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Effect of three insecticides on Post Embryonic development, egg production and body weight of *Rhynocoris longifrons* (Stal) (Insecta: Hemiptera: Reduviidae)

P.J. Edward George

Kalasalingam School of Agriculture and Horticulture, Kalasalingam Academy of Research and Education, Krishnankoil, Tamilnadu, India
georgepje1963@gmail.com

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Abstract— *Post embroyonic development time egg production rate and body weight of Rhynocoris longifrons (Stal°) were studied for three commonly used insecticides in the agro ecosystem namely monocrotophos, dimethoate and quinalphos. All of the instecticides increased and stadial period and decreased the body weight, egg production and longevity. Maximum effect of the insecticides was observed in monocrotophos treated insects which was followed by dimethoate and quinalphos applied insects. This study paves an idea that while applying the insecticides in the agro ecosystem to control insect pests, care should be taken in the selection of insecticides which will be safe to the non-target insects which is already available in the ecosystem.*

Keywords— ***Rhynocoris longifrons, monocrotophos, dimethoate, quinalphos, post embryonic development***

I. INTRODUCTION

Reduviids (Hemiptera : Reduviidae) are one of the highly successful predators, and they play a key role in the biological control of insect pests. The reduviid biocontrol agents inhabit scrub jungles, semi-arid zones and agro ecosystems and they on a wide range of insect pests of various sizes holding promise as useful agents in Integrated Pest Management (Ambrose, 1988,1995,1996). Modern agriculture has come to rely extensively on synthetic chemical pesticides for pest control. Although these toxins are targeted at plant pests , many of them are broad spectrum biocides that have profound effects on the non-target species in agro ecosystems (George and Ambrose, 1999a,b). Non target reduviid predators (Assassin bugs) living in agro ecosystems are being exposed to insecticides frequently which are indiscriminately used to control insect pest population (George and Ambrose, 2004). Even though insecticides are widely studied for their control potential against particular insect pests, they are very less studied or even neglected on their control potential against particular insect pests, they are very less studied or even neglected on their impact on non-target insects. Much less is known about effects of chemical insecticides on non-target predators than on herbivorous insects (Croft and Brown,1975; Sahayaraj and Amalraj, 2005). This prompted the author to study the impact of sub lethal concentrations of the three commonly used insecticides in the cotton ecosystem namely monocrotophos, dimethoate and quinalphos which are both contact and stomach poison on the post embryonic development, egg production and body weight of the reduviid predator *Rhynocoris longiforns* (Stal). *R.longifrons* was reported to be living in cotton agro ecosystem and predating upon various insects pests like *Aphis gossyphii*, *Dysdercus cingulatus*, *P. solenopsis* , *Clavigralla gibbosa* Spinola and *Nesara viridula* Linnaeus, *H. armigera* and *Spodoptera litura* Fab.(Sahayaraj *et.al.*,, 2020). Information from such study will enable researchers

and farmers to select the most suitable insecticides with least damage to *R. longifrons* which are existing in the agroecosystem.

II. MATERIALS AND METHODS

The predator, *R. longifrons* was collected from the Sunkankadi scrub jungle (77. 26'E and 8. 16'N) and Muppanthal (77. 31' E and 8 22' N) scrub jungle, in Kanyakumari district of Tamil Nadu, South India . They were maintained in round plastic troughs with netted lids (16cm diameter x 7 cm height) in the Kalasalingam Biocontrol Laboratory at 28-34° C temperature, 12-13h photoperiod and 75-80% relative humidity. *R.longifrons* was found to inhabit concealed microhabitats such as beneath the boulders and in small crevices in pairs. The nymphs were also found along with the adults. The adults were alate, crepuscular, entomosuccivorous and polyphagous. They laid eggs in clusters. The reduviids mass reared in the laboratory on *Corcyra cephalonica* Stainton were used for the experimental studies. The nymphs were reared separately as the III instar nymphs are used for present study.

