Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

J P P Journal of Pharmacognosy and Phytochemistry

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(1): 1594-1600
Received: 08-11-2017
Accepted: 09-12-2017

NR Sunda
Department of Entomology, SKN College of Agriculture, SKN Agricultural University, Jobner, Jaipur, India

BL Jat
Department of Entomology, SKN College of Agriculture, SKN Agricultural University, Jobner, Jaipur, India

MD Choudhary
Department of Entomology, SKN College of Agriculture, SKN Agricultural University, Jobner, Jaipur, India

RG Samota
Department of Entomology, SKN College of Agriculture, SKN Agricultural University, Jobner, Jaipur, India

Correspondence
NR Sunda
Department of Entomology, SKN College of Agriculture, SKN Agricultural University, Jobner, Jaipur, India

Effect of Plant Oils on *Rhyzopertha dominica* (Fab.) in Barley Grains at Different Storage Periods

NR Sunda, BL Jat, MD Choudhary and RG Samota

Abstract
Investigations on "Effect of plant oils of *Rhyzopertha dominica* (Fab.) in Barley Grains at Different Storage Periods**"** were conducted at Department of Entomology, S.K.N. College of Agriculture, Jobner during 2016 and 2017. The cent per cent adult mortality of *R. dominica* was recorded in malathion 50 EC (0.05 and 0.075%), up to 21 day of adult exposer. The maximum mortality was recorded in higher dose (1.5%) of neem, mustard, castor and taramira oil. The maximum protection was provided with the higher doses of malathion 50 EC (0.075%) and neem oil (1.5%) as adult emergence, grain damage and weight loss were not observed up to 150 days, followed by higher doses of castor, taramira and mustard oil up to 120 days of storage.

Keywords: Barley, *Rhyzopertha dominica,* plant oils

Introduction
Barley (*Hordeum vulgare* (Linn.) is an important *Rabi* season cereal crop after wheat in northern India. It is grown throughout the state of Rajasthan, but Jaipur district hold the pioneer position both in area and production, which is grown for brewing, human consumption and cattle feed. In India, it has occupied an area of 2.95 million hectares with an annual production of 8.59 million tons (Anonymous, 2014) [4]. However, Rajasthan occupied 0.31 million hectares area with an annual production of 0.94 million tonne (Anonymous, 2014) [3]. Post harvest losses to barley grains in different ecological zones have been estimated from zero to 25 per cent (Mookherjee *et al.,* 1968) [13]. In India, barley in storage is heavily infested by a number of insect pests. Among these, the lesser grain borer, *Rhyzopertha dominica* (Fab.) (Bostrichidae: Coleoptera) causes considerable damage. (Campbell and Sinha, 1976) [6]. This pest was recorded as a major pest in all the districts of Rajasthan (Bhargava and Choudhary, 2007) [5]. The original home tract of *R. dominica* is said to be India (Pruthi and Singh, 1950) [14]. It feeds on a variety of stored products like cereals, pulses, groundnut kernels, other edible substances and grocery stores and as such it is considered one of the important pests of stored grains. It not only cause post harvest losses in terms of quantity but also affect the quality through depletion of specific nutrients and contamination with uric acid and excreta. Therefore in the present investigations plant oils impregnation of packaging materials, effect of solar energy and different storage structures has been evaluated to find out their effectiveness against the incidence of *R. dominica* in stored barley.

Materials and method
For evaluating the efficacy of plant oils against *R. dominica*, the materials were procured from general market. The required quantity of plant oils were mixed with 100 g sterilized and conditioned barley grains. Treated grains of 100 g were kept in plastic containers with three replication in a Completely Randomized Design (CRD). The grains treated with malathion 50 EC as check and untreated control were also maintained for comparison. Ten pairs of freshly emerged adults were released on it. The plastic containers were covered with muslin cloth, tied with rubber bands. The observations were recorded on adult mortality, adult emergence (F_1), grain damage, weight loss and germination percentage. The adult mortality was recorded at 7, 14 and 21 days after treatment. The adult emergence was recorded at 30, 60, 90, 120 and 150 days after treatment. The grain damage was recorded by visual counting. The weight loss was recorded by excluding the frass from the grains. The germination test of the treated grains in samples was carried out to know the adverse effect of plant products on the seed viability. For this purpose, 100 grains were placed in the Petri dish between wet blotting papers.

Three replications of each treated seed were maintained. The sprouted seeds were then counted after four days (Anonymous, 1976) [2].

$$\text{Germination per cent} = \frac{\text{Number of seeds germinated}}{\text{Number of seeds kept for germination}} \times 100$$

The per cent data on grain damage, weight loss and germination were transformed in to angular values (arc sine √percentage) and number of insects into log X+ 1 values for analysis of variance.

