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# EVALUATION OF THE CHEMOSTERILANT EFFECT OF *ACORUS CALAMUS* L. EXTRACTS ON MELON FLY, *BACTROCERA CUCURBITAE* COQ.

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**Abstract:** Laboratory studies on the chemosterilant effect of A. *calamus* L. extracts on *Bactrocera. cucurbitae* COQ. revealed remarkable changes in the size and morphology of the reproductive organs of adult flies. The extracts were administered to the flies through food at dosages of 0.1 to 0.01% from the day of emergence. No signs of mating or courtship were seen in treated flies even up to the 25th day after the emergence, after which the flies were found to die. After the normal pre-oviposition period, the treated flies were dissected. Considerable reduction in size of the reproductive organs was noticed in the treated flies as compared to the normal ones. Due to a combined effect of mating inhibition, reproductive suppression and low survival, fecundity realization was not possible.

**Key words:** *Acorus calamus, Bactrocera cucurbitae,* chemosterilant, fecundity, mating inhibition, reproductive suppression.

## INTRODUCTION

The melon fly *Bactrocera cucurbitae* COQ. is the most common and highly destructive pest attacking cucurbitaceous vegetables. It is widespread in all tropical countries and quite difficult to manage. Now the trend in pest control has changed to using plant products in pest management. One such plant, sweet flag *(Acorus calamus* L.) is reported to have several remarkable insecticidal and insectistatic effects on a number of pest species. Joseph *et al.* (1994) found a marked decline in the reproductive potential of *Tribolium castaneum* treated with *A. calamus* extracts. Calamus oil is reported to have sterilizing effects on ants (Schmidt and Borchers, 1981). Saxena *et al.* (1976) found that vapours of calamus oil reduced fecundity and caused regression in the terminal follicle of the vitellarium in treated females of several storage pests. Follicular regression in females of *Trogoderma granarium* has also been reported by Koul *et al.* (1977) and Tikku *et al.* (1978). These studies revealed disturbance in the differentiation of follicular epithelium and resorption of oocytes from the terminal oocyte towards the germarium. Laboratory experiments were conducted to evaluate the efficacy of *A. calamus* in the management of the melon fly, *B. cucurbitae,* by testing for its possible chemosterilant action.

## MATERIALS AND METHODS

Laboratory reared adult flies of uniform nature were used for the experiments. Methanol extracts of *A. calamus* rhizomes were prepared using cold steeping method (Teotia and Pandey, 1979). A stock solution of strength 10% was first prepared and for further dilutions, the required quantity of the stock was taken, the solvent evaporated and the extract re-dissolved in acetone.

The adult flies were treated with the methanol extracts at doses ranging from 0.1 to 0.01%. The extracts were administered to the flies along with their food. One gram of sugar mixed with 1 ml of the extract was provided to a set of 10 flies (five males and five females) of uniform age. The treated food was provided from the day of hatching and replaced daily. As control, 10 flies (five males and five females) of uniform age were provided with pure sugar alone. Once mating was noticed, they were provided with pumpkin fruit pieces to oviposit. The flies were observed daily to record the occurrence and frequency of mating or any other changes in the behaviour. After the pre-oviposition period of 12-15 days, the flies were killed and dissected to observe their developmental anatomy.

## RESULTS AND DISCUSSION

It was noted that by the 15th day, the control flies had mated and started oviposition. The treated flies, however, showed no signs of mating or courtship behaviour, even on the 25th day. From the 27th day onwards, the treated flies were found to die.

In the above experiment, when the control flies started oviposition, the flies from all treatments and replications were sampled and dissected to observe morphological / anatomical changes in the internal reproductive organs

Table 1. Comparison of size of female reproductive organs of normal and treated* *B. cucurbitae*

| Replication | Normal mature ovary, 20th day | | Treated ovary, 20th day | | Normal immature ovary, 5th day | |
|---|---|---|---|---|---|---|
| | Length, urn | Breadth, µm | Length, µm | Breadth, µm | Length, µm | Breadth, µm |
| R1 | 1658.25 | 1363.45 | 479.05 | 368.50 | 589.60 | 552.75 |
| | 1695.10 | 1326.60 | 442.20 | 368.50 | 626.45 | 663.30 |
| R2 | 1621.40 | 1289.75 | 405.35 | 405.35 | 552.75 | 552.75 |
| | 1658.25 | 1289.75 | 442.20 | 442.20 | 552.75 | 589.60 |
| R3 | 1695.10 | 1363.45 | 515.90 | 405.35 | 589.60 | 552.75 |
| | 1731.95 | 1289.75 | 479.05 | 442.20 | 626.45 | 552.75 |
| R4 | 1768.80 | 1289.75 | 405.35 | 368.50 | 663.30 | 575.90 |
| | 1768.80 | 1400.30 | 442.20 | 405.35 | 626.45 | 589.60 |
| R5 | 1768.80 | 1289.75 | 442.20 | 442.20 | 626.45 | 626.45 |
| | 1695.10 | 1363.45 | 515.90 | 368.50 | 626.45 | 663.30 |
| Average | 1706.15 | 1326.60 | 456.94 | 401.66 | 608.02 | 585.91 |

