DOI: 10.33307/entomon.v43i4.408
ENTOMON 43(4): 277-280 (2018)
Short Communication No. ent. 43407

Management of rice weevil, *Sitophilus oryzae* using essential volatile oils

S. R. Binseena*, N. Anitha, Ambily Paul, V. S.Amritha and K. N. Anith

Department of Agricultural Entomology, College of Agriculture, Vellayani, Thiruvananthapuram 695 522, Kerala India; Department of Agricultural Microbiology, College of Agriculture, Vellayani, Thiruvananthapuram 695 522, Kerala India.
Email:binseenasrb@gmail.com

ABSTRACT: Effect of four essential volatile oils *viz*., clove (*Syzygium aromaticum* L.), cinnamon (*Cinnamomum zeylanicum* Blume), lemon grass (*Cymbopogon flexuosus* (Nees *ex* steud)) and pepper (*Piper nigrum* L.) on mortality of rice weevil, *Sitophilus oryzae* L. in stored rice was studied under laboratory conditions. Preliminary toxicity bioassays (without food and with food) were carried for fixing the concentrations of these oils. Percentage mortality of weevils by volatile essential oils increased with increase in concentration and period of exposure. Pepper oil @ 200 µl/500 cm^{-3} volume caused cent per cent mortality without any progeny emergence whereas cinnamon oil @ 30 µl 500 cm^{-3} caused 95.55 per cent mortality of weevils with 98.81 inhibitions on progeny emergence. The highest concentration (30 µl 500 cm^{-3}) of clove oil caused 76.67 percentage mortality of weevils while lemon grass oil (200 µl 500 cm^{-3}) caused 68.89 percentage mortality.

KEY WORDS: Essential volatile oils, rice weevil, *Sitophilus oryzae*

Stored product insects cause 3 to 18 per cent postharvest loss in rice during storage which is relation to the area and period of storage (Tagola *et al.*, 2013). There were 1,663 insect species are reported as pest of stored food commodities, among which few insects were known for its greater damage ability and well distribution all over the world. Their presence was reported from grain elevators, mills and retailers (Hagstrum and Phillips, 2017). Pest infestation contributes to contamination in food products through the presence of dead and live insects, excretions and body fragments. Both whole and milled rice are severely attacked by insect pests belongs to Coleoptera and Lepidoptera. Beetles are highly diversified and cause huge destruction of stored grain when compared with that of moth (Upadhyay and Ahmad, 2011). The increased awareness on the deleterious effect of chemical insecticides and the demand for insecticide free food has prompted the development of safer alternative management option. The use of botanicals offers an alternative management strategy against stored grain insect pests. Essential oils from plant parts exhibit contact, fumigant, repellent and antifeedant actions to several coleopteran insect pests infesting stored products. Fumigant action of volatile oils are due to the presence of monoterpenes (Koul *et al.*, 2008). In

* Author for correspondence

this context, four volatile essential oils such as clove oil (*Syzygium aromaticum* L.), lemon grass oil (*Cymbopogon flexuosus* (Nees *ex* steud)), cinnamon oil (*Cinnamomum zeylanicum* Blume) and pepper oil (*Piper nigrum* L.) were selected to assess their toxicity against rice weevil, *S. oryzae* in stored rice.

Initial culture of rice weevil was obtained from survey conducted in public provision stores, Thiruvananthapuram Kerala. Twenty pairs of rice weevil adults were released into plastic jars of one litre capacity containing 250 g grains. The jars were covered with plastic lids provided with 10 to 15 pin holes to avoid moisture build up and fungal growth. The mated females were allowed to oviposit on the grains for a period of two weeks and thereafter the adults were removed from the grains. Such jars were maintained to get sufficient number of beetles for the conduct of the experiments. Damaged grains were replaced at regular intervals. The culture was maintained in the laboratory conditions of temperature 24 to 32^0C and relative humidity 73 to 92 per cent.

