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Effect of malathion against Sal seeds weevil, *Sitophilus rugicollis* in storage and its persistence

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Abstract

Sal (*Shorea robusta* Gaertn. f.) is an important tree species in India being used for its timber and Non Timber Forest Products specially seed which are often attached by different damaging insect pests in storage. Present study deals with the effect of malathion against the adults, eggs and other developmental stages to control serious seed weevil, *Sitophilus rugicollis* of Sal, *Shorea robust* seeds in storage. Sal seeds were sprayed or fumitated (air fumigation) with malathion EC 50 in different concentrations ranging from 0.0025 to 0.2 %) in glass jars and adults were release for the egg laying and further development. Observations were recorded on mortality of eggs, mortality of developmental stages and reduction in emergence of adults by the direct exposure and persistence effect of the fumigation up to 14 weeks. Highest concentration, 0.1 and 0.2% caused significant reduction in emergence of weevil adults. Similarly 0.1 and 0.2% concentration of fumigant caused 90.64 and 100% mortality in eggs respectively. All the treatments of malathion were effective causing 100% adult mortality compared to control, when adults were exposed directly to freshly treated seeds. Persistence of malathion after fumigation in storage was evaluated till 14 subsequent weeks. Persistence of malathion at 0.1% concentration was observed with 100% mortality in adults. Paper deals with the utility of malathion for controlling the infestation of sal seed weevil in the storage.

Key words : Dichlorvos, forest seeds, Seed borers, seed protection, stored seed.

INTRODUCTION

Sal (*Shorea robusta* Gaertn. f.) is one of the most important tree species after teak in India [1, 2]. Almost all parts of the tree are utilized in various industries. The timber is highly preferred for constructional and joinery work. *Sal* bark, leaves and twigs are a promising tanning material. The tree also yields a commercially important oil resin, locally known as *dammer*. One of the most important and valuable parts is seed, which is of multiple socioeconomic importance. *Sal* fruits/seeds are eaten after roasting, especially in times of food scarcity; though not quite palatable [1].

Despite the above, seeds have been found to be infested by many insect pests in field and in storage conditions [2,3,4,5]. There are some insects like *Sitophilus* (*Calandra*) *rugicollis* Casey, *Gonocephalus planatum* and *Cocotrypes integer* Eich., which begin infestation on the forest floor after fruit/seed shedding and continue to damage the seed during storage [3,5,6]. Most important insect pest feeding on seeds in storage is *S.* (*Calandra*) *rugicollis* Casey [7,8]. This insect has been reported to feed on the cotyledons and embryo of the *Sal* seeds.

Different control methods have been experimented against some curculionid (seed weevils) and other seed borers infesting agricultural grains in storage. Some of such reports include fumigation with different chemical insecticides and gases *viz*., use of CO_2 and O_2 against *Sitophilus oryzae* [9,10], use of phosphine and mixture of phosphine and CO_2 [11,12]. Use of carbonyl sulphide (as gas), carbon disulphide (as liquid), ethyl formate (as solution in water against *S. oryzae* L is also reported [13]. Similarly, CO_2 and N_2 have been experimented at controlled atmosphere against *S. zeamaise* Motsch. and *Rhyzopertha dominica* Fab [14].

In contrast to the agricultural pests, there are not many reports available on control measures against insect pests of forest tree seeds. There is especially no report available on the control measures against the *Sal* seed insect pests including *S. rugicollis* Casey. Although in the monograph of *Sal*, some control methods are mentioned but are incomplete and very fragmentary [2]. In view of all the above, the present investigation was taken up to evolve fumigation control measures of the insect pests infesting the *Sal* seeds in Madhya Pradesh.

MATERIAL AND METHODS

Twenty-five seeds were placed in grass jars (600cm^3) treated with malathion (air fumigatin) at the concentrations 0.0025% (@ 0.05 ml/1L water), 0.005% (@ 0.1 ml/ 1L water), 0.02% (@ 0.4 ml/1L water), 0.025% (@ 0.5 ml/ 1L water), 0.05% (@ 1.0 ml/ 1L water), 0.10% (@ 2.0 ml/ 1L water and 0.2% (@ 4ml/1L water) with control which was treated with distilled water in three replications. Ten freshly mated pairs were released in treated seed jars of each treatment for egg laying. Data on number of eggs layed and number of eggs shrunken or dead was recorded by the keen observation under the light microscope. Similar experimental set up was prepared to and data on emergence of adult stages from treated and untreated jars was recorded.

