

Effect of Temperature and Humidity on the Potentiality of Sweet Flag (*Acorus calamus*) Oil against the Almond Moth, (*Cadra cautella* Walker, Lepidoptera : Phycitidae)

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Abstract: The effect of temperature and humidity on the potentiality of sweet flag (*Acorus calamus* Linn.) as fumigant against the Almond moth (*Cadra cautella* Walker) was studied under varying conditions of temperature (20°C, 25°C and 30°C) and relative humidity (60% and 70%) providing three exposure periods viz., 12 hrs, 24 hrs and 48 hrs. The dosages were 0, 5, 10, 25, 50 and 100 µl/per volume, respectively, of 15 cm x 7 cm cylindrical glass jars. The result was that 50 to 100 µl dosages were very effective in suppressing the viability of two days old eggs, 15 days old larvae, two days old pupae, and two days old adults. The higher dosages and higher exposure periods provided the higher mortality from 78.6% to 98.2% of eggs, larvae, pupae and adults of this insect. The increase in dosages, temperature, humidity and exposure periods provided increased mortality in all stages of the insect.

Key words: Almond moth, *Cadra cautella*, *Acorus calamus*, sweet flag

Introduction

The food range of Almond moth (*Cadra cautella* Walker) is wide viz., dried fruits and cereal grains either in whole or milled form posing a serious problem in India, Srilanka, Burma, Europe and America (Arbogast *et al.*, 2005)

The conventional use of insecticides leave the toxic residues for considerable periods in the treated commodities, which is dangerous to consumers. Plant products have been suggested as an alternative for the management of stored grain insect pests. (Mishra *et al.*, 1992; Singh, 1993; Jood *et al.*, 1996; Arivudainambi & Singh, 2003 and Meena & Bhargava 2003). Plant products are less deleterious to human beings in manufacturing, handling and application especially in developing countries where no safe alternative methods are available. In present work, therefore, *Acorus calamus* extract was evaluated for the bio-efficacy on *Cadra cautella* Walker.

Material and Methods

Extraction of *Acorus calamus*

Rhizomes of *Acorus calamus* Linn. were collected and dried under shade for two weeks time. One kg of such rhizomes was powdered and extracted with Soxhlet apparatus using petroleum ether (bp 40 – 60) as solvent. The extract was filtered through Whatman filter paper No. 1 and freed of solvent under reduced pres-

sure at 50°C to obtain the oil on the lines of Riar *et al.* (1990).

Mass culture of *Cadra cautella*

The laboratory culture of *C. cautella* was maintained on half-milled wheat grains along with 5 per cent dried yeast in plastic jars (20 × 10 cm) at 30 ± 1°C and 70 ± 2% RH in August 2007 by releasing 20 freshly emerged adults (1:1 male, female ratio) and allowed to deposit eggs for mass culturing.

Obtaining of Known Aged Stages of *Cadra cautella*

In separate glass jars (10 kg capacity) having circular mouth were selected and 5 dates (preferred for oviposition) were kept inside. Ten pairs (1:1 male & female) of newly emerged moths of *C. cautella* were released inside it for oviposition. Five per cent glucose solution in the form of a wick was also kept inside the jar to supply food for moths. Mouth of the jar was tied with muslin cloth held by rubber band. The females preferred the ridges of dates for egg laying. Such eggs were daily brushed in a petridish and labelled for dates of egg laying to obtain known aged eggs & larvae for experimentation.

Experimentation

All experiments were conducted in controlled conditions of desired temperature and R. H. using thermostat & humidifier. For testing the effect of plant oil, the glass jars of 15 × 7 cm size were selected. The required dose of treatments (Table 1) was administered on a

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piece of filter paper, which was hanged inside the jar. Its lid was screwed and a wide cello tape was wrapped around it to make it air-tight with the help of a thread fastening on muslin cloth tied on the mouth of jar. The per cent mortality of eggs, larvae, pupae and adults was recorded at different durations. There were three replications. The 'F' test was applied to calculate CD to find critical difference among treatments. The results are presented in Tables 1 to 4.

