Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231-6345 (Online)
An Online International Journal Available at http://www.cibtech.org/jls.htm
2012 Vol. 2 (2) April-June, pp.160-163 /Lingampally et al.
Research Article

INDUCTION OF OVARIAN DYSFUNCTION IN *TRIBOLIUM CONFUSUM* BY SOLASODINE

***Vasudha Lingampally, V.R. Solanki, S. Sabita Raja**
Department of Zoology, Nizam College (A),Osmania University,Hyderabad,AndhraPradesh, INDIA
**Author for Correspondence*

ABSTRACT
Solasodine extracted from the green fruits of *Solanum aviculare* affected normal growth and development of the ovaries of *Tribolium confusum* (Duval) (Coleoptera: Tenebrionidae). The fifth instar, sixth instar larvae and pupae were treated with 1µg/µl of Solasodine. The ovarian development was drastically affected in treated resultant females. The ovaries of the treated resultant *Tribolium confusum* showed variation in the length and size of the ovarioles, ovariole degeneration, oocyte degeneration, resorption, inability of the mature oocytes to oviposite and formation of compound egg chambers. Our results show that the topical application of Solasodine inhibits ovarian development, lowering the reproductive potentiality of females of *Tribolium confusum* suggesting its use as an effective reproductive inhibitor in Integrated pest management programmes against the pest insects.

***Key Words*:** *Tribolium Confusum, Solasodine, Ovarian Deformities, Resorption*

INTRODUCTION
Tribolium confusum is one of the most serious pests in stored grain and related products. It is considered a secondary pest, which can easily infest damaged or broken kernels and apart from grain, it is particularly destructive to flour and other processed grain products. This species is resistant to several traditional insecticides which are commonly used as grain protectants (Boussaada *et al.*, 2008). Moreover, the synthetic insecticides possess inherent toxicities that endanger the health of the farm operators, consumers and the environment. Negative effects on human health led to a resurgence in interest in botanicals because of their minimal costs and fewer ecological side effects (HF Khater, 2012).
In view of this, less hazardous options such as use of behavior modifiers and insect growth regulators have gained prominence in agricultural pest management protocols. Several plant based compounds, which are potent sources of insect growth regulators and sterilants have been evaluated in this respect (Hebsy Bai and George Koshy, 2004). In this line of exploration an attempt has been made to study the sterilant activity of Solasodine extracted from the green fruits of *Solanum aviculare* (purchased from Sigma chemicals) on the stored grain pest *Tribolium confusum.*

MATERIALS AND METHODS
The *Tribolium confusum* was reared on jowar flour at a temperature of 27 ± 1^0C and RH (relative humidity) 60 ± 5%. Freshly ecdysed fifth instar, sixth instar larvae and zero-hour pupae were treated topically on the abdominal region with 1µg/µl of Solasodine with acetone as the carrier solvent with the help of Hamilton micro syringe. Thirty larvae and pupae were treated each time with Solasodine and the experiments were replicated five times. Controls were treated each time with an equivalent volume of carrier solvent acetone. After total absorption of Solasodine the larvae and pupae were transferred into the diet. The treated resultant females were observed for ovarian deformities and the results were compared with controls.

RESULTS
The Solasodine treated resultant females of fifth instar, sixth instar larvae and pupae of *Tribolium confusum* exhibited varied ovarian deformities.

The ovaries of pupal-adult intermediates were inconspicuous showing filamentous ovarioles with no yolk incorporation. These ovaries were small and generally did not show a clear demarcation into germarium and vitellarium (Fig 1).In few cases ovarioles varied in length and size. Few ovarioles exhibited degeneration while in other ovarioles mature terminal oocytes remained unovulated blocking the oviduct. In certain treated resultant abnormal adults and morphologically normal adults vitellogenesis was not uniform. Few ovarioles exhibited complete resorption while in remaining ovarioles one or two oocytes developed. These oocytes were yolk laden, enlarged and failed to oviposite (Fig 2). In certain cases oocytes were resorbed and continuous tube-like chambers were observed (Fig 3). In few treated resultant abnormal adults ovarioles exhibited compound egg chambers following degeneration (Fig 4).

Figure 1: Ovary of Pupal-adult intermediate showing filamentous ovarioles

Figure 2: Ovarioles of abnormal adult showing unovulated terminal enlarged oocytes resulting in resorption of the distal oocytes