Preliminary studies were conducted with each insecticide to find out the LC_{50} concentration of III nymphal instar for 48 h duration and 1/10 values of the 48h LC_{50} concentration of each insecticide were considered as the sub lethal concentrations. They were 0.0011, 0.0018 and 0.0032% for monocrotophos, dimethoate and quinalphos, respectively. 75 ml plastic containers covered with netted lids were used for the present experiment. Cotton leaves were cut based on the size of the container and sub lethal concentration of each of insecticide was sprayed over the leaves separately with help of the hand sprayer. Sprayed leaves were dried for about 15 minutes under normal ceiling fan and then they are placed over moist tissue paper to keep them turgid inside the container for longtime. Three to four leaves were placed inside each container with the ventral surface of the leaves facing upwards (George and Ambrose, 1999).

Fifteen III instar nymphs were taken from the culture and exposed to the sub lethal concentration of each insecticide, separately. Fifteen III instar nymphs were taken and they are exposed to cotton leaves sprayed with water and maintained as a control group. The experimental as well as control group were maintained at room temperature (29 ± 1°C) The insect concentration was maintained continuously for 20 days: ie, the insecticide sprayed leaves were changed with fresh leaves sprayed with insecticide, the insecticide exposed III instar nymphs were reared up to adult. The stadial period and body weight of the IV and V instar nymphs and adults were recorded. The egg production of the adult and longevity of both male and female were also recorded. All the variations caused by the three insecticides, stadial period and weight were initially analyzed by oneway ANOVA (SAS Institute, 1988) to determine if there is any differences existed among and treatment means. If significant differences are there, then the individual treatment means were tested by post ANOVA (Tukey, 1953). Statistical significance was determined by setting the aggregate type 1 error at 5% ($P<0.05$) for each set of comparisons.

Regarding the effect of insecticides on the longevity and fecundity, as 1/10 of 48h LC_{50} will cause mortality in the prolonged exposure, 96h LC_{50} concentration was considered as one toxic unit and 1/3, 1/6, 1/9 and 1/12 of the adult 96h LC_{50} concentrations were selected as sub lethal concentration for all three insecticides. Adult males and females aged less than 10 days were used from the existing laboratory culture. Totally 60 adult insects (30 male insects and 30 female insects) were used for each insecticide, 15 insects per concentration of insecticides (4 x 15 = 60). Fifteen adults were also maintained as control and the insecticide exposure was carried out for 20 days. The number of eggs laid in each experimental and control category were recorded separately. The longevity of male and female in experimental and control were also recorded and all the experimental data were compared with control categories and subjected to students t-test to find out the impact insecticides.

III. RESULTS AND DISCUSSION

The insecticides heavily altered the stadial period, body weight, number of eggs laid and also the longevity. Table 1 shows the impact of the sub lethal concentration of three insecticides monocrotphos, dimethoate and quinalphos on the stadial period of *R.longifrons*. The insecticides showed an extension of III stadial period from 9.13 ± 2.48 (control) to 13.68 ± 3.36, 10.13 ± 3.43 and 11.67 ± 3.13 by the sub lethal concentrations of the insecticides monocrotophos, dimethoate and quinalphos, respectively. Similar observation was also noticed for the IV and V stadial period. It is also observed that the females took more time for the development than males. Among the three insecticides monocrotophos showed maximum extension in the stadial period which is followed by quinalphos and dimethoate. The extension of the stadial might be due to the insecticidal blocking of the hydroxylation process which might have reduced the hormone level necessary for moulting (Conney *et.al*.,1966). George and Ambrose (1999 a, b) also reported similar increase in the stadial period due to the exposure of the sub lethal concentration of 5 insecticides on the on the reduviid *Rhynocoris kumarii* Ambrose and Livingstone.

Table 1. Impact of sub lethal concentration (1/10 0f 48h LC_{50}) of three insecticides on the stadial period (days) of R.longifrons.

