International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(5): 2942-2946

Received: 13-07-2018
Accepted: 14-08-2018

AK Menge
Department of Agril. Entomology, College of Agriculture, Dapoli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra, India

KV Naik
Department of Agril. Entomology, College of Agriculture, Dapoli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra, India

GM Golvankar
Department of Agril. Entomology, College of Agriculture, Dapoli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra, India

Correspondence
AK Menge
Department of Agril. Entomology, College of Agriculture, Dapoli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra, India

Effect of edible oils against *Corcyra cephalonica* (St.) in stored groundnut kernel

AK Menge, KV Naik and GM Golvankar

Abstract
There were seven oils *viz*., mustard, clove, castor, coconut, sunflower, soybean and sesame each applied at rates of 1 ml and 3 ml per 100 g of kernels as kernel protectants of groundnut. Effect of kernel protectants on fecundity revealed that no adult emergence was found on groundnut kernels treated with clove oil each at 1 ml and 3 ml per 100 g of kernels, while in case of the treatments *viz*., castor oil, coconut oil and sesame oil each at 3 ml per 100 g of kernels very few male moths were emerged. Among the remaining treatments, castor oil (134.67 eggs) was found most effective treatment in preventing egg laying by *C. cephalonica* at 3 ml per 100 g of kernels. In castor oil treatment at 1 ml per 100 g of kernels found most promising in delaying the development (58.40 days) of *C. cephalonica*.

Keywords: *C. cephalonica*, grain protectant, edible oil, groundnut

Introduction
Groundnut, *Arachis hypogaea* L. an important oilseed crop, is the native of South America. It is called as the 'king of oilseeds', wonder nut and poor men's cashew nut. Its famous Indian name is '*Mongphali*'. It is an important cash and food crop in many parts of the tropics, particularly in semi-arid areas. India is the second largest producer of groundnut after China. Groundnut kernel as a whole is highly nutritious as it is rich in edible oil and in proteins. It is poor man's almond because it is very cheap as compared to almond and other nuts and at the same time, has comparative food value. It is an excellent combination of calories and essential amino acids in an average Indian diet.

More than 100 insect species are known to live and feed on stored groundnut, some of which are of economic importance (Ranga Rao *et al*., 2010) [7]. Stored insect-pests are serious problem throughout the world, because they reduce the quantity and quality of grain. Their damage to stored grains and grain products may amount 25 to 40 percent in the tropical zone (Shaaya *et al*., 1997) [11]. Among the major pests of stored groundnut, rice moth, *Corcyra cephalonica* (Stainton) is considered to be an important pest. It causes loss by feeding on stored groundnut. The adults do not feed. Females scatter their eggs among the produce. The larvae of *C. cephalonica* are capable of damaging intact kernels and feed both on the surface and within seeds. They spin a tough silken fiber, webbing together kernels, frass, and cast larval skins. Pupation takes place either within the food source, in sacking, or in crevices in storage structures (Dick, 1987) [1].

The search for safer insecticides and ecologically sound methods to manage insect pests is important. Many plants, microbes and their secondary metabolites are known to have various insecticidal properties against different species of insects. Some indigenous plant materials have insecticidal properties against insect pests. Recently it has been realized that major emphasis should be given to plant based grain protectants, and has gained much importance due to their high bio-efficacy against a wide range of pests and no residual toxicity to the environment as compare to chemical pesticides. Therefore, keeping the importance of pest in view, the present experiment was undertaken to study the effect of edible oils against *Corcyra cephalonica* (St.) in stored groundnut kernel under laboratory condition.

Materials and methods
A statistically designed laboratory experiment was laid out during year 2014-15 to study the efficacy of some kernel oil protectants against *C. cephalonica*. The details of experiment conducted are given below.

