) [3]. It was also reported that the cotton crop was attacked by 162 species of insects and mites in sub-continent (Manjunath, 2004) [25].

Dysdercus koenigii Fabricius (Hemiptera: Pyrrhocoridae) is a sucking insect pest and commonly known as cotton strainer, is one amongst the 1326 species of insect and mites that has been reported attacking cotton and is considered as a serious pest of cotton in India and in different part of the world (David and Anantha Krishnan, 2004; Karihaloo and Kumar, 2009) [12, 19].

Cotton crop in the various state of India including Gujrat, Bihar, Madhya Pradesh, Uttar Pradesh and Tamil Nadu was found to be attacked by this insect pest and serious damage was reported. (Varma and Patel., 2012) [39].

Cotton stainer caused damage by feeding on the pre-mature and mature seeds of the bombacaceous and malvaceous plants (Sahayraj and Tomson 2010; Sarangi *et al.*, 2012; Kohno and Bui Thi 2004) [32, 34, 23]. During feeding it transmitted a bacterium *Nematospora gossypii*, which enters at the place of injury and leads to staining of the fiber (Roy *et al.*, 2002) [31].

For minimizing the damage caused by this insect pest different group of the insecticide has been used. Now a days neonicotinoids are most extensively utilized class of insecticide (Morrissey *et al.*, 2015) [26].

Thiamethoxam, [3-(2-chloro-1, 3-thiazol-5-methyl) 25-methyl-4-nitroimino-perhydro-1, 3, 5-oxadiazine], is belong to neonicotinoids group of insecticide which are one of the important class of the new synthetic insecticide (Thany. 2010) [35]. It is one of the most profits earning pesticide throughout the world (Cavusoglu *et al.*, 2012; Barganska *et al.*, 2013) [9, 4] because of its extensive use to control several sucking and biting pests (Karmakar and Kulshrestha, 2009) [20].

As for as the mode of action of the thiamethoxam is concerned it block the acetylcholine receptor and is not removed by the acetylcholinesterases (Nauen *et al.*, 2003) [27]. As a result of unremitting activation of acetylcholine receptors leads to hyperexcitation of the central nervous system, finally leading to death of the insects due to uncontrolled contraction of muscles (Rancan *et al*., 2006) [30]. Considering these views the present studies were carried out to assess the effect of sub lethal concentration of thiamethoxam on the 4th instar nymph of the *Dysdercus koenigii.*

2. Material and Methods

2.1 Insecticide

Insecticide used for the study of the sub lethal effect against *Dysdercus koenigii* was commercial formulation of thiamethoxam (25% WG) with trade name "ATTILA" from Mahindra Company.

2.2 Rearing of *Dysdercus koenigii*

Adults of *D. koenigii* were collected from agricultural fields, Faculty of Agriculture, Aligarh Muslim University, Aligarh and were reared on the overnight water soaked cotton seeds in the rearing jar of size (20×15 cm), under the laboratory condition of 26±2 ºC temperature, 65-70% relative humidity and 14L:10D photoperiod in a B.O.D incubator. The adult female after mating started laying eggs in the moist sterilized sand provided in the bottom of the jar. After the completion of incubation period these eggs were hatched into 1st instar nymph and fresh overnight water soaked cotton seeds were given as a food. From the stock culture the 4th instar nymph of the F2 generation were used for the study of sub lethal effect of the thiamethoxam.

2.3 Preparation of sub lethal concentration of thiamethoxam.

After calculating the LC_{50} value of the thiamethoxam the different sub lethal concentrations were prepared in the distilled water viz. 0.002%, 0.004%, 0.006% and 0.008%. Distilled water without insecticide was used as a control. For each sub lethal concentration 30 healthy 4th instar nymphs were chosen including untreated control. There were five replicate for each sub lethal concentration and control.

2.4 Mode of application

One µl of each sub lethal concentration of thiamethoxam were applied topically on the thoracic terga of each 4th instar nymph with the help of the micro applicator. Post 24 hour of the treatment nymphal mortality was counted and other parameter like nymphal duration, adult emergence, fecundity, fertility, and adult longevity were also recorded.