Result and discussion

The effect of plant oils *viz.,* neem, groundnut, mustard, castor and taramira with three concentration (0.5, 1.0 and 1.5%) were evaluated against *R. dominica* in barley grains with standard check malathion 50 EC (0.025, 0.05 and 0.075 %). The observations on adult mortality was recorded after 7, 14 & 21 days of treatment and adult emergence, grains damage and weight loss after 30, 60, 90, 120 and 150 days of treatment.

Adult mortality

Data presented in (table 1) revealed that all the treatments were found significantly superior over untreated control after 7 days of adult exposer to barley grains treated with plants oils and malathion 50 EC (check), however significant difference existed among them. The maximum adult mortality (91.35%) was achieved in malathion 50 EC 0.075 per cent, which was significantly superior over all the treatments. The next effective treatments were neem oil 1.5 per cent (80.35%), followed by malathion 50 EC 0.05 per cent (78.31%), mustard 1.5 per cent (73.40%) and castor oil 1.5 per cent (71.65%) and the differences amongst the different treatments were non-significant. The minimum adult mortality was found in groundnut oil 0.5 per cent (24.35%), followed by taramira oil 0.5 per cent (26.02%), groundnut oil 1.0 per cent (28.33%), castor oil 0.5 per cent (28.99%) and mustard oil 0.5 per cent (31.65%) and these treatments were statistically non-significant. The treatments of neem oil 0.5 per cent, groundnut oil 1.5 per cent and malathion 50 EC 0.025 per cent registered 33.65, 35.99 and 42.65 per cent adult mortality, respectively. The rest of treatments a gave medium range of efficacy.

After 14 days of adult exposer to treated grains, the cent per cent adult mortality was recorded in malathion 50 EC 0.075 per cent. The maximum adult mortality was recorded in the treatment of malathion 50 EC0.05 per cent (93.65%), followed by neem oil 1.5 per cent (91.35%) and mustard oil 1.5 per cent (88.49%), however these treatments were statistically at par with each other. The next effective treatments were neem oil 1.0 per cent, followed by mustard oil 1.0 per cent, taramira oil 1.5 per cent and castor oil 1.5 per cent, which exhibited 75.67, 76.49, 82.65 and 83.44 per cent mortality, respectively and these were at par with each other. The minimum adult mortality was observed in groundnut oil 0.5 per cent (31.35%), which was at par with groundnut oil 1.0 per cent (39.71%) and taramira oil 0.5 per cent (42.35%) (Table 1).

The cent per cent adult mortality was recorded in the treatments of malathion 50 EC 0.075 and 0.05 per cent after 21 days of adult exposer to treated grains. The maximum adult mortality was recorded in the treatment of neem oil 1.5 per cent (94.65%), followed by mustard oil 1.5 per cent (93.08%) and The moderate effective treatments were castor oil 1.5 per cent (89.08%), taramira oil 1.5 per cent (86.91%), (85.55%) mustard oil 1.0 per cent (85.17%) and neem oil 1.0 per cent (83.17), these were found at par with each other. The minimum adult mortality were recorded in groundnut oil 0.5 per cent (44.65%), followed by groundnut oil 1.0 per cent (58.07%), taramira oil 0.5 per cent (65.35%) and ground nut oil 1.5 per cent (67.33%), however the former two treatments were at par with each other. The rest of treatments were stood in the middle order of efficacy. The descending order of adult mortality was found in malathion 50 EC, neem oil, mustard oil, castor oil, taramira oil and groundnut oil. The higher mortality was also observed in higher dose of neem oil and mustard oil (1.5%). The castor oil and taramira oil at higher dose (1.5%) were found moderately effective treatments, followed by middle dose of neem oil and mustard oil (both 1.0%) for managing of *R. dominica.* Groundnut oil with all dose levels (0.5, 1.0 and 1.5%) was found significantly inferior to other plant oils. Jood *et al.*, (1993) [11] reported neem seed powder and neem oil provided complete protection to grains against *T. granarium*. The present findings are close conformity with Shukla *et al*. (1992) [16] reported high adult mortality of *R. dominica* in soyabean, mustard, sesame and groundnut oils. Gupta *et al.* (1992) [7] reported neem oil and palas oil (5ml/kg seed) offered better protection against pest infestation in storage. Uttam *et al*., (2002) [18] noted that karad, toria, taramira, mustard and sesamum oils (1 and 3ml/kg seed) provided maximum mortality of *S. oryzae* after 5 days of their application in barley grains also support the present findings.

Adult (F_1) emergence

The data presented in table 2 revealed that all the treatments were found significantly superior over untreated control up to 150 days of treatment with regard to adult emergence. The adult emergence was not observed in treatments of malathion 50 EC 0.075 per cent and neem oil 1.5 per cent up to 150 days of treatment, castor oil and taramira oil 1.5 per cent up to 120 days of treatment, mustard oil 1.5 per cent and malathion 50 EC 0.05 per cent up to 90 days of treatment, neem oil 1.0 and ground nut oil 1.5 per cent up to 60 days of treatment and mustard oil 1.0 per cent, castor oil 1.0 per cent and malathion 50 EC 0.025 per cent up to 30 days of treatment.