*0.01 % methanol extract of *Acorus calamus*

Table 2. Comparison of size of male reproductive organs of normal and treated* *B. cucurbitae*

| Replication | Normal mature testes, 20th day | | Treated testes, 20th day | | Normal immature testes, 5th day | |
|---|---|---|---|---|---|---|
| | Length, µm | Breadth, µm | Length, µm | Breadth, µm | Length, µm | Breadth, µm |
| R1 | 1179.20 | 479.05 | 847.55 | 331.65 | 515.90 | 515.90 |
| | 1363.45 | 442.20 | 810.70 | 331.65 | 663.30 | 405.35 |
| R2 | 1252.90 | 475.05 | 958.10 | 368.50 | 552.75 | 442.20 |
| | 1289.75 | 405.35 | 994.95 | 368.50 | 589.60 | 479.05 |
| R3 | 1289.75 | 442.20 | 921.25 | 368.50 | 663.30 | 442.20 |
| | 1326.60 | 442.20 | 700.15 | 405.35 | 663.30 | 479.05 |
| R4 | 1289.75 | 479.05 | 773.85 | 294.80 | 626.45 | 552.75 |
| | 1363.45 | 479.05 | 810.70 | 331.65 | 589.60 | 368.50 |
| R5 | 1216.05 | 442.20 | 884.40 | 368.50 | 663.30 | 405.35 |
| | 1216.05 | 515.90 | 737.00 | 442.20 | 515.90 | 442.20 |
| Average | 1278.69 | 460.62 | 843.86 | 361.13 | 604.34 | 453.25 |

0.01 % methanol extract of *Acorus calamus*

of both sexes. The dissections revealed substantial morphometric changes of the reproductive organs of the treated flies. The organs were measured using micrometry.

Table 1 compares the sizes of ovaries of normal mature flies and flies treated with 0.01% methanol extract from the day of emergence, dissected on the 20th day after emergence. The sizes of normal immature ovaries, dissected 5 days after emergence are also presented for comparison. The average size of a normal 20 day-old ovary was 1706.15 µm to 1326.60 µm, while that of the treated 20 day-old ovary was found to be 456.94 µm to 406.66 µm. The normal immature ovary measured 608.02 µm to 585.91 µm. Table 2 compares the sizes of testes. The average size of normal 20 day-old testes was 1278.69 µm to 460.62 µm and that of the treated 20 day-old testes was found to be 843.86 µm to 361.13 µm. The immature testes measured 604.34 µm to 453.25 µm. The differences are quite remarkable as shown in Plates 1 and 2.

The extracts of A. *calamus* when fed with the food substances inhibited mating, apart from affecting the size of reproductive organs. This

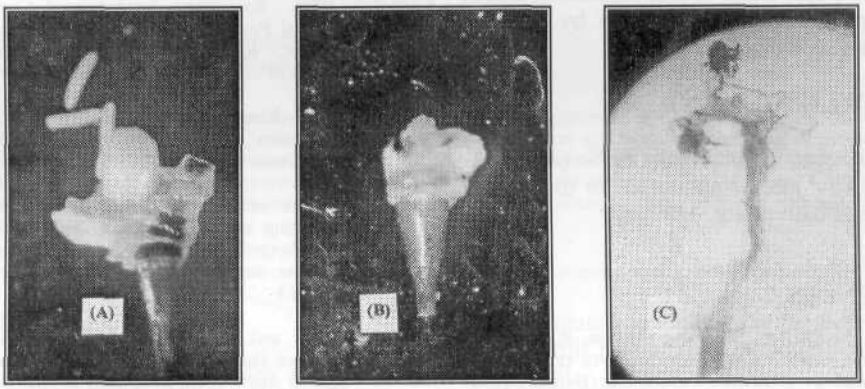


Plate 1. Ovaries of *Bactrocera cucurbitae.* (A) Mature, untreated, 20-days old, actual size 1706.15 to 1326.60 μm; (B) Immature, untreated, 5 day-old, actual size 608.02 to 585.91 μm); (C) Mature, 20 day-old, treated with *A. calamus* extracts, actual size 456.94 to 401.66 μm