Location	:	Biocontrol Laboratory, Department of Agril. Entomology.
Design	:	Randomized Block Design
Variety of groundnut used	:	Konkan Tapora
Name of test insect	:	Rice moth, *Corcyra cephalonica* (Stainton)
No. of eggs released/treatment	:	100 eggs
Quantity of kernels/treatment	:	100 g
Number of replication	:	Three
No. of treatments	:	Fifteen

Treatment Details:		
T_1	:	Mustard oil @ 1 ml per 100g of kernels
T_2	:	Mustard oil @ 3 ml per 100g of kernels
T_3	:	Clove oil @ 1 ml per 100g of kernels
T_4	:	Clove oil @ 3 ml per 100g of kernels
T_5	:	Castor oil @ 1 ml per 100g of kernels
T_6	:	Castor oil @ 3 ml per 100g of kernels
T_7	:	Coconut oil @ 1 ml per 100g of kernels
T_8	:	Coconut oil @ 3 ml per 100g of kernels
T_9	:	Sunflower oil @ 1 ml per 100g of kernels
T_{10}	:	Sunflower oil @ 3 ml per 100g of kernels
T_{11}	:	Soybean oil @ 1 ml per 100g of kernels
T_{12}	:	Soybean oil @ 3 ml per 100g of kernels
T_{13}	:	Sesame oil @ 1 ml per 100g of kernels
T_{14}	:	Sesame oil @ 3 ml per 100g of kernels
T_{15}	:	Untreated Control

In case of treatments with various oils, 100 g healthy kernels were weighed on electronic weighing balance. The required quantity of oils (1 ml and 3 ml /100 g of kernels) of seven plant species *viz*., mustard, clove, castor, coconut, sunflower, soybean and sesame were poured on 100 g healthy kernels of groundnut. The treated kernels were mixed thoroughly so that each and every kernel get covered and kept under shade drying for 24 hours and placed in each transparent glass bottle. Hundred freshly laid eggs were glued on a strip of paper and the strip with eggs was placed in each glass bottle including control. The open end of the bottle was covered with muslin cloth and secured firmly with rubber band and the bottle was kept undisturbed till the emergence of adult. Freshly emerged moths were removed daily to prevent fresh oviposition and the same bottles were observed further till no adult emergence was seen for a week. Such three sets were prepared for present experimentation. All the containers were labeled properly with respective treatments. The studies were conducted at room temperature and relative humidity (temperature 28 ± 2.33 ^{0}C and relative humidity 64 ± 6.30).

Method of recording observations

1. Effect of various treatments on fecundity

The total number of eggs laid by the female emerged from various treatments was counted. The mean number of eggs laid by a female moth was worked out on the basis of the total number of eggs laid by ten females. The data obtained were analysed statistically.

2. Effect of various treatments on oviposition period

Ten females emerged from different treatments were kept separately in plastic containers. First to last egg laid was counted to record the oviposition period. The data obtained were analysed statistically.

3. Effect on incubation period and hatching percentage

For observing incubation period, fifty eggs laid by the female moth emerged from each treatment were collected and kept in separate petriplates. Eggs were observed regularly till hatching. The period required from egg laying to hatching was considered as incubation period. The number of eggs hatched was counted to arrive at percent hatching. The data obtained were analysed statistically.

4. Effect on total development period

The period from egg laying to the emergence of adult was recorded in each treatment to calculate the total developmental period. The data obtained were analysed statistically.

5. Effect on percent adult emergence

Total number of adults emerged from each treatment were counted. The percent adult emergence was worked out for each treatment. The data obtained were analysed statistically.

$$\text{Percent adult emergence} = \frac{\text{Total no. of adults emerged from treated kernels}}{\text{Total no. of adults emerged from untreated control}} \times 100$$

6. Effect on adult longevity

Ten newly emerged adults from each treatment were separated for sexes and kept separately. With the help of thread, the cotton swab soaked with five percent sugar solution was kept in the jars in which adults were released. Ten adults of each sex were kept under the observation and period from adult emergence till its death was recorded. The data obtained were analysed statistically.

