Journal of Biopesticides, 3(3): 590 - 595 (2010)

A comparative study on the efficacy of two lamiaceae plants on egg - laying performance by the pulse beetle *Callosobruchus chinensis* Linn. (Coleoptera : Bruchidae)

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ABSTRACT

The pulse beetle *Callosobruchus chinensis* Linn. (Coleoptera:Bruchidae) is one of the major pests of pulses in storage. During the present study an attempt was made to screen and compare the efficacy of *Ocimum sanctum* and *Ocimum basilicum* (Lamiaceae) on egg-laying performance of the bruchid on grains of *Vigna radiata* (mung). The leaves of the select two plants were employed in the form of crude extract, powder suspension, aqueous extract, ethanol extract and diethyl ether extract at dose concentrations of 10, 25 and 50%. Significant reduction ($P < 0.05$) in oviposition was documented in sets treated with the formulations of both the plants as compared to control and normal. The formulations of *O. basilicum* were observed to be superior to *O. sanctum* in reducing egg-laying. Moreover, ethanol extract, crude extract and powder suspension were also noted to significantly bring down the number of eggs laid by the pulse beetle. Dose concentration was found to be inversely proportional to the number of eggs laid by the bruchid and formulations of 50% concentration resulted in minimum oviposition. The results suggest that formulations of both the species of *Ocimum* have a potential to act as ovipositional deterrent and can be employed against *C.chinensis* for its control.

Key words : *Ocimum sanctum, O.basilicum*, extracts, dose concentration.

INTRODUCTION

Insects have been causing tremendous losses not only to the crops growing in fields but also to post-harvest commodities during storage. Significant losses in grains, both quantitative and qualitative, occur during storage and the damage caused by insects may amount to 5-10% in the temperate and 20 - 30% in the tropical zone (Nakakita, 1998). The worldwide losses in storage due to insects and rodents have been estimated by FAO to be about 20%, the figures ranging from 10% in Europe and North America to 30% in Africa and Asia (Hill, 1992).

The pulse beetle *Callosobruchus* sp. (Coleoptera: Bruchidae), is a major pest of economically important leguminous grains such as cowpeas, lentils, green gram, and black gram (Talukder and Howse, 1994; Park *et al.*, 2003). The adult female lays egg, which are glued to the seed surface. The larvae bore into the pulse grain, where the entire development takes place and the adults emerge out leaving behind holed grains. The grains, therefore, become unsuitable for human consumption, viability for replanting, or for the production of sprouts. They are important pests of pulse crops in Asia and Africa under storage conditions (Ogunwolu and Idowu, 1994; Okonkwo and Okoye, 1996; Mulatu and Gebremedhin, 2000; Raja *et al.*, 2001; Ajayi and Lale, 2001; Tapondjou *et al.*, 2002). *Callosobruchus* has been found to cause weight loss, decreased germination potential and reduction in commercial value of the seeds (Booker, 1967; Caswell, 1981). Serious problems of genetic resistance by insect species, pest resurgence, residual toxicity, phyto-toxicity, vertebrate toxicity, widespread environmental hazards and increasing costs of application of the presently used synthetic pesticides have directed the need for effective, biodegradable pesticides. This awareness has created worldwide interest in the development of alternative strategies, and the use of plant products has become an alternative in protecting nature from pesticidal pollution (Prakash and Rao, 1989; Tiwari *et al.*, 1990). The efforts have been applauded by all and the efficacy of various botanicals has been found against different stored grain pests (Rao *et al.*, 1990; Prakash *et al.*, 1990; Ratnasekera and Rajapakse, 2009). Botanical insecticides are broad spectrum in pest control and many are safe to apply, unique in action, and can be easily processed and used. Plants contain a large number of secondary metabolites and those categorized under terpenoids, alkaloids, glycosides, phenols, tannins etc. play a major role in plant defense and cause behavioural and physiological effects on insects. Thus, in recent years an impetus has been on developing and evaluating botanical insecticides in view of their relative safety to the environment.

Pulse beetle being an internal feeder cannot be controlled with insecticides. Further it is also not advisable to mix insecticides with food grains. Fumigation being the most effective method cannot be practiced in our villages because of economic constraints and also due to storage structures. Thus, plant materials appear to be the most promising agents for grain protection against them. The plant family Lamiaceae is a relatively commonly encountered family, especially in the temperate regions of the world. It comprises of about 3500 species belonging to 200 genera. Commonly known as mint family, the plants are aromatic and include basil, mint, rosemary, lavender etc. These have a sub-cosmopolitan distribution. Mint leaves are often used to repel mosquitoes and it is also found that extracts from mint leaves have a particular mosquito killing capability. Mint oil is also being used as an environmental friendly insecticide for its ability to kill some common pests like wasps, hornets, ants and cockroaches. The present work was, therefore, carried out *to* screen the efficiency of *Ocimum sanctum* and *Ocimum basilicum* against the pulse beetle *C. chinensis.*, raised on grains of Vigna radiata and investigate their effect on egg-laying by the bruchid, employing different formulations namely, crude extract, powder suspension, aqueous extract, ethanol extract and diethyl ether extract at different concentrations.