After 30 days of adult release, the minimum numbers of adults emerged in the grains treated with taramira oil 1.0 per cent (1.33) and neem oil 0.5 per cent (2.0) and were at par with each other. The maximum number of adults emerged from the grain treated with groundnut oil 0.5 per cent (5.0), followed by taramira oil 0.5 per cent (4.67), castor oil 0.5 per cent (3.67) and groundnut oil 1.0 per cent (3.0), these were at par with each other. The other treatments were moderately effective.

After 60 days of grain treatment, the minimum adult emergence was recorded in grains treated with malathion 50 EC 0.025 per cent (2.0), followed by mustard oil 1.0 per cent (2.33), castor oil 1.0 per cent (2.33) and neem oil 0.5 per cent (2.67), these treatments were statistically at par with each other. The maximum adult emergence was recorded in the grains treated with groundnut oil 0.5 per cent (8.33), followed by castor oil 0.5 per cent (5.67) and groundnut oil 1.0 per cent (5.67) and all these treatments were significantly at par with each other. The moderately effective treatments were mustard oil 0.5 per cent (4.33), followed by taramira oil 1.0 per cent (3.0), neem oil 0.5 per cent (2.67), castor oil 1.0 per cent (2.33) and mustard oil 1.0 per cent (2.33), however, former

two and later three treatments were found significantly at par with each other.

After 90 days of grain treatment, the minimum number of adult emergence was observed in neem oil 1.0 per cent (2.0) and malathion 50 EC 0.025 per cent (2.67), which were at par with each other. The maximum number of adults emerged in grains treated with groundnut oil 0.5 per cent (10.67), followed by castor oil 0.5 per cent (7.33), groundnut oil 1.0 per cent (7.33), castor oil 1.0 per cent (6.67) and mustard oil 0.5 per cent (6.33), however later four treatments were found at par with each other. The other treatments were moderately effective (Table 4.9).

After 120 days of grain treatment, the minimum number of adult emergence was recorded in grain treated with malathion 50 EC 0.05 per cent (2.0), followed by mustard oil 1.5 per cent (2.0) and neem oil 1.0 per cent (3.0), these were statistically at par with each other. The maximum number of adults emerged in the grains treated with groundnut oil 0.5 per cent (14.33), followed by taramira oil 0.5 per cent (9.33), castor oil 0.5 per cent (8.67) and mustard oil 0.5 per cent (8.0), however, later three treatments were at par. The rest of the treatments were moderately effective.

Even after 150 days of grain treatment, the minimum number of adults emerged from the grains treated with castor oil 1.5 per cent, followed by mustard oil 1.5 per cent and malathion 50 EC 0.05 per cent, which exhibited 3.0, 3.33 and 4.0 adult emergence, respectively and were statistically at par with each other. The maximum number of adults emerged in the grains treated with groundnut oil 0.5 per cent (16.33), followed by castor oil 0.5 per cent (11.67) and groundnut oil 1.0 per cent (10.67), the later two treatments differed non significantly. The rest of the treatments were moderately effective. The descending order of adult emergence was found to be in groundnut oil, castor oil, mustard oil, taramira oil, neem oil and Malathion 50 EC. The present study fully corroborates with findings of Kumawat (2004) [12] who reported that maximum protection of stored grains against *R. dominica* was provided by neem oil at 1.0 per cent (no adult emergence up to 270 days), followed by castor and taramira oil at 1.0 per cent (no adult emerged up to 90 days of treatment). Abdallah *et al.,* (2001) [1] they reported significant reduction in progeny emergence at all dose levels of castor and sesame oils when mixed in grains against *R. dominica*. Sharma (1999) [15] reported that neem oil (2.0%) effectively reduced the emergence of F_1 and F_2 progeny of *R. dominica* and other pests in stored maize. Yadav *et al.,* (2008a) [17] reported neem, karanj, clove and lemongrass oils at 1.0/100 g seeds were found most effective in reducing adult emergence of *S. oryzae* in wheat. The findings of Jillani and Malik (1973) [10], Gupta *et al*., (1992) [8], Jood *et al*., (1993) [11], Uttam *et al.,* (2002) [18], Singh *et al.,* (2009) [17] and Jakhar and Jat (2010) [9] are partially supporting the present study.