Results and Discussion

From the data presented in Table 1, it is evident that the maximum mortality of eggs (up to 90.0 per cent) was obtained after 48 hrs in 30°C temperature & 70 per cent R. H. at 100 µL dose. It was significantly superior over all other dosages. In general longer exposure of 48 hrs was most effective in comparison of 12 hrs & 24 hrs time. Dosages below 50 µL were less effective.

There was a very slight effect of *Acorus calamus* on the mortality of 15 days old larvae of Almond moth when exposed for 12 to 24 hrs at lower dosages while it provided 90.6 to 98.2 per cent larval mortality at 100 µL dosage at 70 and 60 per cent RH, respectively in 30°C temperature after 48 hrs of exposure (Table 2).

It is further evident that the significantly highest pupal mortality (86.2 to 90.6 per cent) was obtained at 100 µL dosage in 30°C temperature under 70 and 60 per cent RH, respectively. It was followed by 50 µL dosage, but below this dose the mortality was not considerable (Table 3).

It is seen from the Table 4 that at 100 µL dosage after 48 hrs exposure period under 70 and 60% R. H. in 30°C temperature provided significantly highest (78.6 and 81.3 per cent) adult mortality, respectively. The lower dosages, less exposure, less temperature and less humidity

were less effective providing lesser mortality.

Arivudainambi and Singh (2003) have also found the effective dose of neem oil as 50 – 100 µL against the eggs, grubs and adults of Khapra Beetle, *Trogoderma granarium* (Everts).

Meena and Bhargava (2003) have tested some plant extracts/oils against Rice moth, *Corcyra cephalonica* Stainton and found that all the dosages (0.1 to 1.0%) were very effective in reducing the fecundity, egg viability and longevity of adults.

References

- [1] Arbogast, R. T., S. R. Chini and P. E. Kandra (2005). Infestation of stored saw palmetto berries by *Cadra cautella* and the host paradox in stored product insects. *Florida Entomologist*, 88 (3) :314 – 320
- [2] Arivudainambi, N. M. and R. P. Singh (2003). Fumigant toxicity of Neem (*Azadirachta indica* A. Juss.) seed oil volatiles against Khapra beetle. *Ann. Pl. Protec. Sci.* 11(2) :207 – 211
- [3] Jood, S., Kapoor, A. C. and R. Singh (1996). Evaluation of some plant products against *Trogoderma granarium* Everts. in Sorghum and their effects on nutritional composition and organoleptic characteristics. *J. stored prod. Res.* :32 : 345 – 352
- [4] Meena, B. L. and M. C. Bhargava (2003). Effect of Plant products on reproductive potential of *Corcyra cephalonica* stainton. *Ann. Pl. Protec. Sci.* 11(2) :196 – 200
- [5] Mishra, B. K.; P. R. Mishra and H. K. Mohapatra (1992). Studies on some plant product mixtures against *Sitophilus orzae* L. infesting wheat seeds. *Indian J. plant prot*; 20(2) :178 – 182
- [6] Riar, S. S., C. Devakumar, G. Iivazhagan, J. Bardhan, A. K. Kain, P. Thomas, R. Singh and B. Singh (1990). volatile fraction of Neem oil as spermicide *Contraception*, 42 :479 – 487
- [7] Singh, R. P. (1993). Neem for the management of stored grain insects in developing countries. World neem conference souvenir Bangalore, India, pp. 69 – 80

Table 1. Effect of plant oils on the 2 days old eggs of Almond moth, *cadra cautella* at varying temperature and humidity