Results and Discussion

1. Effect of different oil treatments on fecundity

The data regarding effect of different oil treatments on fecundity of *C. cephalonica* are presented in Table 1. The results indicated that the oils affected significantly the fecundity of *C. cephalonica*. The mean numbers of eggs were deposited by female moth emerged from kernels treated with different oils varied from 134.67 to 212.83 as against 392.53 in untreated control. Perusal of the data indicated that no adult emergence was found on groundnut kernels treated with clove oil each at 1 ml and 3 ml per 100 g of kernels, while in case of the treatments *viz*., castor oil, coconut oil and sesame oil each at 3 ml per 100 g of kernels very few male moths were emerged. Therefore, further observations on fecundity could not be recorded in these treatments.

Among the remaining treatments, where egg laying was observed in case of the female moth emerged from the treatment with non-edible oil like castor (134.67 eggs) was found most effective treatment in preventing egg laying by *C. cephalonica*. The treatment with mustard oil (159.67 eggs) at 3 ml per 100 g of kernels and mustard oil (164.53 eggs) at 1 ml per 100 g of kernels were next best treatments in reducing fecundity by *C. cephalonica* and those were at par with each other. Untreated control recorded the highest (392.53 eggs) average number of eggs.

Present findings corroborate the work carried out by Singh *et al*. (1978) [12] who observed that eggs mortality has been attributed to toxic components and also physical properties present in oils, which cause changes in surface tension and oxygen tension within the eggs. Sawant (2001) [8] reported that the no egg laying was observed in the treatments like castor oil, neem oil, mustard oil and groundnut oil used at 3 g,

4 g and 5 g per 100 g of seed concentration. Raktade (2013) [6] observed that no eggs were laid on treated seeds with various oils *viz*., undi oil, safflower oil, karanj oil, castor oil and neem oil. She also observed that in the treatment with castor oil and neem oil each at 3 ml per 100 g of seeds, dead larvae were found on the treated seeds. Jadhav (2013) [3] observed that cowpea grains treated with non-edible oils *viz*., karanj oil, castor oil, neem oil and undi oil applied each at 0.5 ml per 100 g of seeds were most effective in reducing the egg laying by pulse beetle followed by edible oils such as sesame oil, safflower oil, mustard oil, sunflower oil, coconut oil and groundnut oil in their descending order.

2. Effect of different oil treatments on oviposition period, incubation period and hatching percentage of *C. cephalonica*

It was observed that the oils not only reduced the fecundity but also reduced the oviposition period and hatching percentage and prolonged the incubation period. The data regarding effect of oil treatments on oviposition period, incubation period and hatching percentage are presented in Table 1**.**

Among various oil treatments oviposition period ranged from 2.83 to 3.53 days as against 4.27 days in untreated control. No adult emergence was found in groundnut kernels treated with clove oil, each at 1 ml and 3 ml per 100 g of kernels, while in the treatments *viz*., castor oil, coconut oil and sesame oil each at 3 ml per 100 g of kernels very few male moths were emerged hence, no egg laying was observed in these treatments. Therefore, further observations on oviposition period could not be recorded in these treatments.

Among the remaining treatments, in which egg laying was observed, the minimum (2.83 days) oviposition period was observed in case of the eggs which were laid by the female moth emerged from the treatment with mustard oil at 3 ml per 100 g of kernels followed by castor oil (2.87 days) and mustard oil (2.90 days) each at 1 ml per 100 g of kernels. The results of present studies in respect of castor oil and mustard oil are comparable with the observations made by Singh *et al*. (1978) [12] who observed that castor oil at 8 mg/kg provide provided complete protection against *C. maculates*. Patel and Patel (2002) [5] revealed that mixing of neem and eucalyptus leaf powder at 2 percent and mustard oil at 0.5 percent were highly effective against *C. cephalonica* on stored rice.

When different oils were tested, it was revealed incubation period ranged from 4.28 to 5.28 days as against 4.12 days in untreated control. No adult emergence was found in groundnut kernels treated with clove oil, each at 1 ml and 3 ml per 100 g of kernels, while in the treatments *viz*., castor oil, coconut oil and sesame oil each at 3 ml per 100 g of kernels very few male moths were emerged. No egg laying was observed in these treatments. Therefore, further observations on incubation period could not be recorded in these treatments.