Grain damage

The data presented in table 3 revealed that all the treatments were found significantly superior over untreated control up to 150 days of treatment with regard to grain damage in barley by *R. dominica*. The grain damage by the progeny (F_1) developed from adult released was not recorded in malathion 50 EC 0.075 per cent and neem oil 1.5 per cent up to 150 days of treatment, mustard oil 1.5 per cent up to 120 days of treatment, castor oil 1.5 per cent, taramira oil 1.5 per cent and malathion 50 EC 0.05 per cent up to 90 days of treatment, neem oil 1.0 per cent up to 60 days of treatment and mustard oil 1.0 per cent, castor oil 1.0 per cent, groundnut oil 1.5 per cent and malathion 50 EC 0.025 per cent up to 30 days of treatment.

After 30 days of grain treatment, the minimum grain damage was recorded in taramira oil 1.0 per cent (3.67%), followed by neem oil 0.5 per cent (6.0%), mustard oil 0.5 per cent (7.0%) and taramira oil 0.5 per cent (7.67%), later three were at par with each other. The maximum grain damage was recorded in grain treated with groundnut oil 0.5 per cent (13.67%), followed by castor oil 0.5 per cent (8.33%), groundnut oil 1.0 per cent (8.33%) and taramira oil 0.5 per cent (7.67%), later three were at par with each other. The rest of the treatments were moderately effective.

After 60 days of grain treatment, the minimum grain damage recorded with mustard oil 1.0 per cent (3.67%), groundnut oil 1.5 per cent (4.67%) and malathion 50 EC 0.025 per cent (5.33%), these were found statistically at par with each other. The maximum grain damage was recorded in grains treated with groundnut oil 0.5 per cent (17.33%), followed by castor oil 0.5 per cent (14.67%), taramira oil 0.5 per cent (13.0%) and groundnut oil 1.0 per cent (11.67%), later three were at par with each other. The rest of the treatments were moderately effective.

After 90 days of treatment, the minimum damage was recorded in grains treated with neem oil 1.0 per cent (6.00%) followed by malathion 50 EC 0.025 per cent (9.0%) and mustard oil 1.0 per cent (11.67%), which were statistically at par with each other. The maximum damage was observed in the grains treated with groundnut oil 0.5 per cent (31.33%), followed by castor oil 0.5 per cent (21.33%), taramira oil 0.5 per cent (19.33%), groundnut oil 1.0 per cent (18.67%) and mustard oil 0.5 per cent (18.33%), later four were at par with each other. The other treatments were moderately effective (Table 4.10).

After 120 days of grain treatment, the minimum grain damage was observed in malathion 50 EC 0.05 per cent (4.33%), followed by castor oil 1.5 per cent (6.0%) and taramira oil 1.5 per cent (6.0%), which were statistically at par with each other. The maximum grain damage was recorded in grains treated with groundnut oil 0.5 per cent (36.33%), followed by castor oil 0.5 per cent (23.67%), taramira 0.5 per cent (23.33%), groundnut 1.0 per cent (22.67%) and mustard oil 0.5 per cent (22.0%), former one was differed significantly, while later four were at par with each other. The rest of the treatments were moderately effective.

After 150 days of grain treatment, the minimum grain damage was recorded in malathion 50 EC 0.05 per cent (5.33%) and mustard oil 1.5 per cent (6.33%), which were statistically at par with each other. Next effective treatments were castor oil 1.5 per cent (9.67%), followed by taramira 1.5 per cent (9.67%) and neem oil 1.0 per cent (11.67%), these were at par with each other. The maximum grain damage was recorded in grains treated with groundnut oil 1.0 per cent (36.33%), followed by groundnut oil 0.5 per cent (31.67%) and castor oil 0.5 per cent (31.33%). These treatments were statistically at par with each other but significantly proved better than the untreated control (86.67%). The rest of the treatments were moderately effective. The descending order of grain damage was recorded to be caused by groundnut oil, castor oil, taramira oil, mustard oil, neem oil and malathion 50 EC. The present study is fully conformity with findings of Kumawat (2004) [12] who reported that maximum protection of stored grains against *R. dominica* was provided by neem oil at 1.0 per cent (no grain damage was recorded up to 270 days of treatment), followed by castor and taramira oil at 1.0 per cent (no grain damage up to 90 days of treatment). The present

results are also conformity with the findings of Jood *et al*., (1994), Gupta *et al.,* (2000), Singh *et al.,* (2009) [17] and Jakhar and Jat (2010) [9], these carried out study on grain damage and weight loss of grains against different pests.

Weight loss

The data presented in table 4 revealed that all the treatments were found significantly superior over untreated control up to 150 days of treatment in regard to weight loss. The weight loss was not observed in the grains treated with malathion 50 EC 0.075 per cent and neem oil 1.5 per cent up to 150 days of treatment, mustard oil 1.5 per cent up to 120 days of treatment, taramira 1.5 per cent and castor oil 1.5 per cent up to 90 days of treatment, *neem* oil 1.0 per cent, mustard oil 1.0 per cent, castor oil 1.0 per cent and malathion 50 EC 0.05 per cent up to 60 days of treatment and groundnut oil 1.5 per cent and malathion 50 EC 0.025 per cent up to 30 days of treatment.