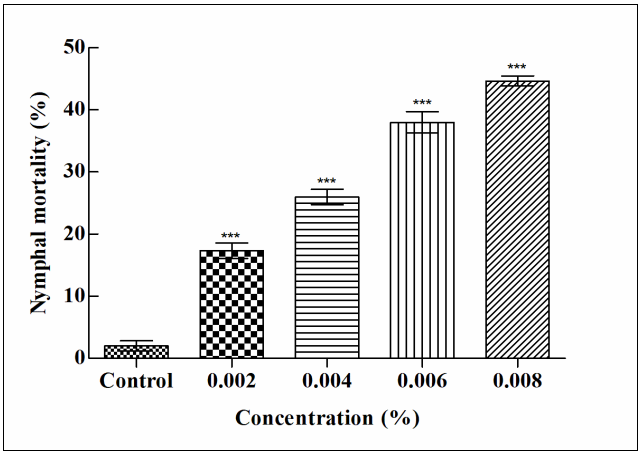
2.5 Statistical analysis

Data are expressed as mean +SEM from the five independent experiments. Data obtained was analyzed by the Tukey's test after one way of Analysis of variance (ANOVA) using statistical software Graph Pad Prism 5.01. (California, USA). Differences were considered statistically significant at $p< 0.05$.

3. Results

3.1 Effect on nymphal mortality

Fourth instar nymph of *Dysdercus koenigii* treated with different sub lethal concentration showed that the trend of mortality after 24 hours of treatment increases as the sub lethal concentration of the thiamethoxam increases (Fig. 1). The data revealed that there was a significant difference at the $p<0.05$ as compare to the control. Maximum mortality of 44.2% was observed at highest sub lethal concentration.



*** represents $p \leq 0.001$

Fig 1: Graph showing nymphal mortality. Bars represent SEM. Results are the mean of five individual experiments.

3.2 Effect on adult emergence

Effect of sub lethal concentration on treated 4th instar nymphs of *Dysdercus koenigii* demonstrated a significant difference ($p\leq0.05$) in comparison to the control (Fig. 2). Percent adult emergence was decreases as the sub lethal concentration thiamethoxam was increases.

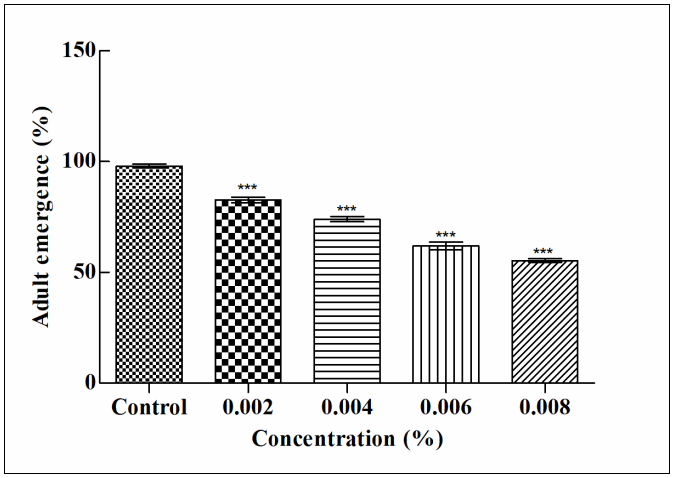


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Fig 2: Graph showing the percentage of adult emergence. Bars represent SEM. Results are the mean of five individual experiments.

3.3 Effect on reproduction

Number of egg laid and there hatching rate were considered in the reproductive parameter. Results obtained clearly demonstrated that there was a significant difference ($p \leq 0.05$) in fecundity in all concentrations in comparison to the control (Fig.3). Significant differences in the fertility of the eggs were also observed with the different sub lethal concentration (Fig.4).