Among the remaining treatments, in which laying was observed castor oil at 1 ml per 100 g of kernels was significantly superior treatment in which maximum (5.28 days) incubation period was observed followed by mustard oil (5.17 days) at 3 ml per 100 g of kernels and those were at par. The next best treatments were mustard oil (4.92 days) at 1 ml per100 g of kernels followed by soybean oil (4.72 days) and sunflower oil (4.67 days) each at 3 ml per 100 g of kernels and those were at par with each other. Present studies are in agreement with Sawant (2001) [8]. She reported that there is no egg laying in treatments like castor oil, neem oil, mustard oil and groundnut oil at 3 g, 4 g and 5 g per 100 g of seed so no incubation period was recorded.

The observations were recorded on effect of oil treatments on percent egg hatching. The percent hatching of eggs ranged from 81.80 to 96.87 as against 99.67 in untreated control. No adult emergence was found in groundnut kernels treated with clove oil, each at 1 ml and 3 ml per 100 g of kernels, while in the treatments *viz*., castor oil, coconut oil and sesame oil at 3 ml per 100 g of kernels very few male moths were emerged. Therefore, further observations on egg laying as well as hatching percentage could not be recorded in respect of the treatment with clove oil each at 1 ml and 3 ml per 100 g of kernels, and castor oil, coconut oil and sesame oil each at 3 ml per 100 g of kernels.

Among the remaining treatments, minimum (81.80) percent hatching was observed in case of eggs laid by the female moth emerged from the treatment with castor oil at 1 ml per 100 g of kernels. The next best treatments in minimizing hatching percentage were mustard oil (86.67%) at 3 ml per 100 g of kernels followed by mustard oil (87.27%) and sesame oil (89.14%) each at 1 ml per 100 g of kernels, respectively and those were at par with each other.

The results are more or less similar to Schoonhoven (1978) [9] reported that oils increased adult mortality and reduced hatching. Jadhav (2013) [3] found that neem oil was most effective treatment where in only 30 percent hatching was noticed in pulse beetle. The treatment of karanj oil with 40 percent egg hatching was observed another effective treatment followed by castor oil and undi oil with 60 percent, safflower oil and sesame oil with 70 percent and sunflower oil and mustard oil with 80 percent egg hatching.

3. Effect of different oil treatments on percent adult emergence of *C. cephalonica*

The data on effect of various oil treatments on percent adult emergence are presented in Table 2.

Data indicated that all the treatments were effective in reducing the emergence of moths. The percent adult emergence ranged from 1.05 to 49.48 against 95.67 in untreated control. No adult emergence was found on groundnut kernels treated with clove oil, applied each at 1 ml and 3 ml per 100 g of kernels.

Among the remaining treatments sesame oil (1.05%) at 3 ml per 100 g of kernels was significantly superior treatment in reducing the percent adult emergence. The next best treatments were castor oil (3.83%) and coconut oil (4.53%) each at 3 ml per 100 g of kernels and both were at par with each other, followed by mustard oil (7.32%) and soybean oil (9.41%) each at 3 ml per 100 g of kernels and those were at par with each other.

According to Senguttuvan *et al*. (1995) [9] found that the average number of adults of *C. cephalonica* that developed from the batches of 10 introduced larvae was lowest in the nochi leaf powder (2.7) followed by neem leaf powder (3.3), neem oil (3.7), sesame oil (3.7), castor oil (4.0) and neem kernel powder (4.3) as against control (5.7). Sawant (2001) [8] observed that at higher concentrations like 3 g, 4 g and 5 g per 100 g of seeds, oils like castor, neem, mustard and groundnut oil, there was no adult emergence in both mixture and layer application. In these treatments, there was no egg laying and hence, there was no adult emergence. Ghosal *et al*. (2005) [2] noticed that oils like soybean, clove, safflower, cintronella, neem and castor were found to be effective to kill beetles. In the treatment with mustard oil, castor oil and soybean oil each at 1ml and 3ml per 100g of kernels abnormal adults were