After 30 days of grain treatment, the minimum weight loss was recorded in the grains treated with neem oil 0.5 per cent (1.62%) and mustard oil 0.5 per cent (2.0%), which were found statistically at par with each other. The maximum weight loss was revealed by groundnut oil 0.5 per cent (4.20%) and castor oil 0.5 per cent (3.90%), which were at par with each other. The other treatments were moderately effective.

After 60 days of treatment, the minimum weight loss was caused in the grains treated with neem oil 0.5 per cent, followed by groundnut oil 1.5 per cent, malathion 50 EC 0.025 per cent and taramira oil 1.0 per cent, which exhibited 2.00, 2.00, 2.02 and 2.10 per cent weight loss, respectively and were statistically at par to each other. The maximum weight loss was recorded in grains treated with groundnut oil 0.5 per cent (6.33%), followed by taramira oil 0.5 per cent (4.67%), groundnut oil 1.0 per cent (4.20%) and castor oil 0.5 per cent (4.0%), later three were at par with each other. The other treatments were ranked in the middle order of efficacy.

After 90 days of grain treatment, the minimum weight loss was observed in malathion 50 EC 0.05 per cent, followed by neem oil 1.0 per cent, mustard oil 1.0 per cent and castor oil 1.0 per cent, which exhibited 1.63, 2.32, 3.27 and 3.30 per cent weight loss, respectively and later two were at par with each other. The maximum weight loss was observed in groundnut oil 0.5 per cent (11.93%), followed by groundnut oil 1.0 per cent (7.20%), castor oil 0.5 per cent (6.30%), later two treatments were at par with each other. The rest of the treatments were moderately effective (Table 4).

After 120 days of grain treatment, the minimum weight loss was recorded in castor oil 1.5 per cent (1.06%) and malathion 50 EC 0.05 per cent (1.60%) treated grains and these treatments did not differ significantly. The maximum weight loss (14.02%) was observed in grains treated with groundnut oil 0.5 per cent, followed by groundnut oil 1.0 per cent (8.30%), taramira oil 0.5 per cent, (7.61%) mustard oil 0.5 per cent (7.31%) and castor oil 0.5 per cent (7.30%), and later four treatments were at par with each other. The rest of treatments were ranked in the middle order of efficacy.

After 150 days of grain treatment, the minimum weight loss was recorded in castor oil 1.5 per cent (3.31%), mustard oil 1.5 per cent (3.71%) and malathion 50 EC 0.05 per cent (4.02%), which were at par each other. The maximum weight loss was observed in grains treated with groundnut oil 0.5 per cent (15.67%) and castor 0.5 per cent (14.0%) and these treatments were at par with each other. The rest of the treatments were ranked in the middle order of efficacy. The descending order of weight loss found to be groundnut oil, castor oil, mustard oil, taramira oil, neem oil and malathion 50 EC. The present study is fully conformity with findings of Kumawat (2004) [12] who reported that maximum protection of stored grains against *R. dominica* was provided by neem oil at 1.0 per cent (no grain damage was recorded up to 270 days of treatment), followed by castor and taramira oil at 1.0 per cent (no grain damage up to 90 days of treatment). The present results are also conformity with the findings of Jood *et al*., (1994), Gupta *et al.,* (2000), Singh *et al.,* (2009) [17] and Jakhar and Jat (2010) [9], these carried out study on grain damage and weight loss of grains against different pests.

Effect of plant oils on the germination of barley seeds

The data on germination after 150 days of treatments ranged from 83.33-86.66 per cent which were statistically at par each other (Table 5). Therefore, the oil treatments were not found deleterious to seed viability.

Table 1: Effect of plant oils on adult mortality of *Rhyzopertha dominica* on barley grain at different storage periods