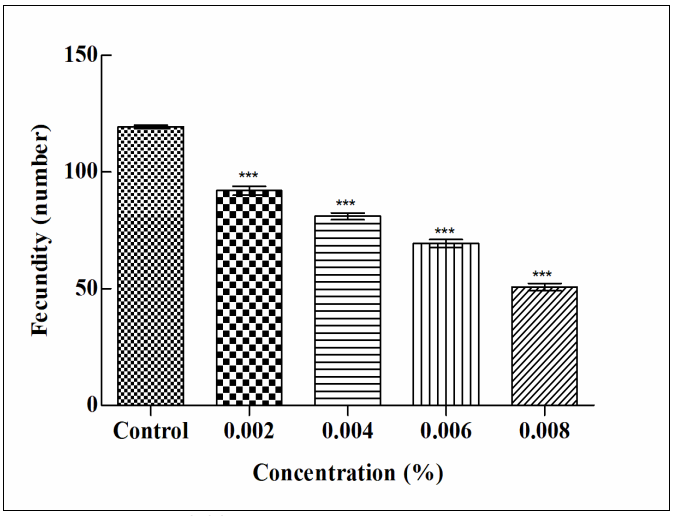

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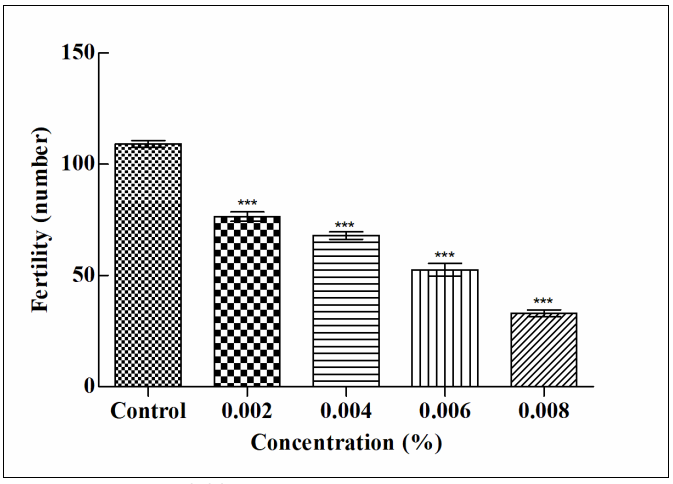
Fig 3: Graph showing the fecundity of female. Bars represent SEM. Results are the mean of five individual experiments.



*** represents $p \leq 0.001$

Fig 4: Graph showing the fertility of the laid eggs. Bars represent SEM. Results are the mean of five individual experiments.

3.4 Effect on longevity

When 4th instar nymphs of the *D.koenigii* were exposed to the different sub lethal concentration of thiamethoxam, a significant difference ($p \leq 0.05$) in the longevity of nymphs and adults were observed in comparison to the control (Fig 5 and Fig.6). Significant variations in the longevity of adult male and adult female were also observed as shown in (Fig.7 and Fig. 8).

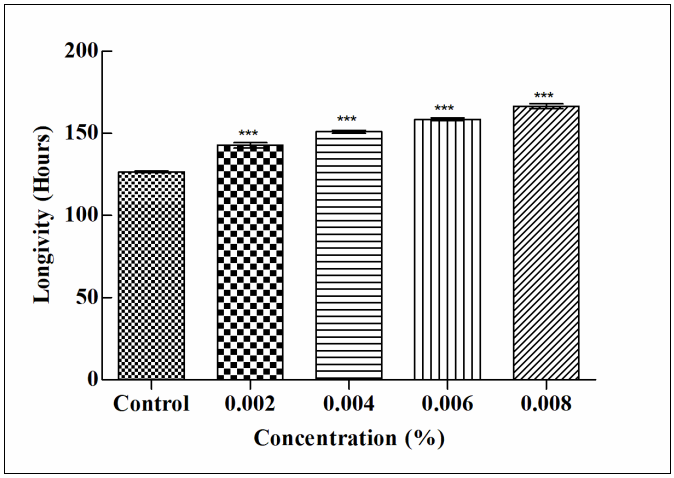


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Fig 5: Graph showing the longevity of 4th instar nymph. Bars represent SEM. Results are the mean of five individual experiments.