observed. Khalequzzaman *et al.* (2007) [4] evaluated the efficacy of edible oils for the control of pulse beetle and revealed that the significantly lower numbers of progeny were observed in all treatments when compared with control (77.00%). Swella and Mushobozy (2007) [13] observed that coconut oil provided the best protection of the natural products against *C. maculates*. Jadhav (2013) [3] reported that the minimum percent adult emergence of pulse beetle was observed in castor oil and undi oil followed by sesame oil, safflower oil, mustard oil, sunflower oil and coconut oil. Raktade (2013) [6] found that in neem oil and castor oil treated seeds each at 3 ml per 100 g of seeds, no adult emergence was recorded as larvae were found dead on treated seeds in both the treatments.

4. Effect of different oil treatments on total developmental period *C. cephalonica*

The data recorded on effects of different oil treatments on total developmental period are presented in Table 2.

The total development period in different oil treatments ranged from 38.33 to 58.40 days. No adult emergence was found on groundnut kernels treated with clove oil, applied each at 1 ml and 3 ml per 100 g of kernels. Therefore, total development period could not be recorded in respect of the treatment with clove oil each at 1 ml and 3 ml per 100 g of kernels. In the treatments *viz*., sesame oil (38.33 days), coconut oil (43.17 days), soybean oil (44.05 days), mustard oil (45.14 days) and castor oil (45.17 days) each at 3 ml per 100 g of kernels very few adult moths were found to be emerged, further the mean total development period was found to be minimum in these treatments as compared to the remaining treatments.

Among the remaining treatments, castor oil (58.40 days) followed by mustard oil (57.31 days) each at 1 ml per 100 g of kernels and sunflower oil (56.29 days) at 3 ml per 100 g of kernels were found to be most promising treatments in delaying the development of *C. cephalonica* and those were at par with each other.

The results are more or less similar with Raktade (2013) [6]. She found that in the treatments with neem oil and castor oil each at 3 ml per 100 g of seeds, dead larvae were found on the treated seeds. Larvae of *S. cerealella* were failed to develop, therefore, no developmental period recorded in these treatments. Jadhav (2013) [3] reported that the maximum total developmental period of pulse beetle was observed in safflower oil (30.96 days) which was closely followed by castor oil (30.67 days), groundnut oil (29.74 days), undi oil (28.83 days) and mustard oil (27.54 days). Minimum development period was observed in sesame oil (25.04 days).

5. Effect of different oil treatments on adult longevity

The data on effect of different oils on adult longevity are presented in Table 3. No adult emergence was found in groundnut kernels treated with clove oil, each at 1 ml and 3 ml per 100 g of kernels. Therefore, further observations could not be recorded in respect of adult longevity, while in the treatments *viz*., castor oil, coconut oil and sesame oil each at 3 ml per 100 g of kernels very few male moths were emerged. Therefore, further observations on female moth longevity could not be recorded in respect of the treatment with castor oil, coconut oil and sesame oil each at 3 ml per 100 g of kernels. Among the remaining treatments, the longevity of male and female moths ranged from 6.83 to 9.37 days as against 10.07 days in untreated control and 5.13 to 7.03 days as against 8.33 days in untreated control, respectively.

The minimum (6.83 days) longevity was observed in case of the male moth emerged from the treatment with castor oil followed by mustard oil (6.94 days) each at 3 ml per 100 g of kernels, castor oil (7.17 days) and mustard oil (7.33 days) each at 1 ml per 100 g of kernels and sesame oil (7.67 days) at 3 ml per 100 g of kernels, respectively and those were at par with each other, while minimum (5.13 days) longevity noticed in case of the female moth emerged from the treatment with castor oil at 1 ml per 100 g of kernels followed by mustard oil (5.17 days) at 3 ml per 100 g of kernels and mustard oil (5.20 days) at 1 ml per 100 g of kernels, respectively and those were at par with each other. It was noticed from previous studies that most of the oils reduced the adult longevity.