S. No.	Plant oils	Dose (%)	Adult mortality (%) days after storage		
			7	14	21
1.	Neem oil	0.5	33.65 (35.42)	62.40 (52.23)	71.35 (57.80)
		1.0	57.00 (49.03)	75.67 (60.47)	83.17 (65.84)
		1.5	80.35 (63.78)	91.35 (73.45)	94.65 (75.63)
2.	Groundnut oil	0.5	24.35 (29.54)	31.35 (34.03)	44.65 (41.92)
		1.0	28.33 (32.14)	39.71 (39.05)	58.07 (49.66)
		1.5	35.99 (36.83)	51.65 (45.94)	67.35 (55.25)
3.	Mustard oil	0.5	31.65 (34.23)	65.40 (53.97)	74.60 (59.76)
		1.0	59.17 (50.29)	76.99 (61.40)	85.17 (67.53)
		1.5	73.40 (59.13)	88.49 (72.19)	93.08 (74.74)
4.	Castor oil	0.5	28.99 (32.56)	53.65 (47.09)	71.35 (57.73)
		1.0	47.35 (43.47)	64.67 (53.60)	82.65 (65.95)
		1.5	71.65 (57.84)	83.44 (66.05)	89.08 (70.84)
5.	Taramira oil	0.5	26.02 (30.66)	42.35 (40.60)	65.35 (53.95)
		1.0	45.35 (42.32)	61.99 (51.98)	80.02 (63.84)
		1.5	68.65 (56.02)	82.65 (65.72)	86.91 (69.42)
6.	Malathion 50 EC (check)	0.025	42.65 (40.76)	58.91 (50.15)	85.35 (67.69)
		0.05	78.31 (62.56)	93.65 (75.36)	100 (90.00)
		0.075	91.35 (74.69)	100 (90.00)	100 (90.00)
7.	Untreated control		0.00 (0.00)	3.35 (10.53)	4.65 (12.44)
	S. Em. ±		2.08	2.36	2.66

	CD (P=0.05%)		6.09	6.80	7.60
	CD (P=0.01%)		7.970	9.06	10.19

Figures in the parentheses are arc sine √ percentage values

Table 2: Effect of plant oils on adult (F_1) emergence of *Rhyzopertha dominica* in barley grains at different storage periods

S. No.	Plant oils	Dose (%)	Adult emergence days after storage				
			30	60	90	120	150
1	Neem oil	0.5	2.00 (0.47)	2.67 (0.56)	4.67 (0.75)	7.33 (0.91)	9.33 (1.01)
		1.0	0.00 (0.00)	0.00 (0.00)	2.00 (0.47)	3.00 (0.60)	6.00 (0.84)
		1.5	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	Groundnut oil	0.5	5.00 (0.77)	8.33 (0.96)	10.67 (1.06)	14.33 (1.18)	16.33 (1.23)
		1.0	3.00 (0.60)	5.67 (0.82)	7.33 (0.91)	8.67 (0.98)	10.67 (1.06)
		1.5	0.00 (0.00)	0.00 (0.00)	5.67 (0.82)	7.33 (0.91)	8.33 (0.96)
3	Mustard oil	0.5	2.67 (0.56)	4.33 (0.72)	6.33 (0.86)	8.00 (0.95)	9.67 (1.02)
		1.0	0.00 (0.00)	2.33(0.52)	4.33(0.72)	5.33(0.80)	7.67(0.93)
		1.5	0.00(0.00)	0.00(0.00)	0.00(0.00)	2.00(0.478)	3.33(0.63)
4	Castor oil	0.5	3.67(0.66)	5.67(0.82)	7.33(0.91)	8.67(0.98)	11.67(1.10)
		1.0	0.00(0.00)	2.33(0.52)	6.67(0.88)	6.33(0.86)	9.33(1.01)
		1.5	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	3.00(0.60)
5	Taramira oil	0.5	4.67(0.75)	4.67(0.75)	5.67(0.82)	9.33(1.01)	9.33(1.01)
		1.0	1.33(0.36)	3.00(0.60)	4.33(0.72)	6.67(0.88)	8.00(0.95)
		1.5	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	5.67(0.82)
6	Malathion 50 EC (check)	0.025	0.00(0.00)	2.00(0.47)	2.67(0.56)	4.33(0.72)	6.67(0.88)
		0.05	0.00(0.00)	0.00(0.00)	0.00(0.00)	2.00(0.47)	4.00(0.69)
		0.075	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)
7	Untreated control	-	32.00(1.51)	33.00(1.53)	34.00(1.54)	33.33(1.53)	31.33(1.50)
	S. Em. ±		0.01	0.01	0.02	0.02	0.04
	CD (p=0.05%)		0.11	0.14	0.12	0.13	0.15
	CD (p=0.01%)		0.13	0.17	0.16	0.17	0.18

Figures in parentheses are log X + 1 values

Table 3: Effect of plant oils on grain damage by *Rhyzopertha dominica* in barley grains