Toxicity of volatile essential oils on *S. oryzea* was studied by dosage mortality bioassays. A plastic jar of 500 ml capacity (11 cm height and 7.5 cm diameter) was used for the experiment. Initially two bioassays (without food and with food) were conducted with different concentrations to fix the final concentrations of essential volatile oils. Clove oil at 20, 25 and 30 µl, cinnamon oil at 20, 25 and 30 µl, lemon grass oil at 125, 150 and 200 µl and pepper oil at 125, 150 and 200 µl with three replications were tested against rice weevil. Observations on mortality were recorded at 2^{nd}, 4^{th}, 6^{th}, 8^{th} and 10^{th} day after treatment. Percentage mortality in all treatments was corrected for control mortality by Abbott's formula (Abbott, 1925).

$$\text{Corrected per cent mortality} = \frac{(Tm - Cm)x100}{(100 - Cm)}$$

Tm – Per cent mortality in treatment and Cm – Per cent mortality in control

Emerged adults were counted after 55^{th} day of treatment and recorded. Progeny emergence inhibition was calculated using the formula,

$$\text{Progeny emergence inhibition (\%)} = \frac{(Cp - Tp)x100}{Cp}$$

Cp – Number of progenies emerged in control and Tp – Number of progenies emerged in treatment

Efficacy of volatile essential oils on *S. oryzae:* On comparing the different concentrations of essential oils at four days after treatment, weevil mortality correspondingly increased with increasing concentration. All the treatments were significantly superior to control. Complete mortality of weevils was recorded in pepper oil @ 200 µl 500 cm^{-3}. Treatment with cinnamon oil @ 30 µl 500 cm^{-3} (91.11) was statistically on par with pepper oil @ 150 µl 500 cm^{-3} (83.33). Significant difference was observed in percentage mortality of weevils at six days after treatment which ranged from 38.89 to 100.00. On sixth day, pepper oil @ 200 µl 500 cm^{-3} showed cent per cent mortality and it was followed by pepper oil @ 150 µl 500 cm^{-3} with percentage mortality 93.33. A similar trend was observed on tenth day after treatment (Table 1).

Percentage mortality of weevils by volatile essential oils increased with increase in concentration and period of exposure. On comparing percentage mortality of weevils, the highest concentration (30 µl 500 cm^{-3}) of cinnamon oil caused more than 90.00 percentage mortality than clove oil at same concentration. Higher concentration of pepper oil (200 µl 500 cm^{-3}) caused cent per cent mortality which was superior over same concentration of lemon grass oil. Pepper oil @ 200 µl 500 cm^{-3} caused complete inhibition of progeny emergence over control whereas clove oil @ 20 µl 500 cm^{-3} inhibited only 73.37 per cent progeny emergence which was noted as least effective in the control of rice weevil. Pepper oil regarded as highly toxic followed by cinnamon oil; while clove and lemon grass oils were reported to be moderately toxic. This finding was supported by the mortality data obtained in both bioassays, without food and with food. Khani *et al.* (2012) reported that essential oil from black pepper (*P. nigrum*) caused mortality in rice weevil. The highest mortality of weevils in without food condition

Table1. Effect of volatile essential oils on mortality and progeny emergence of rice weevil