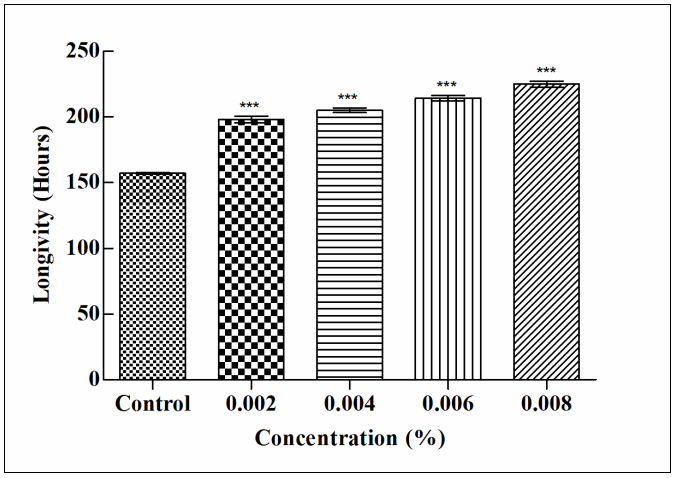

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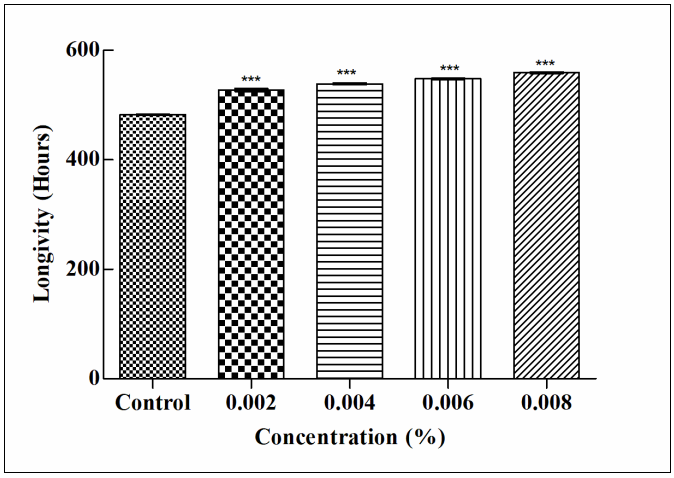
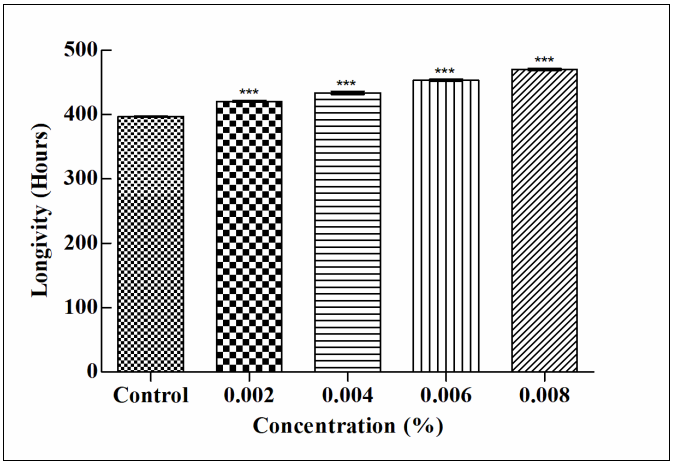
Fig 6: Graph showing the longevity of 5th instar nymph. Bars represent SEM. Results are the mean of five individual experiments.



*** represents $p \leq 0.001$

Fig 7: Graph showing the longevity of adult male. Bars represent SEM. Results are the mean of five individual experiments.



*** represents $p \leq 0.001$

Fig 8: Graph showing the longevity of adult female. Bars represent SEM. Results are the mean of five individual experiments.