According to Schoonhoven (1978) [9] who reported that the mode of action of oils is partially attributed to interference in normal respiration, resulting in suffocation. This might be the reason that adult moths survived for short period in oil treatments. The observations recorded during present study are in conformity with Raktade (2013) [6]. She reported that larvae of *S. cerealella* were found dead on castor oil and neem oil treatments therefore, in these treatments longevity of adults was not recorded. Jadhav (2013) [3] found that longevity of pulse beetle was comparatively very low among the treatments of undi oil (2.40 days) and castor oil (2.60 days) as against untreated control (10.80 days). In remaining treatments the lowest average longevity was observed in sunflower oil followed by safflower oil, sesame oil, mustard oil.

Table 1: Effect of different oil treatments on fecundity, mean oviposition period, mean incubation period and hatching percentage of *C. Cephalonica*

Treatment	Dose (ml/100 g of kernels)	Fecundity	Mean oviposition period (Days)	Mean incubation period (Days)	Percent hatching
Mustard oil	1	164.53 (12.85)*	2.90	4.92	87.27 (69.11)**
	3	159.67 (12.65)	2.83	5.17	86.67 (68.69)
Clove oil	1	0.00 (0.71)	0.00	0.00	0.00 (0.18)
	3	0.00 (0.71)	0.00	0.00	0.00 (0.18)
Castor oil	1	134.67 (11.62)	2.87	5.28	81.80 (64.78)
	3	0.00 (0.71)	0.00	0.00	0.00 (0.18)
Coconut oil	1	189.40 (13.78)	3.27	4.52	94.87 (77.13)
	3	0.00 (0.71)	0.00	0.00	0.00 (0.18)
Sunflower oil	1	212.83 (14.58)	3.53	4.28	96.87 (80.35)
	3	208.57 (14.44)	3.43	4.67	94.93 (77.15)
Soybean oil	1	198.63 (14.11)	3.40	4.48	93.80 (75.72)
	3	182.39 (13.51)	3.22	4.72	91.89 (73.59)
Sesame oil	1	198.93 (14.12)	3.20	4.64	89.14 (70.84)
	3	0.00 (0.71)	0.00	0.00	0.00 (0.18)

Untreated control	-	392.53 (19.82)	4.27	4.12	99.67(86.73)
S.E.(m±)		0.26	0.06	0.09	1.15
C.D. at 5%		0.72	0.16	0.25	3.19

* Figures in parentheses are $\sqrt{n} + 0.5$ values. ** Figures in parentheses are arcsine values.

Table 2: Effect of different oil treatments on percent adult emergence and total development period of *C. Cephalonica*

Treatment	Dose (ml/100 g of kernels)	Percent adult emergence	Total development period (Days)
Mustard oil	1	46.34 (42.90)*	57.31
	3	7.32 (15.66)	45.14
Clove oil	1	0.00 (0.18)	0.00
	3	0.00 (0.18)	0.00
Castor oil	1	22.65 (28.38)	58.40
	3	3.83 (11.28)	45.17
Coconut oil	1	44.25 (41.69)	52.75
	3	4.53 (12.27)	43.17
Sunflower oil	1	49.48 (44.70)	52.69
	3	45.99 (42.70)	56.29
Soybean oil	1	48.08 (43.90)	52.12
	3	9.41 (17.84)	44.05
Sesame oil	1	48.43 (44.10)	54.02
	3	1.05 (5.87)	38.33
Untreated control	-	95.67 (78.12)	47.18
S.E.(m±)		0.81	1.09
C.D. at 5%		2.26	3.01

* Figures in parentheses are arcsine values.

