Pak. J. Agri. Sci., Vol. 43(1-2), 2006

INSECTICIDAL ACTIVITY OF DIFFERENT DOSES OF *ACORUS CALAMUS* OIL AGAINST *TROGODERMA GRANARIUM* (EVERTS)

Mansoor-ul-Hasan, Muhammad Sagheer, Ehsan Ullah*, Farooq Ahmad and Waqas Wakil
Department of Agricultural Entomology, University of Agriculture, Faisalabad.
*Department of Agronomy, University of Agriculture, Faisalabad.

In order to evaluate the toxic effects of essential oil from rhizomes of *Acorus calamus* L., different doses (30, 50 and 70 µL) were tested against grubs of *Trogoderma granarium* (Everts). Percent mortality for exposure periods of 3, 5 and 7 days was observed. Post treatment population build up was observed at 60 days. The exposure period appeared to be the most important factor affecting the toxic effect of the vapours of the *Acorus* oil rather than the dosage. Insect showed 11.10, 22.59 and 44.70 % morality at exposure time of 3, 5 and 7 days, respectively, whereas 22.18, 24.44 and 27.77 % mortality was observed with 30, 50 and 70 µL of oil respectively. Population build up was reduced both with increase in dose of *Acorus calamus* oil and exposure time.

INTRODUCTION

Khapra beetle, *Trogoderma granarium,* is the world's worst pest of the stored grains (Christensen and Kaufmann, 1969). Losses caused by khapra beetle have been reported to range from 0.2 to 2.9 % over a period of 1 to 10.5 months (Irshad *et. al.,* 1988). Phsophine is most frequently used to protect stored agricultural products. Various stored grain insect pests including *T. granarium* (Everts.) have become tolerant to this fumigant. Appreciably high resistance was recorded in *T. granarium* strains collected from Punjab and Sindh (Alam *et al.,* 1999)

In addition to phosphine, grain protectants like synthetic pyrethroids and organophosphates have been in use during last many years. These chemicals like malathian, cypermethrin, deltamethrin, bifenthrin etc. pose risk to human health and the environment (Tarakanov *et al., 1994;* Tsumura *et al.* 1994). Moreover, malathian and cypermethrin have gone ineffective due to development of resistance in insect pests of stored grain particularly in *Trogoderma granarium* (Irshad and Iqbal, 1994; Saxena and Sinha, 1995).

Rhizomes of sweet flag, *Acorus calamus* L. (Aracae), possesses insecticidal properties against a wide variety of insect pests. The powder and extracted oil of rhizomes act as stomach / contact poison, anti-feedant and repellent. The toxic and sterilizing effects of vapours of rhizome oil against certain insect pests have also been observed. (Schmidt *et al.*, 1991).

In the present project studies were made to evaluate the toxic effects of essential oil of *A. calamus* L. rhizomes in different doses against *T. granarium* (Everts) at different exposure times.

MATERIALS AND METHODS

Trogoderma granarium collected from various godowns of Punjab Food Department located in Faisalabad district was reared in one liter capacity glass jars containing wheat. These glass jars were placed in an incubator maintained at 30 ± 2 ºC and 60 ± 5 % R.H.

The rhizomes of sweet flag, *Acorus calamus,* were collected from northern hilly areas of Pakistan. The rhizomes were cleaned, dried and ground to a fine powder (30 mesh) and then extracted with n-hexane in the Soxhlet extraction apparatus. Extracts were concentrated in a rotary evaporator and finally made solvent free in vacuum desiccator to obtain pure oil. The oil was stored in a refrigerator at 4 ºC.

Acetone was used as a solvent for *Acorus calamus* oil. Different dilutions were prepared as under: -

999 ml of acetone + 1 ml of oil = 1 liter of solution.
1 ml of solution = 1 µl of oil

Glass jars of 1150ml capacity were used as exposure chamber. 250 grams of wheat grains were taken for each treatment. Thirty grubs of *Trogoderma granarium* were placed in each glass jar. These grubs were exposed to different doses of *Acorus calamus* oil. The doses of *Acorus calamus* oil were 30, 50 and 70µl. All treatments were replicated four times. There was one untreated control for each treatment.

Application of *Acorus calamus* oil was carried out by releasing the required volume of appropriate oil solution from an automatic pipette to a disk of 4 cm diameter filter paper (Whatman No. 2) attached to inner surface of the lid of the glass jars (Zaidi *et al.,* 2003, Rasool *et al.,* 2002). Exposure periods for each treatment were 3, 5 and 7 days. At the end of exposure period, jars were opened. The grubs of *Trogoderma granarium* were separated from the grains and mortality was assessed.