Insecticides	III – IV instar	IV – V instar	V – Adult male	V – Adult female
Control	9.13 ± 2.48[a]	13.67 ± 3.84[a]	16.85 ± 3.59[a]	17.41 ± 3.81[a]
Monocrotophos	13.68 ± 3.36[b]	18.33 ± 4.12[c]	21.21 ± 4.19[c]	23.11 ± 2.89[c]
Dimethoate	10.13 ± 3.43[a]	14.11 ± 3.52[ab]	17.87 ± 3.12[ab]	18.23 ± 3.11[ab]
Quinalphos	11.67 ± 3.13[ac]	15.54 ± 3.28[b]	18.56 ± 3.87[b]	19.25 ± 3.55[b]

Means followed by the same alphabetic letter in a column are not statistically significant at 5% (P > 0.05) by Tukey test

The body weight also shows drastic reduction by the sub lethal concentration of insecticides. The impact of insecticides on the body weight is shown in the table 2. All the three insecticides reduced the body weight of the IV, V instar insects and adults of *R.longifrons*. It is observed that the weight of insects in the IV instar 34.16 ± 2.21mg is reduced to 27.33 ± 3.41, 30.18 ± 2.22 and 29.77 ± 2.36mg by the sub lethal concentration of the insecticides monocrotophos, dimethoate and quinalphos, respectively. Maximum reduction in the body weight is observed in the monocrotophos treated category which is followed by quinalphos and dimethoate. The reduction in body weight might be due to the blocking of lactate and succinate dehydrogenases (Dimov and Kalyanova (1967). George and Ambrose (1999a, b) reported such reduction in the body weight in the reduviid predator *R.kumarii*. O'Brien (1957) reported some degree of inhibition of glycolytic tricarboxylic metabolic pathways for the reduction of body weight in cockroaches.

Table 2. Impact of sub lethal concentration (1/10 0f 48h LC_{50}) of three insecticides on the body weight (mg) of R.longifrons.

Insecticides	IV instar	V instar	Adult
Control	34.16 ± 2.21[c]	82.45 ± 4.11[c]	136.34 ± 8.53[c]
Monocrotophos	27.33 ± 3.41[a]	67.54 ± 5.23[a]	118.45 ± 6.77[b]
Dimethoate	30.18 ± 2.22[b]	75.23 ± 3.46[a]	127.49 ± 4.67[a]
Quinalphos	29.77 ± 2.36[ab]	71.92 ± 4.64[a]	123.65 ± 5.34[ab]

Means followed by the same alphabetic letter in a column are not statistically significant at 5% (P > 0.05) by Tukey test

The variations caused by the sub lethal concentration of the insecticides on the fecundity and longevity is shown in the table 3. All of the four sub lethal concentrations of all three insecticides reduced the fecundity of *R. longifrons* than the control. The total number of eggs laid in the control insects (143.08 ± 17.07) is drastically reduced to 83.23 ± 6.49, 87.11 ± 5.41, 90.68 ± 5.39 and 95.19 ± 4.86 in the 1/3, 1/6, 1/9 and 1/12 of 96h LC_{50} sub lethal concentrations treated insects. Similar reduction in fecundity is noticed in the sub lethal concentration treated insects of dimethoate and quinalphos. Here again, maximum reduction in the fecundity is noticed in the monocrotophos treated insects which explicit the highest toxicity. The reduced fecundity might be due to the the inhibition of food intake. Khowaja *et.al.*, (1992, 1994) reported similar reduced egg out put in *Dysdercus cingulatus* Fabricius by monocrotophos. George and Ambrose (1999 a, b) also reported similar reduction in the fecundity in *R. kumari* treated with five insecticides.