For evaluating the effect of malathion fumigation (air fumigation) on known developmental stages, counted number of second instar larvae were exposed to jars filled with 25 sal seed treated with 0.05, 0.1, 0.2, 0.4, 0.5, 1.0 and 2.0gm malathion/100gm seeds in triplicates. Separate control set was prepared treated only with distilled water. Observations were recorded on mortality of developmental stages and were compared with the mortality in control set.

For evaluating the effect of direct exposure on adult, 25 seeds were treated with 0.005, 0.015, 0.025, 0.05, 0.075 and 0.1% malathion 50 EC with control treated only with distilled water and 10 weevils were exposed to the treated and untreated seeds for 72 hours. After 72 hrs mortality in adult seed weevils were observed and percentage mortality was calculated. For testing persistence effect of malathion, 10 weevils were exposed to treated seeds every week till the subsequent 14 weeks and mortality observations were recorded. The data on weevils survived in treated and control seeds were used to calculate percentage mortality and subjected to analysis.

Mean data obtained in percentages were transformed to arcsin (Angular transformation) before subjecting to Analysis of Variance (ANOVA) for RBD and Duncans Multiple Range Test (DMRT) [15], using Statistical software SX.4 (Statistics PC DOS Version 2.0, 1985,1987, NH, Analytical Software).

RESULTS

Malathion caused 90.64 and 100% mortality in eggs at 0.1 and 0.2% concentration respectively as compared to the control with no mortality ($CD_{(P<0.05)} = 11.21$, $SE_{(d)}\pm = 5.71$) (Fig. 1). Lower doses below 0.025% were at par ($P<0.05$) with the control.

Effect of malathion on emergence of weevil adults was statistically at par ($P<0.05$) for 0.05, 0.1 and 0.2% concentration which caused 56.54, 90.64 and 100.0% reduction in emergence respectively as compared to control with no mortality ($CD_{(P<0.05)}$ = 35.64, $SE_{(d)}\pm = 16.62$) (Fig. 2).