The survivors were transferred to glass jars containing untreated grains. The jars were kept at 32 ± 2 ºC and 65 ± 5 % relative humidity. After 60 days, total number of adult and grubs were calculated for population build up. At the end, collected data of percent mortality and mean population build up were analyzed statistically following CRD analysis of Variance and Duncan's Multiple Range Test (Steel and Torrie, 1980)

RESULTS AND DISCUSSION

Results showed that exposure time had highly significant effect on the mortality of *T. granarium* (Everts), whereas doses of *A. calamus* oil and the interaction of *Acorus calamus* oil doses and exposure times had significant effect on the mortality of *T. granarium* (Everts).

Table -1 shows the mean values of percent mortality and population build up of *T. granarium* at different doses of *A. calamus* oil. 70 µL dose of *A. calamus* oil with 27.77% mortality was statistically at par with 50 µL dose causing 24.44% mortality of test insect and differed significantly from 30 µL dose with 22.18% mortality which was statistically at par with 50 µL dose whereas population build-up was 12.62, 7.04, 5.67 and 4.49 per insect against 0, 30, 50 and 70 µL respectively.

Table-2 shows the effect of exposure time on the mean percent mortality and population build up of *Trogoderma granarium.* In case of mortality all the main exposure times differed significantly from one another having mean values of 40.70, 22.59 and 11.10% at 7, 5 and 3 days respectively. Similarly, in case of population build up per insect, all exposure time differed significantly from one an other having mean values 8.544, 7.459 and 6.374 times for 3, 5 and 7 days respectively.

The mean percent mortality observed in response of interaction of doses with exposure time is given in Table-3. Maximum mortality (43.33%) was achieved with 50 µL x 7days, which was found to be statistically at par with that at 70 µL x 7days (40.00 %) and 30 µL x 7days (38.77 %), differing significantly from all other interactions. Mortality with 70 µL x 5days (31.11 %) differed significantly from all other combinations. Mortality of 50 µL x 5days (18.89%) and 30 µL x 5days (17.78%) were non-significant to each other. Combinations 30 µL x 5days (17.78%) and 70 µL x 3days (12.20%) are statistically at par with one another. Combinations 70 µL x 3days (12.20%), 50 µL x 3days (11.11%) and 30 µL x 3days (10.00 %) had non-significant difference. These combinations have given statistically the lowest mortality.

Means of population build observed in response of interaction of doses of *Acorus calamus* oil with exposure time are also given in table 3. Maximum population build-up per insect (12.69) was observed under (control (0 µL) x 5 days) which was found to be match able to the population build up at 0 µL x 3 days (12.62) and 0 µL x 7 days (12.56), differing

Table 1. Comparison of percent mortality and Population build up of *T. granarium* (Everts) at different doses of *A. calamus* oil

Doses (µL)	Means of percent Mortality	Means of Population build-up per insect
30 µL	22.18 a	7.04 a
50 µL	24.44 ab	5.67 b
70 µL	27.77 b	4.48 c

F. ratio = 5.2, LSD value = 6.3, Standard error = 2.1 at α 0.05 (For mean percent mortality)
F. ratio = 149.3, LSD value = 0.3, Standard error = 0.1 at α = 0.05 (For mean population build up)

Table 2. Comparison of percent mortality and post treatment population build up of *T. granarium* (Everts) at various exposure times

Exposure Time (Days)	Means of percent Mortality	Means of Population build-up per insect
7 days	40.70 a	8.544 a
5 days	22.59 b	7.459 b
3 days	11.10 c	6.374 c

F. ratio = 147.1, LSD value = 3.6, Standard error = 1.2 at α 0.05 (For mean percent mortality)
F. ratio = 97.8, LSD value = 0.3, Standard error = 0.1 at α = 0.05 (For mean population build up)

Table 3. Comparison of percent mortality and population build up of *T. granarium* (Everts) caused by interaction between various doses of *A. calamus* oil and exposure times.

Dose x Exposure Time	Means of percent Mortality	Means of Population build-up per insect
30 µL x 3 days	10.00 e	3.318 f
30 µL x 5 days	17.78 cd	5.442 c
30 µL x 7 days	38.77 a	6.972 b
50 µL x 3 days	11.11 e	4.167 e
50 µL x 5 days	18.89 c	5.452 c
50 µL x 7 days	43.33 a	8.722 a
70 µL x 3 days	12.28 de	4.703 d
70 µL x 5days	31.11 b	5.470 c
70 µL x 7 days	40.00 a	7.395 b

F. ratio = 4.2, LSD value = 6.3, Standard error = 2.1 at α 0.05 (For mean percent mortality)
F. ratio = 22.8, LSD value = 0.5, Standard error = 0.2 at α 0.05 (For mean percent mortality)

significantly from all other combinations. Population build-up per insect at 30 µL x 3 days was 8.72 insects differing significantly from all other combinations. Combinations 50 µL x 3 days (7.39) and 50 µL x 5 days (6.97) were statistically at par, having significant difference from other values. Similarly, combination 50 µL x 5days (5.47), 30 µL x 7 days (5.45) and 70 µL x 3days (5.44) are statistically at par, having significant difference from other values. Minimum population build-up per insect (3.31) was observed at 70 µL x 7 days, which differed significantly from all other interactions.