S. No.	Plant oils	Dose (%)	Grain damage (%) days after storage				
			30	60	90	120	150
1.	Neem oil	0.5	6.00(14.16)	8.33(16.75)	15.33(23.02)	18.33(25.32)	25.33 (30.18)
		1.0	0.00(0.00)	0.00(0.00)	6.00(14.17)	9.67(18.11)	11.67(19.98)
		1.5	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)
2.	Groundnut oil	0.5	13.67(21.68)	17.33(24.58	31.33(34.01)	34.33(35.05)	36.33(37.05)
		1.0	8.33(16.76)	11.67(19.96)	18.67(25.58)	22.67(28.41)	31.67(34.23)
		1.5	0.00(0.00)	4.67(12.46)	14.33(22.21)	18.99(25.80)	25.67 (30.41)
3.	Mustard oil	0.5	7.00(15.33)	11.33(19.66)	18.33(25.34)	22.00(27.96)	25.33(30.21)
		1.0	0.00(0.00)	3.67(11.04)	11.67(19.97)	13.99(21.95)	18.00(25.09)
		1.5	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	6.33(14.55)
4.	Castor oil	0.5	8.33(16.76)	14.67(22.50)	21.33(27.49)	23.67(29.09)	31.33(34.02)
		1.0	0.00(0.00)	6.67(14.94)	13.00(21.10)	15.99(23.54)	28.67(32.34)
		1.5	0.00(0.00)	0.00(0.00)	0.00(0.00)	6.00(14.17)	9.67(18.11)
5.	Taramira oil	0.5	7.67(16.07)	13.00(21.12)	19.33(26.07)	23.33(28.87)	26.00(30.65)
		1.0	3.67(11.03)	9.33(17.77)	12.67(20.83)	14.67(22.50)	18.99(25.81)
		1.5	0.00(0.00)	0.00(0.00)	0.00(0.00)	6.00(14.16)	9.67(18.10
6.	Malathion 50 EC (check)	0.025	0.00(0.00)	5.33(13.33)	9.00(17.44)	13.67(21.68)	15.67(21.68)
		0.05	0.00(0.00)	0.00(0.00)	0.00(0.00)	4.33(11.99)	5.33(11.99)
		0.075	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)
7.	Untreated control	-	82.33(65.46)	84.67(67.39)	85.99(68.56)	86.33(68.87)	86.67(69.19)
S. Em. ±			0.80	0.92	1.04	1.10	1.20
CD (p=0.05%)			2.31	2.64	3.00	3.16	3.42
CD (p=0.01%)			3.09	3.53	4.02	4.23	4.60

Figures in the parentheses are arc sine √ percentage values

Table 4: Effect of plant oils on weight loss by *Rhyzopertha dominica* in barley grains

S. No.	Plant oils	Dose (%)	Weight loss (%) days after storage				
			30	60	90	120	150
1.	Neem oil	0.5	1.62(7.31)	2.00(8.11)	4.93(12.81)	6.33(14.55)	8.73(17.16)
		1.0	0.00(0.00)	0.00(0.00)	2.32(8.75)	4.27(11.92)	5.02(12.94)
		1.5	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)
2.	Groundnut oil	0.5	4.20(11.81)	6.33(14.55)	11.93(20.19)	14.02(21.97)	15.67(23.30)
		1.0	2.99(9.96)	4.20(11.81	7.20(15.55)	8.30(16.71)	10.59(18.97)
		1.5	0.00(0.00)	2.00(8.11)	6.01(14.18)	6.21(14.41)	8.61(17.04)

3.	Mustard oil	0.5	2.00(8.13)	3.67(11.04)	5.30(13.30)	7.31(15.68)	11.00(19.37)
		1.0	0.00(0.00)	0.00 (0.00)	3.27(10.41)	5.34(13.35)	5.97(14.13)
		1.5	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	3.71(11.09)
4.	Castor oil	0.5	3.90(11.38)	4.00(11.52)	6.30(14.52)	7.30(15.67)	14.00(21.95)
		1.0	0.00(0.00)	0.00(0.00)	3.30(10.45)	6.00(14.16)	10.60(18.97)
		1.5	0.00(0.00)	0.00(0.00)	0.00(0.00)	1.06(5.90)	3.31(10.48)
5.	Taramira oil	0.5	3.40(10.62)	4.67(12.47)	5.48(13.53)	7.61(16.00)	9.81(18.24)
		1.0	1.80(7.70)	2.10(8.32)	4.00(11.52)	4.67(12.46)	8.30(16.72)
		1.5	0.00(0.00)	0.00(0.00)	0.00(0.oo)	2.67(9.40)	6.32(14.55)
6.	Malathion 50 EC (check)	0.025	0.00(0.00)	2.02(8.12)	3.00(9.96)	4.02(11.55)	6.02(14.19)
		0.05	0.00(0.00)	0.00(0.00)	1.63(7.33)	1.60(7.26)	4.02(11.55)
		0.075	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)
7.	Untreated control	-	30.67(33.61)	30.99(33.81)	32.00(34.43)	32.67(34.84)	33.00(35.04)
S. Em. ±		-	0.28	0.31	0.40	0.43	0.50
CD (P=0.05%)		-	0.81	1.00	1.12	1.23	1.44
CD (P=0.01%)		-	1.10	1.20	1.50	1.64	1.92

Figures in the parentheses are arc sine √ percentage values

Table 5: Effect of plant oils on the germination of barley seeds after 150 days of treatments