Developmental stages were well surviving at 0.05, 0.1, 0.2,

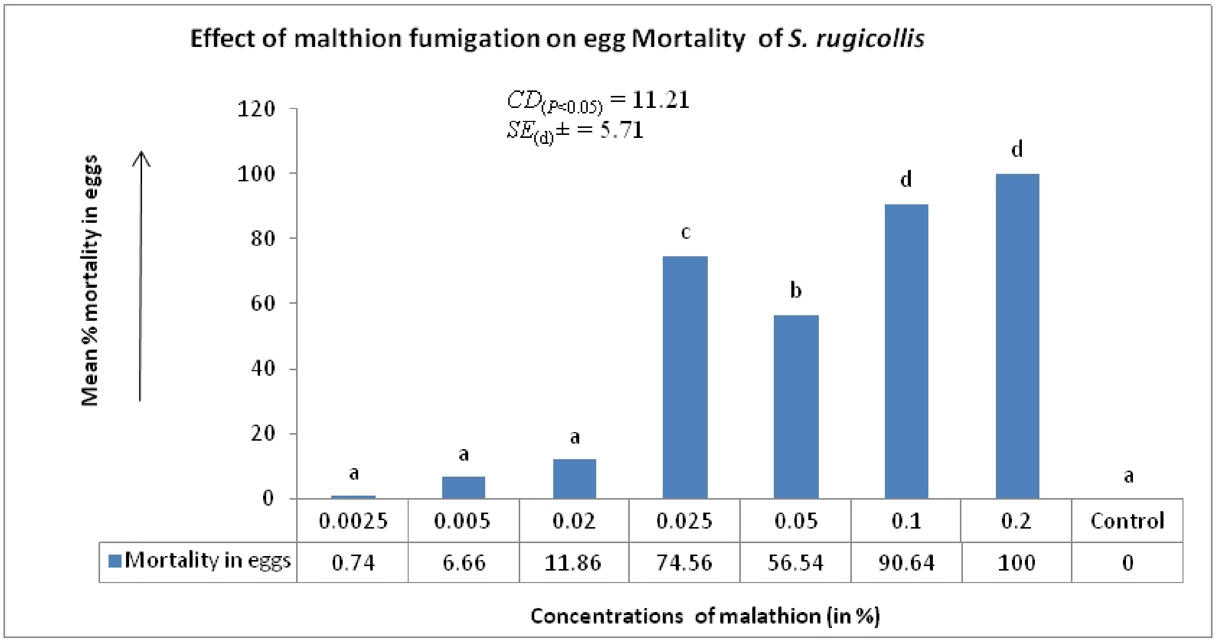

Fig 1: Fumigant action of malathion (50 E.C.) against eggs of *S. rugicollis*

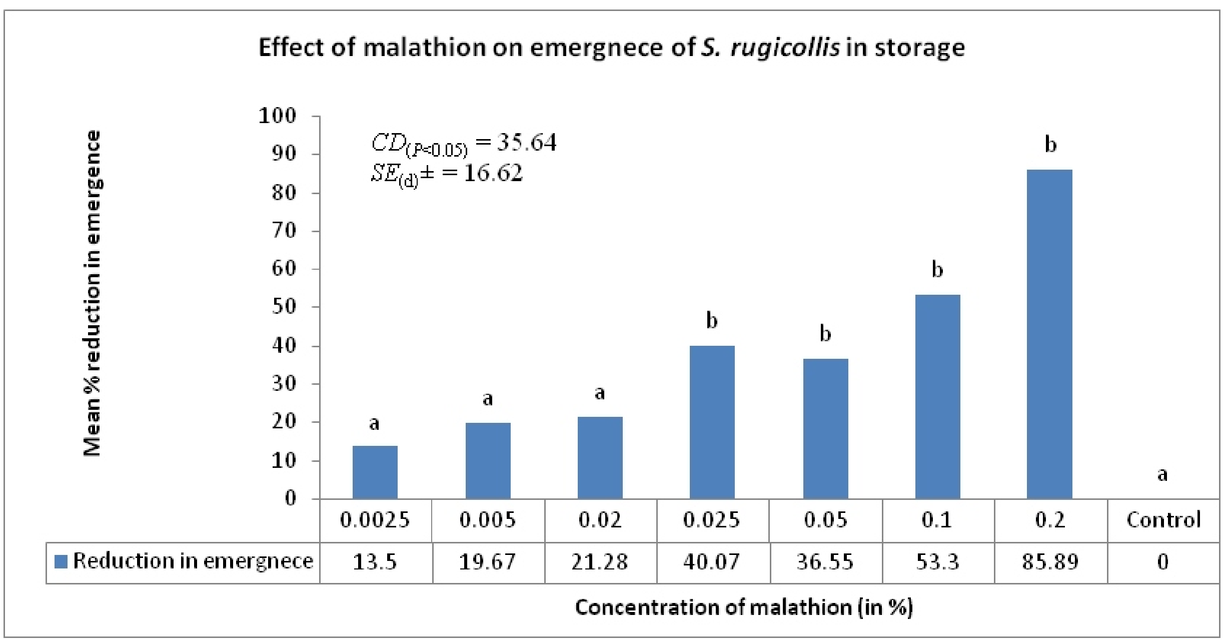

Fig 2: Effect of malathion (50 E.C.) on emergence of *S. rugicollis* in storage

Table 1: Fumigation effect of Malathion 50 E.C. on Sal seeds against S. rugicollis in storage and its persistence