Treatments (µl 500 cm^{-3})	Mortality (%) DAT				# Progeny inhibition
	4	6	8	10	55
Cinnamon oil 20	56.67 (48.84)^{de}	64.45 (53.41)^{ef}	70.00 (56.93)^{cd}	70.00 (56.93)^{bcd}	96.86
Cinnamon oil 25	63.33 (52.78)^{d}	69.99 (56.84)^{de}	72.22 (58.25)^{cd}	73.33 (59.02)^{bcd}	97.64
Cinnamon oil 30	91.11 (73.48)^{b}	92.22 (74.36)^{bc}	95.55 (79.85)^{ab}	95.55 (79.85)^{a}	98.81
Clove oil 20	32.22 (34.42)^{g}	38.89 (38.52)^{h}	43.33 (41.14)^{e}	44.44 (41.79)^{e}	73.37
Clove oil 25	40.00 (39.16)^{fg}	50.00 (44.98)^{fgh}	56.67 (48.93)^{de}	57.78 (49.58)^{de}	80.47
Clove oil 30	54.44 (47.65)^{def}	65.56 (54.79)^{e}	72.22 (59.03)^{cd}	76.67 (62.18)^{bc}	89.35
Lemon grass oil 125	35.55 (36.55)^{g}	45.55 (42.45)^{gh}	61.11 (51.45)^{de}	61.11 (51.45)^{de}	85.80
Lemon grass oil 150	38.89 (38.43)^{fg}	50.00 (45.00)^{fgh}	61.11 (51.49)^{de}	63.33 (52.78)^{cd}	91.12
Lemon grass oil 200	44.44 (41.72)^{efg}	57.78 (49.53)^{efg}	68.89 (56.29)^{cd}	68.89 (56.29)^{cd}	94.67
Pepper oil 125	78.89 (62.22)^{c}	82.22 (65.08)^{cd}	82.22 (65.08)^{c}	84.44 (66.79)^{b}	97.64
Pepper oil 150	83.33 (66.19)^{bc}	93.33 (77.54)^{b}	94.44 (78.69)^{b}	96.67 (81.34)^{a}	98.83
Pepper oil 200	100.00 (89.48)^{a}	100.00 (89.48)^{a}	100.00 (89.48)^{a}	100.00 (89.48)^{a}	100.00
Control	0.00 (0.52)^{h}	0.00 (0.52)^{i}	0.00 (0.52)^{f}	0.00 (0.52)^{f}	-
CD (0.05)	9.690	9.724	10.437	9.991	

DAT-Days after treatment Mean of 3 replications
Figures in parenthesis are angular transformed values; #Inhibition of progeny emergence (%)

may be due to the direct exposure of insect with oil which may interfere with respiratory system (Table 1).

In the present study, complete mortality of weevils with no progeny emergence were recorded in treatment with pepper oil at 200 µl 500 cm^{-3} within four days of exposure which were on par with pepper oil at 150 µl 500 cm^{-3} and cinnamon oil at 30 µl 500

cm^{-3} at 10 days after treatment. Results revealed that earlier death of beetles in pepper oil treatment may be due to the pungency. Khani *et al*, (2012) revealed that major component of pepper were piperine followed by oleic acid, linoleic acid, caryophyllene and limonene which may be the reason for mortality of test insects. Devi and Devi (2013) also reported potential lethal effect of pepper oil on rice weevil.

Treatment with cinnamon oil at concentration of 30 µl 500 cm^{-3} recorded a percentage mortality of 95.55 and less progeny emergence. This could be attributed to the possible insecticidal and ovicidal effect of cinnamon oil. These findings are in line with Lee *et al*. (2008), Ishii *et al.* (2010) and Kanda *et al*. (2017) who reported insecticidal and repellent activity of cinnamon oils due to the presence of benzaldehyde, cinnamonitrile, hydrocinnamyl acetate and á-terpineol. Properties like repellency, post ingestive toxicity, alteration in nutritional index and reduced relative growth rate were observed in cinnamon oil towards rice weevil (Stefanazzi *et al.*, 2011). Moderate mortality of lemon grass oil and clove oil were observed in this experiment. Insecticidal activity of clove oil was reported in a study conducted by Devi and Devi (2013). This concurs with Kerdchoechuen *et al*. (2010) and Saad *et al*. (2017) where they reported that clove bud oil containing eugenol (71.56 %) and eugenol

acetate (8.99 %) gave higher toxicity after 72 h of exposure. Among the four tested volatile oils, lemon grass showed lower initial mortality which were increased on increasing exposure period. It may be due to its slow toxicity release and activation of insecticidal property. These results agree well with findings of Jayaratne *et al.* (2001) and Saljoqi *et al.* (2006) who reported repellent and insecticidal activity in lemon grass oil.