Our findings are in accordance with the findings of Chandel *et al.* (2001); Kumari *et al.* (1999); Risha (1993) and Rasool *et al.* (2002) who observed that in case of *Acorus calamus* oil exposure period was much more important than dosage.

The results of present study for percent mortality of *Trogoderma granarium* (Everts) against *Acorus calamus* oil differ from the findings of Schmidt and Risha (1990); Risha *et al.* (1990); Schmidt *et al.* (1991) and Chairat *et al.* 2002).

Post treatment population build-up of surviving insect from various treatments revealed that population build up was reduced with the increase in dose of *Acorus calamus* oil and exposure period.

REFERENCES

Alam, M.S., S.S. Shaukat, M. Ahmad, S. Iqbal and A. Ahmad. 1999. A survey of resistance to phosphine in some coleopterous pests of stored wheat and rice grain in Pakistan. Pak. J. Biol. Sci., 2(3) : 623-626

Chandel, B.S., R.R.S. Chauhan and A. Kumar. 2001.Phagodetterent efficacy of rhizome extract of sweet flag, *Acorus calamus* against *Tribolium castaneum*. Indian J. Entomol., 63(1):8-10.

Chairat, C., T. Siripan, J. Suratwadee and I. Somchai. 2002. Fumigation toxicity of Eucalyptus oil against three stored product beetles. Thai J. Agri. Sci. 35 (3):265-272.

Christensen, C.M. and H.H. Kaufmann. 1969. Grain Storage. Univ. Minnesota Press, pp 128.

Irshad, M., A. Khan and U.K. Baloch. 1988. Losses in wheat in public sector storage in Rawalpindi region during 1984-85. Pak. J. Agric. Res., 9(2): 136-140.

Irshad, M. and J. Iqbal. 1994. Phosphine resistance in important stored grain insect pests in Pakistan. Pak. J. Zool., 26(4): 347-350.

Kumari, P., P. Kumari and M.K. Verma. 1999. Effect of *Acorus calamus* as grain protectant against *Callosobruchus chinensis*. J. Appl. Biol., 9(2): 188-189.

Proctor, D.L. 1994. Grain storage techniques. FAO, Agric. Serv. Bull., 109: 207-209.

Rasool, A., F. Ahmad, M. Hassan and M.S. Ahmad. 2002. Insecticidal activity of different doses of *Acorus calamus* L. oil against *Tribolium castaneum* (Hbst.) (Coleptera: Tenebrionidae). Pak. Entomol., 24(1):49-52.

Risha, E.M., A.K. M. EL-Nahal and G.H. Schmidt. 1990. Toxicity of vapours of *Acorus calamus* oil to the immature stages of some stored product coleoptera. J. Stored Prod. Res., 26(3): 133-137. (Rev. Agric. Entomol., 79(10): 1340, Abst., 11598; 1991).

Risha, E.M. 1993. Efficiency of synthetic beta-asarone, the active ingredient of *Acorus calamus* oil as space treatment against *Sitophilus zeamais* Motsch. Bull. Entomol. Soci. Egypt, Econ. series, 20: 123-131.

Schmidt, G.H. and E.M. Risha. 1991. Vapours of *Acorus calamus* oil are suitable to protect stored products against insects. In proceedings: IPM in tropical and subtropical cropping systems Frankfurt, Germany; Duetsche Landwirtschafts. Gesellschaft, 3: 997-999. (Rev. Agric. Entomol., 81(5), Abst., 5199; 1993).

Schmidt, G.H., E.M. Risha and A.K.M. EL-Nahal. 1991. Reduction of progeny of some stored-product coleoptera by vapours of *Acorus calamus* oil. J. Stored Prod. Res., 27 (2): 121-127.

Saxena, J.D. and S.R. Sinha. 1995. Evaluation of some insecticides against malathion resistant strains of red flour beetle, *Tribolium castaneum* (Herbst). Indian J. Entomol., 75(4): 401- 405.

Steel, R.G.D. and J.H. Torrie. 1980. Principle and Procedures of Statistics. McGraw Hill Book Co. Inc., New York, pp. 15-38

Tarakanov, I.A., Y. Kurambaev, A.A. Khusinov and V.A. Safonov. 1994. Respiratory and circulatory disorders in experimental poisoning with an organophosphorus pesticide. Bull. Exper. Biol. Med. 117(5): 466-471.

Tsumura, Y., S. Hasegawa, Y. Sekiguchi, Y. Nakamura, Y. Tonogai and Y. Ito. 1994. Residues of post-harvest applied pesticides in buckwheat after storage and processing into noodle. J. Food Hygienic Soci. Japan, 35(1): 1-7.

Zaidi S.R., G. Jilani, M. Ashfaque, J. Iqbal and U. Rafeeq. 2003. Oviposition response of *Sitotroga cerealella* (Oliv.) to plant extracts. Pak. Entomol., 25(2): 183-189.