Treatments (In %)	Percentage Mortality observed in *S. rugicollis* in direct exposure to fumigant and persistence of effect in week(s) (wk/wks)														
	Direct Effect	1wk	2wks	3 wks	4 wks	5 wks	6 wks	7 wks	8 wks	9 wks	10 wks	11 wks	12 wks	13 wks	14 wks
0.005	100.0 (90.00)	100.0 (90.00)	100.0 (90.00)	60.0^{b} (50.85)	20.0^{b} (21.93)	16.66^{a} (19.92)	0.00^{a}	0.00^{a}	0.00^{d}	0.00	0.00	0.00^{d}	0.00^{a}	0.00^{a}	0.00^{a}
0.015	100.0 (90.00)	100.0 (90.00)	100.0 (90.00)	83.33^{c} (70.07)	46.66^{c} (42.78)	60.00^{b} (55.77)	36.66^{b} (39.93)	10.00^{b} (15.00)	0.00^{d}	0.00	0.00	0.00^{d}	0.00^{a}	0.00^{a}	0.00^{a}
0.025	100.0 (90.00)	100.0 (90.00)	100.0 (90.00)	100.0^{d} (90.00)	100.0^{d} (90.00)	100.0^{c} (90.00)	100.0^{c} (90.00)	100.0^{c} (90.00)	100.0^{d} (90.00)	100.0 (90.00)	100.0 (90.00)	76.66^{d} (66.14)	86.66^{b} (76.92)	60.0^{b} (56.15)	0.00^{a}
0.05	100.0 (90.00)	100.0 (90.00)	100.0 (90.00)	100.0^{d} (90.00)	100.0^{d} (90.00)	100.0^{c} (90.00)	100.0^{c} (90.00)	100.0^{c} (90.00)	100.0^{d} (90.00)	100.0 (90.00)	100.0 (90.00)	100.0^{d} (90.00)	83.33^{b} (75.00)	83.33^{b} (75.50)	83.33^{b} (75.50)
0.075	100.0 (90.00)	100.0 (90.00)	100.0 (90.00)	100.0^{d} (90.00)	100.0^{d} (90.00)	100.0^{c} (90.00)	100.0^{c} (90.00)	100.0^{c} (90.00)	100.0^{d} (90.00)	100.0 (90.00)	100.0 (90.00)	100.0^{d} (90.00)	100.0^{b} (90.00)	100.0^{b} (90.00)	100.0^{b} (90.0)
0.10	100.0 (90.00)	100.0 (90.00)	100.0 (90.00)	100.0^{d} (90.00)	100.0^{d} (90.00)	100.0^{c} (90.00)	100.0^{c} (90.00)	100.0^{c} (90.00)	100.0^{d} (90.00)	100.0 (90.00)	100.0 (90.00)	100.0^{d} (90.00)	100.0^{b} (90.00)	100.0^{b} (90.00)	100.0^{b} (90.0)
Control	0.00	0.00	0.00	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{d}	0.00	0.00	0.00^{d}	0.00^{a}	0.00^{a}	0.00^{a}
$SE_{(d)}\pm$ $CD_{(p=0.05)}$	- NS	- NS	- NS	5.49 11.97	7.11 15.50	10.55 22.96	2.91 6.34	4.20 9.15	- NS	- NS	- NS	6.98 15.22	11.40 24.84	13.05 28.43	10.86 23.68

[*]all the values are mean of three replications
[a,b,c..]means with different alphabets are statistically different from each other
[#]values in parentheses are arc sin transformation value of mean percentages
[NS]Non significant difference among means