MATERIALS AND METHODS

The pulse beetle *C. chinensis* was raised on green gram *V. radiata* in incubators maintained at 28 ± 2° C and 70% RH. The plants were collected from Bikaner (20° N and 73° 17” E, 28m) and its vicinity and the leaves were separated cleaned and shade dried. The plant derivatives were applied in the form of crude extract, powder suspension, aqueous extract, ethanol extract and diethyl ether extract at different dose concentrations *viz.*, 10%, 25% and 50%. For comparison normal and control sets were also kept under observation. Specific number of adult insects/pairs were released in muslin cloth covered beakers containing weighed green gram grains and treated with different dose concentrations (w/v). Each experimental set comprised of five replications. Observations were recorded after three days of treatment. The data were subjected to statistical analysis employing ANOVA using SPSS (2004).

RESULTS

The number of eggs laid by *C. chinensis* in normal, control and various experimental sets has been presented in Figs.1 to 5. The ANOVA for egg laying has been presented in Tables 1 to 3. In normal sets, the average number of eggs laid by the pulse beetle was observed to be 37.33 ± 2.51/ pair, while in control sets treated with GDW it was 30.66 ±0.57/ pair, in ethanol treated sets it was 28.33 ± 2.51 / pair and in DEE treated sets the number was observed to be 27.66 ± 2.88/ pair. Overall, all the treatments were observed to result in significant reduction in oviposition by *C. chinensis*. Among the treated sets less than 10eggs / pair was noted in treatments of 10, 25 and 50% crude extracts, 25 and 50% aqueous extracts, 25 and 50% of ethanol extracts and 10, 25 and 50%. DEE extracts of *O. basilicum*. Further, treatments of 50% crude extracts, 10, 25 and 50% ethanol extracts and 50% DEE of *O. sanctum* also effectively brought down the number of eggs laid by the pest insect.

Although all the treatments significantly reduced the egg-laying, when comparisons were made as per ANOVA, it

Table 1. Comparison of egg laying (No. / pair) by *C. chinensis* under different treatments of *O.sanctum* and *O.basilicum*

Type of treatment	Plant	Doses (in %)				
		Normal	control	10	25	50
Crude extracts	*O.sanctum*	4.44	16.66	66.66	55.55	38.88
	O.basilicum			77.77	66.66	49.99
Powder suspension	*O.sanctum*	37.33	30.66	8.00	18.00	0
	O.basilicum			4.00	11.66	0
Aqueous extract	*O.sanctum*	37.33	30.66	30.00	29.00	9.00
	O.basilicum			18.33	24.66	7.00
Ethanol extract	*O.sanctum*	37.33	30.66	3.33	6.33	8.66
	O.basilicum			1.33	6.33	2.00
Diethyl ether	*O.sanctum*	37.33	30.66	15.33	13	7.66
	O.basilicum			14.33	8.66	6.33

was found that the treatments of leaves of *O. basilicum* significantly ($p < 0.05$) reduced egg laying (6.37/pair) as compared to *O. sanctum* (14.21/pair). When overall analysis was made to compare the effect of various extracts using ANOVA on egg-laying, it was found that although crude extracts, ethanol extracts and powder suspension significantly reduced egg laying to 6.33, 7.83 and 9.33/pair respectively, these values differed non-significantly among themselves. A significant ($p < 0.05$) difference in egg - laying was observed between ethanol and DEE and crude and aqueous extracts, powder suspension and aqueous extract and DEE and aqueous extract treated sets, ethanol extract being the most effective. Non-significant difference was also observed among sets treated with crude extracts, powder suspension and DEE extracts. Among various formulations, extracts of 50% concentration were most effective in reducing egg laying (8.17/ pair) and ANOVA (Table 1) indicates that these treatments differ significantly ($p < 0.05$) from those treated with 25% (11.80/pair) and 10% (14.26/pair) concentrations.

DISCUSSION

During the present investigations, the egg-laying in normal sets was observed to be 37.33/pair and in control sets treated with GD water, ethanol and DEE extract to be 30.66, 28.33 and 27.66/pair respectively. Overall, the treatments of leaves of *O. sanctum* and *O. basilicum* were found to significantly reduce the number of eggs laid by the pest beetle being 14.21 and 6.37/pair respectively. The treatments of *O. basilicum* were noted to be more effective as compared to *O. sanctum.*

The results obtained are in conformation with the works of Sathyaseelan *et al.* (2008) who reported that the leaf extract of *Ocimum sp*. caused significant ovipositional deterrent effect against *C. chinensis* on green gram and Guerra *et al.* (2007). He also documented that the shoot and essential oils of *Minthostachya sp*. (Lamiaceae) deterred potato tuber moth to oviposit. They also tested essential oil of *M. spicata* and *M. glabresecens* and found that this impaired oviposition by the moth, reducing the number of eggs laid by about 80% as compared to control treatment. According to Roger and Hamraoui (1994) Lamiaceae plants *viz., M. piperita, Origanum vulgare, Rosmarinus officinalis, Thymus vulgaris, Satureia hortensis* act as ovipositional deterrent against *A. obtectus*. Repellent properties of *O. kilimandscharicum* and *O. suave* have also been reported by Seyoum *et al.* (2003) and Odalo *et al.* (2005). According to Marderosian (2001), *M. pulegium* has been traditionally used as insect repellent in Iran.