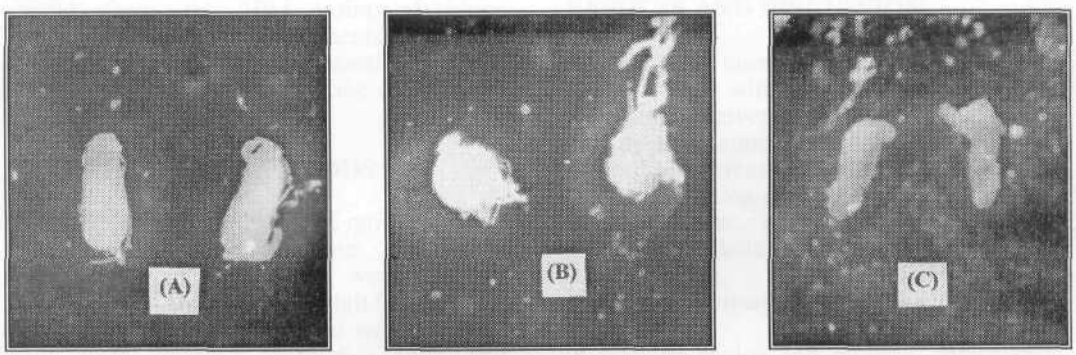


Plate 2. Testes of *Bactrocera cucurbitae.* (A) Mature, untreated, 20 day-old, actual size 1278.69 to 460.62 μm; (B) Immature, untreated 5 day-old, actual size 843.86 to 361.13 μm; (C) Mature, 20 day-old, treated with *A. calamus* extract, actual size 604.34 to 453.25 μm

inhibition could be due to hormonal imbalance caused by the effect of the ingested extracts on the reproductive organs. The continuous intake of low doses of the extract also caused early death of the insects as compared to normal untreated ones. Thus, due to a combined effect of mating inhibition, reproductive suppression and low survival, fecundity realization was not possible for the flies in the normal way.

The activity of the isolated compound in *A. calamus* rhizomes, p-asarone has been established on a variety of insects. Unlike other sterilizing agents, the vapours of *A. calamus* possess a specific effect on egg resorption in females. This is due to abnormal functioning of follicular cells, making the gravid insects infecund. In males, the sterility is caused due to malfunctioning of interstitial cells, which leads to immobility and agglutination of sperms (RRL, 1983).

If the treated flies survived longer and mating had occurred, it was possible that a low fecundity realization might have been noted. If there was low fecundity realization, it could be stated that A. *calamus* had a strong chemosterilant effect on both sexes of *B. cucurbitae.* The significance of the study lies in the fact

that the extracts could be used to induce sterility in wild population of this menacing insect without polluting the ecosystem by suitable bait feeding techniques.

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## REFERENCES

Joseph, M., Mukherjee, S.N. and Sharma, R.N. 1994. Growth inhibition and impairment of reproductive potential in *Tribolium castaneum* (Herbst.) (Coleoptera: Tenebrionidae) by commercially available plant extracts. *Insect Sci. Appl.* 15 (2) : 197-202

Koul, O., Tikku, K. and Saxena, B.P. 1977. Follicular regression in *Trogoderma granarium* due to sterilizing vapours of *Acorus calamus* L. oil. *Curr. Sci.* *46* : 724-725

R.R.L. 1983. *Souvenir: International Conference on Natural Products as Regulators of Insect Reproduction.* Regional Research Laboratory, Jammu. pp. 28-29

Saxena, B.P., Koul, 0. and Tikku, K. 1976. Nontoxic protectants against the stored grain insect pests. *Bull. Grain Technol.* 14(5) : 190-193

Schmidt, G.H. and Borchers, D. 1981. Studies on the sterilizing effects of Indian calamus oil on ants. *Mitteilungen der Deutschen Gesellschaft fur Allgemeine und angewandte Entomologie.* 3 (1/3): 201-213

Teotia, T.P.S. and Pandey, G.P. 1979. Insecticidal properties of rhizomes of sweet flag, *Acorus calamus* against rice weevil, *Sitophilus oryzae* L. *Indian J. Ent.* 41 : 91-94

Tikku, K., Koul, O. and Saxena, B.P. 1978. The influence of *Acorus calamus* L. oil vapours on the histocytological pattern of the ovaries of *Trogoderma granarium* Evert. *Bull. Grain Technol.* 16 (1): 3-9