Similarly, the insecticides reduced the longevity of the reduviid predator *R.longifrons* which is also shown in the Table 3. All of the three insecticides reduced the life span of both the males and females of *R. lonfifrons*. Monocrotophos caused the maximum reduction in the longevity of males and females of *R. longifrons* from 117.23 ± 12.36 and 114.43 ± 11.45 to 85.23 ± 9.77 and 83.41 ± 9.34, 88.56 ± 8.67 and 85.19 ± 7.24, 90.33 ± 7.43 and 87.19 ± 6.91 and 92.54 ± 6.45 and 89.26 ± 6.11 respectively, for the 1/3, 1/6, 1/9 and 1/12 of 96h LC_{50} sub lethal concentrations treated insects. Increased respiration and the release of a paralysis inducing stress factor by the insecticides may account for the decrease in longevity and Lucky (1968) explained this through hormologosis hypothesis. Similar results were also obtained by Hamilton and Schal (1990) and Abd Elghafar and Appel (1992) on German cockroaches and George and Ambrose (1999 a, b) in *R. kumarii*. This research clearly gives an idea to the agriculturists who are engaged in IPM that the insecticides monocrotophos and quinalphos are not safe and should not

be applied when *R. longifrons* is incorporated in biological control of insects pests and dimethoate is considered as safe pesticide which cause very less impact on *R. longifrons*.

Table 3. Impact of sub lethal concentration (1/3, 1/6, 1/9 and 1/12 of 96 LC_{50}) of three insecticides on the fecundity (nos.) and longevity (days) of R. longifrons.

Insecticides	Concentration	Total number of eggs laid	Longevity (days)	
			Male	Female
Control		143.08 ± 17.07	117.23 ± 12.36	114.43 ± 11.45
Monocrotophos	1/3 of 96h LC_{50}	80.23 ± 6.49***	85.23 ± 9.77***	83.41 ± 9.34***
	1/6 of 96h LC_{50}	87.11 ± 5.41***	88.56 ± 8.67***	85.19 ± 7.24***
	1/9 of 96h LC_{50}	90.68 ± 5.39**	90.33 ± 7.43**	87.19 ± 6.91***
	1/12 of 96h LC_{50}	95.19 ± 4.86**	92.54 ± 6.45**	89.26 ± 6.11**
Dimethoate	1/3 of 96h LC_{50}	121.10 ± 4.54*	97.26 ± 6.83*	93.25 ± 6.55**
	1/6 of 96h LC_{50}	126.33 ± 5.11*	99.39 ± 7.49*	96.25 ± 6.55*
	1/9 of 96h LC_{50}	129.70 ± 4.29NS	102.45 ± 6.43^{NS}	98.26 ± 5.87*
	1/12 of 96h LC_{50}	131.19 ± 4.71NS	105.27 ± 5.71^{NS}	101.46 ± 6.28*
Quinalphos	1/3 of 96h LC_{50}	100.21 ± 6.21**	91.35 ± 7.58**	90.28 ± 5.98**
	1/6 of 96h LC_{50}	106.41 ± 4.68**	93.56 ± 8.13*	92.43 ± 6.38**
	1/9 of 96h LC_{50}	110.13 ± 5.11*	96.43 ± 6.26*	96.11 ± 5.49*
	1/12 of 96h LC_{50}	115.40 ± 5.44*	97.18 ± 8.41*	95.28 ± 4.67*

Significance is shown at 0.1% (***), 1% (**) and 5% (*) levels of probability. NS indicates not significant.

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REFERENCES

[1] Abd Elghafar, S.F. and Appel, A.G. 1992. Sub lethal effects of insecticides on adult longevity and fecundity on German cockroaches (Dictyoptera: Blatellidae). *Econ.Entomol*., **85**(5): 1809 – 1817.

[2] Ambrose, D. P. 1988 Biological control of insect pests by augmenting assassin bugs. (Insecta, Heteroptera: Reduviidae). *Bicovas* , **2**, 25 40.

[3] Ambrose, D. P. 1995 Reduviid as predators: their role in biological control. In: *Biological Control of Social Forest and Plantation Crops Insects.* (eds T. N. Ananthakrishnan IBH New Delhi: Publishing Co.) Pvt. Ltd, pp. 153 170.