The present findings also get support from the earlier works of Kamakshi *et al*. (2000) who reported significant reduction in the number of eggs laid by *C. maculatus* when treated with *M. arvensis* and *O. sanctum* as compared to control. Raja *et al.* (2001) also concluded that egg laying by *C. maculatus* was significantly influenced by treatments of volatile oils derived from *Mentha* species in the order of potency as *M. spicata* > *M. piperita* > *M. arvensis*. A complete prevention of egg - laying by *C. analis* was observed by Juneja and Patel (1994), when the grains were treated with different plant products including mint leaves. Weaver *et al.* (1992) found the ovipositional pattern in two species of bruchids was influenced by the treatment of dried leaves of *Tetradenia riparia*, a perenial mint that suppressed population size. Oviposition inhibition by *C. maculatus* was observed by Ogunwolu *et al*. (1998), when treated *Z. zanthoxyloides*, a plant belonging to family Lamiaceae.

Among formulations ethanol extracts, crude extracts and powder suspension were found to significantly reduce the number of eggs laid by the pulse beetle during the present study, ethanol extract being the best. Earlier, Dover (1985) also observed alcohol extract of hyssop, rosemary, sage, thyme, white clove to reduce oviposition by *P. xylostella* which support the present findings. Ethanol extracts of different plants / parts were also suggested by Adedire and Lajide (1999) to reduce egg - laying by *C. maculatus.* The present results are also in conformation with the works of Dwivedi and Maheshwari (1997), who reported that acetone extract of *Croton*, petroleum ether extract of *V. enceliodes* and *Occidentalis* exhibited ovipositional deterrent activity against *C. chinensis*; Pandey *et al.* (1986), who observed various plants diluted in benzene and mixed with green gram seeds to be very repulsive and a potent oviposition inhibitor for *C. chinensis* (Dwivedi and Garg, 2000), who reported that acetone leaf extracts of *Tagetes*, *Ipomea* and *Acacia* exhibited 50% reduction in oviposition by *C. cephalonica;* Mann (1997), who documented powder suspension of *Aerva* to be effective in reducing egg-laying remarkably by *C. chinensis*; Adedire and Akinneye (2004), who reported powder suspension and ethanol extract of *T. diversifolia* leaves were found to reduce egg - laying by *C. maculatus;* Dwivedi and Kumar (1998), who found petroleum ether and acetone extracts of *A. mexicana* leaves to possess ovicidal property against *T. granarium*.

The extract concentration was also found to have a considerable effect on the number of eggs laid by *C. chinensis,* which was found to decrease significantly with the increase in concentration of the formulation during the present study. These results are in agreement with the work of Olaifa and Erhun (1988), who observed a complete suppression of oviposition by *C. maculatus* when treated with 42% powder of *P. guineense*. Elhag (2000) studied the oviposition deterrence of nine plant materials on *C. maculatus* and found seed treatment with 0.1% crude extract resulted in significant reduction in egg-laying by the bruchid. Treatments of 10% powder suspension of roots and leaves of *Tephrosia* were found to reduce the average number of eggs laid by *C. chinensis* (Ghei, 2001). Savitri and Subbarao (1976), observed powdered neem kernel mixed directly with paddy at 1 and 2% was effective in reducing oviposition by *R. dominica* and *S. cerealella* respectively. Treatments of 10% powder suspension and aqueous extract of bark of *Prosopis sp.* were found to reduce egg-laying by *C. chinensis* (Negi and Shailja, 2007). Al Lawati *et al.* (2002) suggested that the number of eggs laid by *C. chinensis* when treated with ethanol extract were significantly less than, from those treated with methanol extract. Prijona *et al.* (1997) found extracts of seeds of *A. glabra*, *A. inuricata*, *A. squamosa*, *Stelechocarpus cauliflorus*, *Aglaia elliptica* and *Dysoxylum cauliflorum* to result in significant decrease in oviposition by *C. maculatus* at 0.5% concentration. According to Adedire and Lajide (1999) dose concentrations of 1.25 to 10% were found to inhibit oviposition by *C. maculatus*. Tebkew and Mekashe (2002), while evaluating botanicals found that *Mellettia ferruginea* when mixed with grains at 5% (w/w), deterred egg-laying by *C. chinensis.* Adedire and Akinneye (2004) also found that mean number of eggs laid by *C. maculatus* was reduced to 4.7 at 2% extract concentration of leaf extracts of *T. diversifolia*. They documented that egg - laying reduced from 4.13 in the untreated to 17.3 in 2% powder treatments, while, Pitlehra and Borad (2001) suggested *Bougainvillea* and *Naffatia* leaf extract at 3% concentrations to be less effective in reducing oviposition by *L. trifolii.* Prasad *et al.* (1998) observed the extracts of *L. camara* in all the used concentrations to check the egg - laying by *S. oryzae*.

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Received: January 20, 2010 Revised: June 21, 2010 Accepted: June 28, 2010