REFERENCES

Abbott W. S. (1925) A method of computing the effectiveness of an insecticide. Journal of Economic Entomology 18: 266-267.

Boxall R. A. (2001) Post-harvest losses to insects- a world overview. International Biodeterioration Biodegradation 48: 137-152.

Devi K. C. and Devi S. S. (2013) Insecticidal and oviposition deterrent properties of some spices against coleopteran beetle, *Sitophilus oryzae*. Journal of Food and Science Technology 50: 600–604.

Hagstrum D. W. and Phillips T. W. (2017) Evolution of stored-product entomology: Protecting the world food supply. Annual Review of Entomology 62: 379–97.

Hill D. S. (1990) Pests of Stored Products and Their Control. CBS publishers and distributors, Delhi. 264 pp.

Ishii T., Matsuzawa H. and Vairappan C. S. (2010) Repellent activity of common spices against the rice weevil, *Sitophilus zeamais* Motsch (Coleoptera, Curculionidae). Journal of Tropical Biology and Conservation 7: 75-80.

Jayaratne K. H. T. and Paranagama P. A. (2001) Bioactivity of the essential oil of lemongrass, (*Cymbopogon citratus*) against rice weevil-*Sitophilus oryzae* (L.) and grain moth – *Sitotroga cerealella* (Oliver). Annual Review of Entomology 46: 17-24.

Kanda D., Kaur S. and Koul O. (2017) A comparative study of monoterpenoids and phenylpropanoids from essential oils against stored grain insects: acute toxins or feeding deterrents. Journal of Pesticide Science. 90: 531-545.

Kerdchoechuen, O., Laohakunjit, N., Singkornard, S., and Matta, F. B. 2010. Essential oils from six herbal plants for biocontrol of the maize weevil. Horticulture Science 45: 592-598.

Khani M., Awang M. and Omar D. (2012) Insecticidal effects of peppermint and black pepper essential oils against rice weevil, *Sitophilus oryzae* L. and Rice Moth, *Corcyra cephalonica* (St.). Journal of Medicinal Plants 11(43): 97-110.

Koul O., Walia S. and Dhaliwal G. S. (2008) Essential oils as green pesticides: potential and constraints. Biopesticide International 4: 63–84.

Lee E., Kim J., Choi D. and Ahn Y. (2008) Toxicity of cassia and cinnamon oil compounds and cinnamaldehyde-related compounds to *Sitophilus oryzae* (Coleoptera: Curculionidae). Journal of Economic Entomology 101: 1960- 1966.

Nagpal M. and Kumar A. (2012) Grain losses in India and government policies. Quality Assurance Safety of Crops and Foods 4: 143-147.

Saad A. S., Elsayed A., Tayeb H. M. and Metraw H. L. (2017) Botanical oils as eco-friendly alternatives for controlling the rice weevil *Sitophilus oryzae*. Alexandria Science Exchange Journal 38: 921-932.

Saljoqi A. U. R., Afridi M. K., Khan S. A. and Rehman S. (2006) Effects of six plant extracts on rice weevil *Sitophilus oryzae* L. in the stored wheat grains. Journal of Agricultural Biology Science 1: 1-5.

Stefanazzi N., Stadler T. and Ferrero A. (2011) Composition and toxic, repellent and feeding deterrent activity of essential oils against the stored grain pests *Tribolium castaneum* (Coleoptera: Tenebrionidae) and *Sitophilus oryzae* (Coleoptera: Curculionidae). Pest Management Science 67: 639-646.

Togola A., Seck P. A., Glitho I. A., Diagne A., Adda C., Toure A. and Nwilene F. E. (2013) Economic Losses from Insect Pest Infestation on Rice Stored on-farm in Benin. Journal of Applied Sciences 13: 278-285.

Upadhyay R. K. and Ahmad S. (2011) Management strategies for control of stored grain insect pests in farmer stores and public ware houses. World Journal of Agricultural Science 7: 527-549.

(Received 14 June 2018; revised ms accepted 05 November 2018; published 31 December 2018)