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Full Length Research Paper

Comparison of repellency of essential oils against red flour beetle *Tribolium castaneum* Herbst (Coleoptera: Tenebrionidae)

Muhammad Tayyib Naseem* and Rashad Rasool Khan

Department of Agricultural Entomology, University of Agriculture, Faisalabad, Punjab, Pakistan.

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Tribolium castaneum **Herbst (Coleoptera: Tenebrionidae) is one of the most prevalent stored-product insect pests in Pakistan. It feed on those grains only, which have already been damaged by primary pest. To check the efficacy of different essential oil repellency behavior, Experiment was conducted in the Toxicology Laboratory, Department of Agricultural Entomology, University of Agriculture, Faisalabad, Pakistan, to determine the efficacy of oil extracted from extraction of *Eucalyptus camaldulensis* and *Piper nigrum* in various concentrations that is 20, 40 and 60% for the suppression control of red flour beetle under laboratory conditions. The incubator was maintained at 30 ± 2°C and 65 ± 5% R.H. The experiment was laid in completely randomize design. The results showed that higher concentration of plant extracted is in the form of essential oils resulted in maximum repellency at maximum exposure period as compared to minimum oil concentrations at minimum exposure period. Furthermore, it was also observed that *E. camaldulensis* proved more effective as compared to *P. nigrum* at all the concentrations as well as at all the post treatment interval.**

Key words: *Tribolium castaneum, Eucalyptus camaldulensis, Piper nigrum*, repellency, wheat flour.

INTRODUCTION

Tribolium castaneum Herbst (Coleoptera: Tenebrionidae) is one of the most established insect pests of store products. It is the most abundant and detrimental pest in flourmills, grain bulks, oilseeds and warehousing facilities (Zettler and Cuperus, 1990; Zettler, 1991). It feed on those grains only, which have already been damaged by primary pests. Its presence in stored foods directly affects both the quantity and quality of the commodity (Mondal, 1994). Qualitative impair is due to product alterations such as loss of dietary and aesthetic value, high value of rejected grain in the grain mass and loss of manufacturing (baking) characteristics. Insects may cause damage to the seed embryos, which results in decreased germination (Baier and Webster, 1992; Moino et al., 1998). Repellent, toxic and developmental inhibitory activity of *Piper nigrum* was determined against wheat flour insect pest *T. castaneum*. The death of larvae and adults of *T. castaneum* was caused by *P. nigrum* essential oil, when fumigated. *P. nigrum.* The essential oil of *P. nigrum* reduced the oviposition potential, of the *T. castaneum*. *T. castaneum* inhibited the development of larvae to pupae and the pupae to adults was inhibited by the essential oil by oil vapors. Fumigation also resulted to deformities in the different developmental stages of the insect, *P. nigrum*, and caused suffocation and inhibition of various biosynthetic processes of *T. castaneum* (Chaubey, 2007).

The leaves of *Eucalyptus saligna* were used in Cameroon for local storage structures to protect their stored grains from insect influx (Tapondjou et al., 2000). Cymol, one of the main constituents of the essential oils extracted from *E. saligna* and *Cupressus sempervirens* leaves, was evaluated along with its repellent to show their lethal effects on *Sitophilus zeamais* and *T. confusum.* Eucalyptus oil was established as more toxic than Cupressus oil to both insect species (Tapondjou et al., 2005). The essential oil of *Piper nigrum* (L.) was evaluated for its repellent activity against an important wheat grain pest *T. castaneum* (Herbst). Adults of

*Corresponding author. E-mail: tayyibnaseem@hotmail.com Tel: +92-333-6511797.

Table 1. Means comparison of the data regarding repelency percentage of red flour beetle at different concentration of oil of *E. camaldulensis* at various post treatments intervals.

Time interval (min)	Concentration x time interval (ns)			LSD at 5% = 5.12
	20%	40%	60%	Means
30	30.00	38.33	51.67	40.00 [e]
60	43.33	56.67	68.33	56.11 [d]
90	51.67	65.00	76.67	64.44 [c]
120	61.67	73.33	83.33	72.77 [b]
150	66.67	75.00	86.67	76.11 [ab]
180	68.33	80.00	88.33	78.88 [a]
Means (**)LSD at 5% = 3.62	53.61 [c]	64.72 [b]	75.83 [a]	

T. castaneum were repelled significantly by *P. nigrum* at 0.2% concentration (v:v) and above in filter paper test (Upadhyay and Jaiswal, 2007).

Control of stored grain insects relies greatly on synthetic insecticides and fumigants use, which has led to problems, in addition to direct toxicity to users, such as environmental pollution, increasing expenses of application, pest renaissance, pest resistance to pesticides and lethal effects on non target organisms (Okonkwo and Okoye, 1996). So, this project had been planned to study the effect of different essential oils of plant origin *P. nigrum* and *E. camaldulensis* the repellency of *T. castaneum* under laboratory conditions for safe control.

MATERIALS AND METHODS

The experiment was conducted in the Toxicology Laboratory, Department of Agriculture Entomology, University of Agriculture, Faisalabad, Pakistan. The incubator was maintained at 30 ± 2°C and 65 ± 5% R.H. The experiment was laid in completely randomize design.