Table 3: Effect of different oil treatments on adult longevity (Days)

Treatment	Dose (ml/100 g of kernels)	Adult longevity (Days)	
		Male	Female
Mustard oil	1	7.33	5.20
	3	6.94	5.17
Clove oil	1	0.00	0.00
	3	0.00	0.00
Castor oil	1	7.17	5.13
	3	6.83	0.00
Coconut oil	1	8.63	6.50
	3	8.38	0.00
Sunflower oil	1	9.37	7.03
	3	9.03	6.43
Soybean oil	1	8.70	6.37
	3	8.34	6.17
Sesame oil	1	8.60	5.50
	3	7.67	0.00
Untreated control	-	10.07	8.33
S.E.(m±)		0.20	0.12
C.D. at 5%		0.56	0.32

Conclusion

From the present study, it can be concluded that different oils use as grain protectant by farmer to avoid infestation of pests during storage condition. In here clove oil at the rate 1 ml and 3 ml per 100 g of kernel found to be best groundnut kernel protectants against *C. cephalonica*. There was no fecundity and adult emergence occurs in kernel. It is safe and effective method for reducing the infestation of *C. cephalonica* in stored grains.

References

1. Dick KM. Losses caused by insects to groundnut stored in a ware house of India. Trop. Sci. 1987; 27(2):65-75.
2. Ghosal TK, Senapati SK, Deb DC. Pesticidal effect of edible and non edible oils on pulse beetle, *Callosobruchus chinensis* (Coleoptera: Bruchidae). J Ecobiology. 2005; 17(4):321-327.
3. Jadhav SS. Reaction of different cowpea cultivars against *Callosobruchus maculatus*, Feb. (Coleoptera: Bruchidae) and efficacy of plant products as grain protectant. M.Sc. (Agri.) thesis submitted to Dr. B. S. K. K. V., Dapoli, (Maharashtra) Unpublished, 2013, 1-2.
4. Khalequzzaman M, Shah Hussain Ahmad Mahdi, Osman Goni SHM. Efficacy of edible oils in the control of pulse beetle, *Callosobruchus chinensis* L. in stored pigeonpea. Univ. J zool. Rajshahi Univ. 2007; 26:89-92.
5. Patel RA, Patel BR. Evaluation of certain plant products as grain protectants against the rice moth, *Corcyra cephalonica* Stainton, in stored rice. Pest Manag. and Eco. Zool. 2002; 10(2):121-124.
6. Raktade AA. Reaction of different rice varieties against *Sitotroga cerecella* (Oliv.) (Lepidoptera: Gelechiidae) and efficacy of some grain protectants. M.Sc. (Agri.) thesis submitted to Dr. B. S. K. K. V., Dapoli, (Maharashtra) Unpublished, 2013, 1-2.
7. Ranga Rao GV, Rameshwar Rao V, Nigam SN. Post harvest insect pests of groundnut and their management. Information Bulletin No. 84. Int. crops Res. Inst. for Semi-Arid Tropics, 2010, 20.
8. Sawant VP. Efficacy of some botanicals and oils to protect stored grains form major pests. M.Sc. (Agri.) thesis submitted to Dr. B. S. K. K. V., Dapoli, (Maharashtra) Unpublished. 2001, 1-2.
9. Schoonhoven AV. The use of vegetable oils to protect stored beans from bruchid attack. J Econ. Entomol. 1978; 71:254-256.
10. Senguttuvan TA, Abdul Kareem, Rajendran R. Effects of plant products and edible oils against rice moth *Corcyra cephalonica* (St.) in stored groundnut. J Stored Prod. 1995; 31:207-210.
11. Shaaya E, Kostjukovski M, Eilberg J, Sukprakarn C. Plant oils as fumigants and contact insecticides for the control of stored product insects. J Stored Prod. Res. 1997; 33:7-15.
12. Singh SR, Luse RA, Leuschrer LK, Nangju D. Groundnut oil treatment for the control of *Callosobruchus maculates* (F.) during cowpea storage. J Stored Prod. Res. 1978; 14:77-80.
13. Swella GB, Mushobozy DMK. Evaluation of the efficacy of protectants against cowpea bruchids (*Callosobruchus maculates*, F.) on cowpea seeds (*Vigna unguiculata* (L.) Walp.). Plant Protect. Sci. 2007; 43(2):68-72.