[4] Ambrose, D. P. 1996 Assassin bugs (Insecta: Heteroptera: Reduviidae) in biocontrol: success and strategies, a review. In: Biological and Cultural Control. Of Insect Pests, an Indian Scenario. (eds). D. P. Ambrose Tirunelveli: Adeline Publishers), pp. 262 284.

[5] Croft, B. A. and Brown, A.W.A. 1975. Response of Arthropod natural enemies to insecticides. *Ann. Rev. Entomol*. **20**: 285- 335.

[6] Conney, A.H., Welch, R.H., Kunmann, R. Burnes, J.J. 1966. Effec t of pesticides on drug and steroid metabolism. *Clin. Pharmacol. Ther*., **8**: 2-10.

[7] Dimov, G.and Kalyanova, F. 1967. Carbohydrate metabolism disordersin the liver and muscles in acute parathion poisionings. *C.R. Acad. Bulg. Sci.,* **20**: 1007-1009.

[8] George, P. J. E. and Ambrose, D.P. 1999a. Insecticidal impact on the post-embryonic development of *Rhynocoris kumarii* Ambrose and Livingstone (Het., Reduviidae). *Journal of Applied Entomology* **123**(8):509 – 512.

[9] George, P. J. E. and Ambrose, D.P. 1999b. Post-embryonic developmental changes in non-target *Rhynocoris fuscipe*s (Fabricius) (Insecta : Heteroptera : Reduvidae) by insecticides in cotton agro ecosystem. *Journal of Advanced Zoology* **20**(1):12-16.

[10] George, P. J. E. and Ambrose, D.P. 2004. Toxic effects of insecticides in the histomorphology of alimentary canal, testis and ovary in a reduviid Rhynocoris kumarii Ambrose and Livingstone (Hemiptera: Reduviidae). *Journal of Advanced Zoology* **25**(1-2): 46-50

[11] Hamilton, R. L. & Schal, C. 1990 Sublethal effects of chlorpyrifos methyl on reproduction in female German cockroaches (Dictyoptera, Blattellidae). *Econ. Entomol.*, **83**, 441 443.

[12] Lucky, T.D. 1968. Insect hormoligosis. *J. Econ. Entomol*., **61**: 7-12.

[13] O'Brien, R.D.1957. the effect of malathion and its isomer on carbohydrate metabolism of mouse, cockroach and housefly. *J. Econ. Entomol*., **50**: 79-84.

[14] Khowaja, J., Mumtaz, A. K., Qamar, A., Bachchan, A. K. 1992 Changes in fecundity, fertility, longevity and weight of *Dysdercus cingulatus* (Hemiptera: Pyrrhocoreidae) following topical application of monocroptophos. In: Proceedings of the 79th Indian Sci. Cong. Part III Section IX. Baroda: Indian Science Congress Association, pp. 76 77.

[15] Khowaja, J., Khan, M. A., Qamar, A., Khan, B. A. 1994 Biological effects of sublethal concentrations of monocrotophos on *Dysdercus cingulatus* Fabr.(Hemiptera, Pyrrhocoreidae). *J. Ent. Res.*, **18** (1), 37 44.

[16] Sahayaraj, K and Amalraj, A. 2005. Impact of monocrotophos and neem oil mixture on defoliator management in groundnut. *Journal of Central European Agricultur*e **6**(4).

[17] Sahayaraj, K. Kalidas S. and Loko Y.L. 2020. Bioefficacy of *Rhynocoris longiferons* (Stal) (Heteroptera: Reduviidae) against multiple cotton pests under screen house and field conditions. Scientific reports, **10**: 6637.

[18] SAS Institute Inc 1988. SAS/STAT Users guide, Release 6.03 edition. Cary. NC. SAS Institute Inc.

[19] Tukey, J. W. 1953 The problem of multiple comparisons. In: *Experimental Design, Procedures for the Behavioural Sciences.* (eds R. E. Kirk California: Brooks Cole.) Princeton, NJ: Princeton University.