4. Discussion

Thiamethoxam is the most extensively used insecticide throughout the world. It belongs to novel class of insecticide "neonicotinoids" with systemic mode of action. It interfere with the insects nervous system by acting on the nicotinic acetylcholine receptors (Tomizawa and Casida, 2003; Jeschke and Nauen, 2008) [38, 18]. It shows very low toxicity to fishes, birds and mammals (Foster *et al.,* 2003) [12]. In the present study, effects of sub lethal concentrations of thiamethoxam on the *Dysdercus koenigii* with reference to different biological parameters as nymphal mortality, nymphal longevity, adult's emergence, adult's longevity, fecundity and fertility were observed. As the sub lethal concentration of thiamethoxam increases the nymphal mortality increases accordingly as shown in (Fig.1). Khowaja *et al.,* (1995) [21] also reported the similar type of results when the 4th nymphs of *Dydercus cingulatus* treated with the different sub lethal concentration of temik. Similar kinds of mortality trends in 4th instar nymphs of *Dysdercus koenigii* were also observed by Fakhri *et al.,* (2012) [13] when treated with the different sub lethal concentration of oxydemeton-o-methyl.

Our experimental results prove that thiamethoxam is highly effective insecticide against *Dysdercus koenigii*. The current studies showed that the fecundity and fertility of the adults emerged from the treated 4th instar nymph were significantly and adversely affected as shown in (Fig.3 and Fig.4). A significant reduction in fecundity and fertility as compare to the control were observed with increase of sub lethal concentration of thiamethoxam. Similar kinds of results regarding reduced fecundity and fertility of insect after treatment with different concentration of insecticide were also reported by different workers which confirm our results of reduced fecundity and fertility. Reduced fecundity and fertility in adults of bud moth, *Platynota idaeusalis* corn earworm, *Helicoverpa zea* and codling moth, *Cydia pomonella* were observed when the larvae fed on the diet containing different sub lethal concentration of tebufenozide. (Carpenter JE., 1994, Brown JJ., 1996 and Biddinger D, 2006) [8, 7, 6]. Chattoraj and Bhise (1980) [10] also reported the significant reduction in the fecundity of adults of *Spodoptera litura* emerged from larvae which were treated with the different sub lethal concentration of the dieldrin as compared to the untreated control.

Patil and Khanvilkar (1997) [28] also reported the similar type of trends, i.e. reduction of fecundity and fertility of adults of *Spodoptera litura* emerged from the treated larvae with different sublethal concentrations of parathion.

A significant effect on the emergence of adults from the surviving nymphs was also observed. The reduction of adult's emergence was high at the highest concentration as compare to the control. Bhanukiran and Panwar (2002) [5] also reported the inhibition of adults emergence in the larvae of *Chilo Partellus* treated with the different concentration of neem, which is similar to our findings.

Longevity of the 4th and 5th instar nymph of the *Dysdercus koenigii* treated with different sub lethal concentration of thiamethoxam was significantly varied as compare to the untreated control as shown in (Fig. 5 and Fig. 6). Increased longevity of 4th and 5th instar nymphs of the *Dysdercus cingulatus* treated with the different concentration of monocrotophos was also observed by (Khowaja *et al.,* 1992) [22]. Increased longevity male *Blatella germanica* following the treatment of LD_{50} dose hydramethylnon and cyfluthrin was also observed by (Abd-Elghafar & Apple, 1992) [1].

The findings of current study showed that thiamethoxam is potent insecticide with a novel mode of action against the nymphs of *Dysdercus koenigii*. In addition it has excellent effect on the reproductive potential of the adults emerged from the treated nymphs. As the offspring's number was reduced when treated with the different sub lethal concentration of thiamethoxam, prove to be beneficial from the ecological point of view as the insects population can be maintained below the economic injury level. Keeping these toxicological parameters in mind this insecticide can be used as a potent tool in IPM.