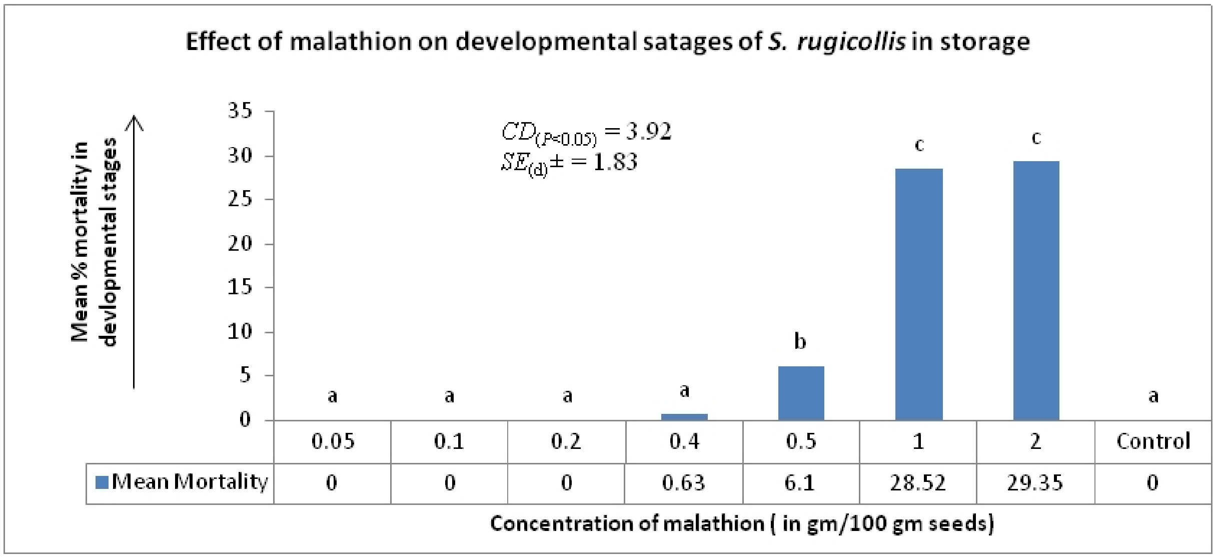

Fig 3: Effect on malathion on developmental stages of *S. rugicollis* in storage.

0.3 and 0.4 gm/100 seeds treatment and the effects were at par (P<0.05) with the control with no mortality ($CD_{(P<0.05)}$ = 3.92, $SE_{(d)}$± = 1.83) (Fig. 3). Highest tested doses i.e., 1.0 and 2.0 gm malathion/100gm seeds caused 28.52 and 29.35% mortality in second instar larvae.

All the treatments of malathion were effective causing 100% adult mortality compared to control, when adults were exposed directly to freshly treated seeds. Efficacy of the treatments of 0.005% and 0.015% declined on third week onwards with 60.0 and 83.33% mortality. They remained significantly superior to control from that of other treatments (P<0.05). Lowest treatment of 0.005% concentration declined to its lowest significant activity with 20.0% in fourth week. Higher treatments of 0.015% could cause mortality till seventh week with declining trend of 60.00, 46.66, 36.66 and 10.0%, respectively. Treatments 0.025 to 0.10% were effective up to tenth week with 100.0% mortality. Treatments 0.075 and 0.10% remained very effective till 14 week, after which the experiment was terminated (Table 1).

DISCUSSION

Malathion was effective on direct seed treatment causing 100% adult mortality. It also showed persistent effect up to fifth week even in case of lowest concentration of 0.005% and continued up to fourteenth week at highest dose of 0.1%, after which the experiment was terminated. Literature reports that malathion has been the most widely used grain protectant in agriculture, but now gradually being replaced by other products, because of developing resistance [16]. It is still one of the most widely used insecticide for controlling forest seed pests (in present case also *S. rugicollis* weevils have shown good susceptibility to malathion). Malathion 50 EC (0.5%) and BHC 10D (1%) along with neem leaves(1%), castor oil (1%), ash (1%) were tested for prevention of damage by *C. chinensis* in stored chickpea and found that malathion 0.5% and BHC 10 D 1% exerted similar effect on mortality of beetles and were at par [17]. Surviving beetles deposited least number of eggs in malathion 0.5% (0.00 eggs) and BHC 10 D 1% (6.25 eggs). No seed damage and emergence was recorded in malathion 0.5%. Toxicity and residual effects of malathion, dimilin and neem extract against *S. oryzae* L., reported that concentrations of 0.05, 0.25 and 0.5% were very effective for 7 to 10 days after the treatment [18]. These observations support the present results obtained against *S. rugicollis* as regards the reduction in the adult emergence and toxicity against the adults. Other reports on the use of malathion also support the present results [19,20]. There are no reports available against *S. rugicollis* to compare the present results.

CONCLUSION

Malathion was found less effective against the emergence of adults from the pupa in dose lover than 0.025% but 0.2% concentration showed significant role to prevent the emergence in the storage. Significant mortality was achieved in eggs when exposed to 0.025% concentration and above. However, the chemical was found less effective against the developmental stages in same concentrations tested against eggs. Persistence of Malathion was tested up to 14 weeks and caused 100% adult mortality at 0.1% concentration. Finally it can be concluded that the recommended chemical is effective against eggs and adults and shows good persistence up to 14 weeks. Thus this study is a guide for the management of Sal seed weevil in the storage.

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