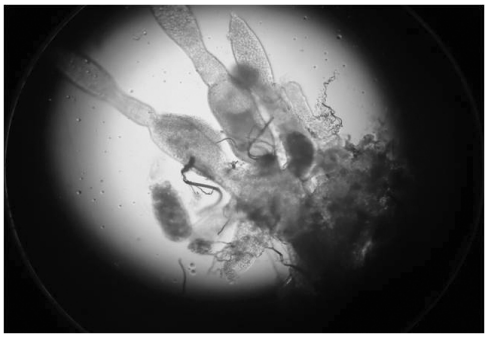

Figure 3: Ovarioles of abnormal adult showing resorption of oocytes

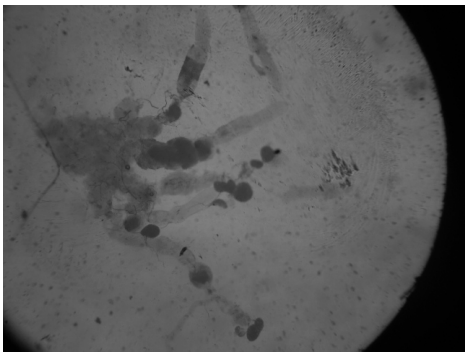

Figure 4: Ovarioles of abnormal adult exhibiting compound egg chamber following degeneration

DISCUSSION

Solasodine has drastically affected the development of the ovaries of T*ribolium confusum* and resulted in different abnormalities.

The ovaries of pupal-adult intermediates were inconspicuous showing filamentous ovarioles with no yolk incorporation. These ovaries were small and generally did not show a clear demarcation into germarium and vitellarium. Inhibition of ovarian development was also reported in *Bactrocera cucurbitae* reared on food treated with methanolic extract of *Acorus calamus* (Nair and Thomas, 2001).

In few of the treated resultant abnormal adults of *Tribolium confusum* ovariole size and length varied. Variation in ovariole size and length was also observed in *Oryctes rhinoceros* treated with methanolic extract of *Eupatorium odoratum* leaves (Sreelatha and Geetha, 2010).

In certain Solasodine treated resultant abnormal adults and morphologically normal adults vitellogenesis was not uniform. Only one oocyte developed in each ovariole and the rest of them were resorbed. These oocytes were yolk laden but they failed to oviposite. Abnormal vitellogenesis and oocyte development was also observed in *Anopheles stephensi* Liston (Nathan *et al.,* 2007) and *Helicoverpa armigera* Hubner (Malarvannan *et al.,* 2009).

According to (Kaur *et al.,*1984) the juvenile hormone controls vitellogenesis. During vitellogenesis the follicular epithelium changes its shape from columnar to cuboidal and then to squamous, in accordance with the size of the oocyte. The incorporation of the yolk into the oocytes takes place through the intercellular spaces of the follicular epithelium. An optimum supply of juvenile hormone is necessary for vitellogenesis and any variations in the titre of juvenile hormone will lead to changes in the development of oocytes.

The Solasodine treatment also resulted in the formation of compound egg chambers. Their formation is probably due to the degeneration of the interfollicular septum. Compound egg chambers were also observed in *Achaea janata* (L.) (Nair and Muraleedharan, 1992) exposed to methoprene.

In most of the treated resultant abnormal adults of *Tribolium confusum* ovarioles exhibited resorption. Resorption of oocytes may be due to abnormal functioning of follicular cells as also reported by Nair and Thomas (2001) working with *Acorus calamus* L. extract on melon fly.

In certain cases ovarioles exhibited degeneration. Ghazawi *et al.* (2007), reported that topical treatment of azadirachtin in *Heteracris littoralis* resulted in the shrinkage of ovaries with abolished oocyte growth and disintegration and destruction of follicle cells.

In few cases the oocytes were resorbed and continous tube-like chambers were observed. Similar observation was seen in *Dysdercus similis* treated with methanol leaf extract of *Chrysanthemum indicum* (Kaur *et al.,* 1989).

According to Koeppe *et al.* (1980) juvenile hormone induces morphological and biochemical changes in the follicle cells which help in the deposition of yolk. Solasodine might caused disturbance in the normal pattern of juvenile hormone in such a way that it results in the atrophy of the follicle, the follicular cells then taking part in the degeneration. Nijhout and Riddiford, (1974) have also made similar observations and according to them rapid vitellogenic growth is initiated by follicles of a threshold size and is a juvenile hormone dependent event. Thus when the hormonal rhythm is disturbed the follicles grow to a threshold size and then degenerate.

The failure of the follicle cells to differentiate properly may be the cause of resorption which in turn is juvenile hormone dependent event as also reported by Anderson, (1971).

These abnormalities in the ovaries of the treated resultants drastically decreased the fecundity of the pest.

The adverse effect of Solasodine on ovarian development may be due to its interference with either the synthesis of vitellogenic protein or its uptake by oocytes as also observed in teak defoliator treated with *Melia azedarach* L. extract and neem (Nathan and Sehoon, 2006; Murugan *et al.,* 1999).

All these findings point towards lowering of the reproductive potentiality of females of *Tribolium confusum* as a result of Solasodine treatment.

Conclusions

Thus Solasodine can be used as an effective reproductive inhibitor in Integrated pest management programmes against the pest insects.

ACKNOWLEDGEMENTS
The authors are thankful to Prof. Naidu Ashok, Principal, Nizam College (A) Osmania University for extending lab facilities and for his encouragement.

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