Laboratory mass culture of *T. castaneum*

Mixed population of *T. castaneum* was collected from wheat grain stores and brought to the Toxicology Laboratory, Department of Agricultural Entomology, University of Agriculture, Faisalabad, Pakistan, for rearing. The insects were kept in open mouth plastic jars covered with muslin cloth placed in the laboratory for about two months for rearing. Then 100 adults were shifted to another plastic jar containing fresh wheat flour. After three days adults were removed and the jar was kept at 30 ± 2°C and 65 ± 5% R. H. in an incubator. Progeny obtained from these stocks was almost of equal age and size which was further kept there for another period of 1 week before testing.

Isolation of oils

E. camaldulensis leaves were dried for 7 days at 25+5°C and grounded to powder. The powder was subjected to hydrodistillation using Clevenger apparatus for 6 h (Tapondjou et al., 2005). Similarly seeds of *P. nigrum* were grounded to powder and essential oil was isolated by hydrodistillation method using Clevenger apparatus for five hours (Chaubey, 2007a). Acetone was used as solvent in both processes. The oils were collected in 250 ml conical flask and kept at 4°C until they were used.

Repellency assay

The repellency assay of essential oils was carried out in Petri dishes of (80 mm). Test solutions were prepared by dissolving different volumes of essential oils in acetone (5, 10 and 15 ml dissolved in 25 ml acetone). Whatman filter paper was cut into two halves of 80 mm Petri dish (80 mm diameter) and each oil solution was applied to a half filter paper as uniform as achievable, using a pipette. The second half of the filter paper was soaked with acetone only. The both essential oils treated and acetone treated halves was dried to evaporate the solvent completely. After that both treated and untreated pieces were attached with cellophane tape and placed at the bottom in the Petri disc. Twenty adults of *T. castaneum* were released at the center of the filter paper disc, and then Petri dish was covered and kept in dark until data were recorded. Three replicates were running set for each concentration of essential oil. The numbers of the insects beetles on both halves were recorded after two hours. In control, half filter paper was treated with acetone only.

RESULTS AND DISCUSSION

Eucalyptus camaldulensis

The means comparisons of the data are shown in Table 1. The results reveal highly significant difference among concentrations and post treatment intervals (Table 1). Interaction among concentrations and time intervals was non significant. The maximum repellency of the pest *T. castaneum* was recorded to be 75.83% in those treatments where 60% dose of essential oil was applied and which differed significantly from those observed on other concentrations. The oil concentration of 40% showed intermediate trend resulted in 64.72% repellency of the pest beetle and also differed significantly from those recorded in other treatments. The degree of repellency according to concentrations are 60% >40% >20%; according to the exposure times 180>150> 120>90>60>30> and according to the plants are *E. camaldulensis*. The application of 20% concentration

Table 2. Means comparison of the data regarding repelency percentage of red flour beetle at different oil concentrations of *P. nigrum* at various post treatments intervals.

Time interval (min)	Concentration x time interval (ns)			LSD at 5% = 5.78
	20%	40%	60%	Means
30	16.67	30.00	41.67	29.44 [d]
60	30.00	40.00	53.33	41.11 [c]
90	35.00	43.33	60.00	46.11 [c]
120	40.00	50.00	70.00	53.33 [b]
150	45.00	58.33	75.00	59.44 [a]
180	46.67	60.00	76.67	61.11 [a]
Means (**) LSD at 5% = 4.08	35.56 c	46.94 b	62.78 [a]	

oil showed minimum repellency of the pest that is 53.61% and also showed significant variations with those obtained in other concentrations.

The percent repellency of the pest recorded on different time intervals also showed significant variation with each other. Maximum exposure time that is 180 min resulted in maximum repellency of the pest and did not show significant difference with those of observed at 150 min of post treatment interval that is 76.11%. The minimum repellency of the pest was recorded to be 40.00% after an interval of 30 min. The repellency of the pest was recorded to be 56.11, 64.44 and 72.77% at the post treatment intervals of 60, 90 and 120 min, respectively and was differed significantly with each others. The later mentioned figure did not show significant difference with those found at 150 min of post treatment intervals. The interactional response among concentrations and time intervals was non significant. However, the repellency percentage ranged from 30.00 to 88.33%. From these results it was concluded that maximum exposure time resulted in maximum repellency of the pest at all the concentrations. Higher concentration also showed maximum repellency as compared to lower concentration.

Piper nigrum

The means were compared at DMR Test at P=0.05 (Table 2). The maximum repellency was observed to be 62.70% at maximum concentrations that is 60% and differed significantly (Table 2). From those observed in all other concentrations. The minimum repellency of the pest was observed to be 35.56%, while 20% concentration showed significant difference from those found in other concentrations. The repellency percentage of 46.94 was recorded in 40% concentration and showed intermediate trend and also differed significantly from those found in other concentrations. The minimum repellency of the pest was recorded to 29.44% at minimum exposure time that is 30 min and differed significantly from those of observed in all other time intervals. The maximum repellency of the pest was recorded to be 61.11% at maximum exposure period that is 180 min and did not show significant difference with those of obtained at 150 min after treatment. The repellency recorded at 120 min of post treatment (53.33%) showed significant variations with those of observed in all other time intervals.

The repellency percentage was recorded to be 46.11 and 41.11 at 90 and 60 min of post treatment interval respectively but no significant variations with one another. From these results it was concluded that higher concentration of essential oils resulted in maximum repellency of the pest as compared to lower concentrations. Furthermore, maximum exposure period showed the highest repellency of the pest as compared to minimum exposure period. In *P. nigrum* the degree of repellency was: 60%>40%>20%; according to exposure times: 180>150>120>90>60>40 M.

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