Treatment (dose) in µl.	Egg mortality (%)																	
	After 12 hrs exposure						After 24 hrs exposure						After 48 hrs exposure					
	20 °C	25 °C	30 °C	1	2	2	20 °C	25 °C	30 °C	1	2	2	20 °C	25 °C	30 °C	1	2	2
RH	1*	2*	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
100	15.5 (23.19)	18.6 (25.55)	10.8 (19.19)	12.3 (20.53)	18.6 (25.55)	22.4 (28.25)	40.2 (39.35)	45.3 (42.30)	55.8 (48.33)	67.1 (55.00)	70.3 (56.90)	72.5 (58.18)	66.3 (54.51)	67.8 (55.43)	70.6 (57.17)	85.6 (66.11)	85.6 (67.54)	90.0 (71.56)
50	12.5 (20.70)	8.4 (16.55)	14.2 (22.30)	6.3 (14.54)	12.6 (20.79)	8.4 (16.55)	32.7 (34.88)	34.8 (36.15)	38.2 (38.17)	40.7 (39.64)	56.2 (48.50)	54.3 (47.47)	50.0 (45.00)	55.6 (48.22)	62.2 (52.06)	66.3 (52.71)	70.5 (57.10)	66.7 (54.76)
25	2.5 (9.10)	3.8 (11.24)	4.2 (11.83)	3.2 (10.31)	4.8 (12.66)	5.6 (13.69)	11.5 (19.82)	16.4 (23.39)	7.5 (15.29)	10.2 (18.63)	10.2 (18.63)	15.5 (23.19)	22.8 (28.52)	20.2 (26.71)	25.3 (30.20)	28.5 (32.27)	30.6 (33.58)	34.5 (35.97)
10	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	2.8 (9.63)	6.6 (14.89)	0.0 (0)	2.5 (9.10)	0.0 (0)	4.4 (12.11)	5.5 (13.56)	10.8 (19.19)	10.5 (18.91)	8.5 (16.95)	10.5 (18.91)	5.2 (13.18)	12.8 (20.96)	15.7 (23.34)
5	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	5.5 (13.56)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	10.8 (19.19)	12.7 (20.89)	6.5 (14.77)	0.0 (0)	12.6 (20.79)	0.0 (0)	15.5 (23.19)	6.6 (14.89)
0	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	6.8 (15.12)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	5.6 (13.69)	0.0 (0)	0.0 (0)	0.0 (0)	10.5 (18.91)	0.0 (0)	15.0 (22.79)	0.0 (0)
SE(M) ±	2.71	3.62	2.56	2.95	1.98	1.12	2.44	2.09	2.33	2.47	2.52	2.76	1.62	1.85	1.16	3.47	2.46	4.92
CD 5%	5.53	7.31	5.78	6.08	4.23	2.33	5.11	4.75	4.95	5.13	5.98	6.01	4.05	3.92	2.76	6.94	5.01	9.96
1* = 60 % RH																		
2* = 70 % RH																		

Table 2. Effect of plant oils on the 15 days old larvae of Almond moth, *cadra cautella* at varying temperature and humidity