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6. References

1. Abd-Elghafar S F, Appel A G. Sublethal effects of insecticides on adult longevity and fecundity of German cockroachs (Dictyoptera: Blattelidae). Journal of Economic Entomology. 1992; 85(5):1809-1819.
2. Aslam M, Razaq M, Saeed NA, and Ahmad F. 2004**.** Comparative resistance of different cotton varieties against bollworm complex. International Journal of Agriculture and Biology. 2004; 6:39-41.
3. Balakrishnan N, Vinothkumar B, and Sivasubramnian P. Bioefficacy of kinadongold against sucking pests of cotton. Madras Agricultural Journal. 2004; 97:88-91.
4. Barganska Z, Slebioda M, Namiesnik J. Pesticide residues levels in honey from apiaries located of Northern Poland. Food Control. 2013; 31:196–201.
5. Bhanukran Y, Panwar V P S. Effect of neem product on neem products on the devbelopment of maize stalk borer. Annals of Plant Protection Sciences. 2002; 10:188-191.
6. Biddinger D, Hull L, Huang H, McPheron B, Loyer M. Sublethal effects of chronic exposure to tebufenozide on

the development, survival, and reproduction of the tufted apple bud moth (Lepidoptera: Tortricidae). Journal of Economic Entomology. 2006; 99: 834-842.
7. Brown JJ. The compatibility of tebufenozide with a laboratory lepidopteran host/hymenopteran parasitoid population. Biological Control. 1996; 6(1):96-104.
8. Carpenter JE, Chandler LD. Effects of Sublethal Doses of Two Insect Growth Regulators on *Helicoverpa zea* (Lepidoptera: Noctuidae) reproduction. Journal of Entomological Science. 1994; 29(3):428-35.
9. Cavusoglu K, Yalcin E, Turkmen Z, Yapar K, Sagir S. Physiological, anatomical, biochemical, and cytogenetic effects of thiamethoxam treatment on Allium cepa (amaryllidaceae) L. Environmental Toxicology. 2012; 27:635–643.
10. Chattoraj AN, Bhise A. Latent effect of DDT and dieldrin on fecundity of *Spodoptera litura* following sublethal larval treatment. Zeitschrift fur Angewandte zoologie. 1980; 67(2):239-247.
11. Cotton Corporation 2011. The Cotton Corporation of India Ltd., Navi Mumbai, India, Online [http:// cotcorp.gov.in (accessed March 2012)].
12. David BV, Ananthakrishna TN**.** General and Applied Entomology. Tata McGraw-Hill Publishing Company Limited, New Delhi. 2004, 1184.
13. Fakhri MSA, Ansari MS, Khowaja J, Ali H. Comparative toxicity of quinolphos and oxydemeton-o-methyl on different life stages of *Dysdercus koenigii* (Fabr.) Annals of Plant. Protectection Sciences. 2012; 20(1):51-54.
14. Foster SP, Denholm I, Thompson R. Variation in response to neonicotinoid insecticides in peach potato aphids, *Myzus persicae* (Homoptera: Aphididae). Pest Management Science. 2003; 59 (2):166-173.
15. Henry TJ. Biodiversity of Heteroptera in Insect Biodiversity Science and Society. Edt. By Robert, G. Foottit and Piter, H. Adler, Blackwell Publisher limited. 2009, 224-263.
16. Indrasith L, Sasaki ST, Yaginuma T, Yamashita O. The occurrence of premature form of egg-specific protein in vitellogenic follicles of *Bombyx mori***.** Journal of Comparative Physiology. 1988; 158:1-7.
17. Jaleel W, Saeed S, Naqqash MN. Biology and bionomics of *Dysdercus koenigii* F. (Hemiptera: Pyrrhocoridae) under laboratory conditions. Pakistan Journal of Agricultural Sciences. 2013; 50:373-378.
18. Jeschke P, Nauen R. Neonicotinoids-from zero to hero in insecticide chemistry. Pest Management Science. 2008; 64:1084-1098.
19. Karihaloo JL, Kumar PA. Bt cotton in India – A status report (2nd Edn.). Asia-Pacific Consortium on Agricultural Biotechnology (APCoAB), New Delhi, India, 2009, 56.
20. Karmakar R, Kulshrestha G. Persistence, metabolism and safety evaluation of thiamethoxam in tomato crop. Pest Management Science. 2009; 65:931-937.