S. No.	Plant oils	Dose (%)	Germination (%)
1.	Neem oil	0.5	86.33
			(69.23)
		1.0	86.00
			(68.11)
		1.5	84.00
			(66.58)
2.	Groundnut oil	0.5	85.00
			(68.06)
		1.0	84.00
			(66.82)
		1.5	83.33
			(66.52)
3.	Mustard oil	0.5	86.66
			(68.67)
		1.0	85.33
			(67.68)
		1.5	85.00
			(68.06)
4.	Castor oil	0.5	85.67
			(68.27)
		1.0	84.67
			(67.69)
		1.5	84.00
			(66.49)
5.	Taramira oil	0.5	85.00
			(67.39)
		1.0	84.33
			(67.43)
		1.5	84.00
			(66.82)
6.	Malathion 50 EC	0.025	86.00
			(68.57)
		0.05	85.67
			(68.71)
		0.075	85.33
			(67.97)
7.	Untreated control	-	86.00
			(68.57)
S.Em. ±		-	3.47
CD (p= 0.05%)		-	NS
CD (p= 0.01%)		-	NS

Figures in the parentheses are arc sine √ percentage values

References

1. Abdallah SA, Badawy HMA, Barakat AA, El-Sabaay TN. Efficacy of certain vegetable oils as wheat protectants against the lesser grain borer, *Rhyzopertha dominica* (F.). Bulletin of Faculty of Agriculture, Cairo University, 2001; 52:167-182.
2. Anonymous. Germination method part-I agriculture and horticulture seeds. Seed Science and Technology, 1976; 4:120.

3. Anonymous. *Agricultural statistics at a glance.* Directorate of Economics and Statistics. Department of Agriculture and Cooperation, Ministry of Agriculture, 2014.
4. Anonymous. Vital Agricultural Statistics. Directorate of Agriculture, Government of Rajasthan, Jaipur, 2014.
5. Bhargava MC, Choudhary RK. Grain interaction in stored products with relation to storage structures/receptacles used in different parts of Rajasthan. National Seminar: Organic Waste Utilization and Eco-friendly Technologies for Crop Protection (Hyderabad): 2007, 147-149.
6. Campbell A, Sinha RN. Damage of wheat by feeding of some stored beetles. Journal of Economic Entomology. 1976; 69:11-13.
7. Gupta HC, Verma JP, Bareth SS, Mathur BN. Evaluation of some non edible oils as grain protectant in wheat and their subsequent effect on germination. Food Technology Abstract. 1992; 27:34-35.
8. Gupta HC, Verma JP, Bareth SS, Mathur BN. Evaluation of some non edible oils as grain protectant in wheat and their subsequent effect on germination. Food Technology Abstract, 1992; 27:34-35.
9. Jakhar BL, Jat SL. Efficacy of plant oils as grain protectants against khapra beetle, *Trogoderma granarium* Everts in wheat. Indian Journal of Entomology. 2010; 72(3):205-208.
10. Jilani, Malik. Studies on the neem plant as repellent against stored grain insects. Pakistan Journal of Science and Industrial Research. 1973; 16(6):251-254.
11. Jood S, Kapoor AC, Singh R. Evaluation of some plant products against *Trogoderma granarium* Everts in stored wheat and their effects on nutritional composition and organoleptic characteristics of treated grains. International Journal of Pest Management, 1993; 39(1):93-98.
12. Kumawat KC. Bioecology and Management of *Rhyzopertha dominica* (Fab.) on Wheat. *Ph.D. Thesis,* submitted to Rajasthan Agricultural University, Bikaner, 2004.
13. Mookherjee PB, Jotwani MG, Yadav TD, Sircar P. Disinfestations of stored seeds by heat treatment. Indian Journal of Entomology. 1968; 30:197-202.
14. Pruthi HS, Singh M. Pests of stored grain and their control. Indian Journal of Agricultural Sciences. 1950; 18(4):52-58.
15. Sharma RK. Efficacy of neem products against storage pests in maize. Annals of Agricultural Research. 1999; 20:198-201.
16. Shukla RM, Chand G, Saini ML. Laboratory evaluation of effectiveness of edible oils against three species of stored grain insects. Plant Protection Bulletin. 1992; 44(1-2):14-15.
17. Singh DK, Shukla IN, Singh R. Effect of some indigenous grain protectants against *Trogoderma granarium* on stored wheat. Current Advances in Agricultural Sciences. 2009; 1(2):119-120.
18. Uttam JR, Pandey ND, Verma RA, Singh DR. Efficacy of different indigenous oils as grain protectant against *Sitophilus oryzae* on barley. Indian Journal of Entomology, 2002; 64(4):447-450.
19. Yadav JP, Bhargava MC, Yadav SR. Effect of various plant oils on rice weevil, *Sitophilus oryzae* in wheat. Indian Journal of Plant Protection. 2008; 36(1):35-39.