21. Khowaja J, Khan MA, Qamar A, Khan BA. Toxicity of temik (aldicarb) to the red cotton bug *Dysdercus cingulatus* (Hemiptera: Pyrrhocoridae). Advances in Biosciences. 1995; 14(II):49-56.
22. Khowaja J, Khan MA, Qamar A, Khan BA. Changes in fecundity, fertility, longevity and weight of *Dysdercus cingulatus* (Hemiptera: Pyrrhocoridae) following topical application of monocrotophos. Proceedings. 79th Indian Science Congress. 1992; III:76-77.
23. Kohno K, Bui Thi N. Effects of host plant species on the development of *Dysdercus cingulatus* (Heteroptera: Pyrrhocoridae). Applied Entomology and Zoology. 2004; 39:183-187.
24. Leicht W. Imidacloprid-a chloronicotinyl insecticide biological activity and agricultural significance. Pflanzenschutz nachrichten-bayer-english edition. 1996; 49:71-84.
25. Manjunath TM. Bt Cotton in India. In: The technology wins as the controversy wanes. Online: www. Monsanto.co.uk/news ukshowlib. html?wid=8478, 2004.
26. Morrissey CA, Mineau P, Devries JH, Sanchez-Bayo F, Liess M, Cavallaro MC, Liber K. Neonicotinoid contamination of global surface waters and associated risk to aquatic invertebrates: a review. Environmental International. 2015; 74:291-303.
27. Nauen R, Ebbinghaus-kintscher U, Salgado VL, Kaussmann M. Thiamethoxam is a neonicotinoid precursor converted to clothianidin in insects and plants. Pesticide Biochemistry and Physiology. 2003; 76:55-69.
28. Patil AK, Khanvilkar VG. Effect of sublethal concentrations of parathion on the biology of *Spodoptera litura* (Fab.). Indian Journal of Plant Protection. 1977; 5(2):172-177.
29. Qadri SS, Ahmad I. *Dysdercus evanescens* distant. (Hemiptera: Pyrrhocoridae) and its phylogenetic relationships. Pakistan Journal of Zoology. 2011; 43:469–472.
30. Rancan M, Rossi S, Sabatini AG. Determination of Thiamethoxam residues in honeybees by high performance liquid chromatography with an electrochemical detector and post-column photochemical reactor. Journal of Chromatography A. 2006; 1123(1):60-5.
31. Roy A, Banerjee S, Majumder P, Das S. Efficiency of mannose-binding plant lectins in controlling a homopteran insect, the red cotton bug. Journal of Agricultural and Food Chemistry. 2002; 50 (23): 6775-9.
32. Sahayaraj K, Tomson M. Impact of two pathogenic fungal crude metabolites on mortality, biology and enzymes of *Dysdercus cingulatus* (fab.) (Hemiptera: Pyrrhocoridae). Journal of Biopesticides. 2010; 3:163-167.
33. Sammaiah C, Laxman P, Samatha CH. Study on infestation of cotton insect strainers on BT-cotton and non BT-cotton in Warangal. Andhra Pradesh. International Journal of Environmental Sciences. 2012; 3:1155-1160.
34. Sarangi P, Gupta SK, Saha GK. Seasonal occurrence of the ectoparasitic mite Hemipteroseius indicus on the red cotton bug *Dysdercus koenigii* (Hemiptera: Pyrrhocoridae) in West Bengal. Munis Entomology and Zoology. 2012; 7:292-297.
35. Sharma H, Pampapathy G. Influence of transgenic cotton on the relative abundance and damage by target and non-target insect pests under different protection regimes in India. Crop Protection. 2006; 25:800-813.
36. Sinzogan AA. Collaborative Development of Crop Protection-the case of Integrated Pest Management in the Cotton Sector in Benin. Facilitating learning toward

sustainable cotton pest management in Benin The interactive design of research for development. 2006, 121.
37. Thany SH. Neonicotinoid insecticides: Historical evolution and resistance mechanisms. Advance Experimental Medicine and Biology. 2010; 683:75–83.
38. Tomizawa M, Casida JE. Selective toxicity of neonicotinoids attributable to specificity of insect and mammalian nicotinic receptors. Annual review of entomology. 2003; 48(1):339-64.
39. Varma HS, Patel RK. Biology of red cotton bug (*D. koenigii*). AGRES-An International e-Journal. 2012; 1:148-156.