Treatment (dose) in µl.	Larval mortality (%)																
	After 12 hrs exposure				After 24 hrs exposure				After 48 hrs exposure								
	20 °C	25 °C	30 °C	1	2	1	2	1	2	1	2	1	2				
RH	1*	2*	1	2	1	2	1	2	1	2	1	2	1	2			
100	22.1 (28.04)	18.6 (22.55)	27.2 (31.44)	22.5 (28.32)	29.3 (32.77)	24.6 (29.73)	27.5 (31053)	25.2 (30.13)	32.3 (34.63)	32.6 (34.82)	28.4 (32.20)	80.6 (63.87)	82.8 (65.05)	85.8 (67.86)	80.2 (82.29)	98.2 (82.29)	90.6 (72.15)
50	20.2 (26.71)	12.4 (20.62)	15.6 (23.26)	16.2 (23.73)	19.6 (26.28)	15.2 (22.95)	13.4 (21.47)	16.9 (24.27)	18.9 (25.77)	14.8 (22.63)	22.4 (28.25)	15.2 (22.95)	18.2 (25.25)	16.8 (24.20)	21.3 (27.49)	29.5 (32.90)	24.2 (26.47)
25	8.5 (16.95)	7.2 (15.55)	8.4 (16.85)	6.2 (14.42)	7.2 (15.55)	4.6 (12.39)	8.4 (16.85)	18.6 (25.55)	7.4 (15.79)	6.3 (14.54)	8.6 (17.05)	6.8 (15.12)	8.4 (16.85)	6.2 (14.42)	7.3 (15.68)	8.5 (16.95)	9.6 (18.05)
10	0.0 (0)	0.0 (0)	2.5 (9.10)	0.0 (0)	10.5 (18.91)	4.8 (12.66)	2.5 (9.10)	8.6 (17.05)	10.5 (18.91)	4.8 (12.66)	12.6 (20.79)	3.3 (10.47)	4.4 (12.11)	15.4 (20.2)	20.2 (26.71)	22.5 (28.32)	16.5 (23.97)
5	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	6.2 (14.42)	0.0 (0)	10.5 (18.91)	2.4 (8.91)	12.5 (20.70)	8.6 (17.05)	7.5 (15.89)	0.0 (0)	0.0 (0)	8.8 (17.26)	0.0 (0)	10.5 (18.91)	0.0 (0)
0	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	3.3 (10.47)	0.0 (0)	0.0 (0)	0.0 (0)	4.8 (12.66)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	5.3 (13.31)	0.0 (0)	8.6 (17.05)	0.0 (0)
SE(M) ±	2.77	1.54	2.59	1.24	1.52	2.46	2.77	2.16	3.12	2.18	2.01	1.16	2.05	1.77	3.62	1.13	1.62
CD 5%	5.82	3.46	5.78	2.65	3.98	5.34	5.81	4.55	6.71	4.72	4.21	2.67	4.62	3.79	7.23	2.43	4.22
1* = 60 % RH																	
2* = 70 % RH																	

Table 3. Effect of plant oils on the 2 days old pupae of Almond moth, *cadra cautella* at varying temperature and humidity

Treatment (dose) in μ l.	Pupal mortality (%)																		
	After 12 hrs exposure						After 24 hrs exposure						After 48 hrs exposure						
	20 °C	25 °C	30 °C	20 °C	25 °C	30 °C	20 °C	25 °C	30 °C	20 °C	25 °C	30 °C	20 °C	25 °C	30 °C	20 °C	25 °C	30 °C	
RH	1*	2*	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
100	34.2 (35.79)	35.5 (36.57)	45.2 (42.25)	38.4 (38.29)	40.2 (39.35)	44.6 (41.90)	40.6 (39.58)	36.6 (37.23)	49.1 (44.48)	44.6 (41.90)	48.5 (44.14)	48.5 (44.14)	75.8 (60.63)	48.5 (44.14)	70.6 (57.17)	82.2 (65.20)	75.5 (60.33)	90.6 (72.15)	86.2 (68.19)
50	25.7 (30.46)	28.4 (32.20)	27.4 (31.56)	29.5 (32.90)	34.6 (36.03)	30.5 (3.52)	35.1 (36.33)	30.4 (33.046)	34.8 (36.15)	40.2 (39.35)	40.2 (39.35)	38.6 (38.41)	52.8 (46.61)	48.6 (44.20)	61.8 (51.83)	59.3 (50.36)	75.6 (60.40)	72.4 (58.31)	
25	15.6 (923.26)	13.9 (21.89)	16.6 (24.04)	14.2 (22.14)	28.6 (32.33)	24.2 (29.47)	22.4 (29.60)	18.6 (25.55)	21.3 (27.49)	19.5 (26.21)	28.1 (32.01)	30.2 (33.34)	31.2 (33.96)	30.3 (33.40)	38.2 (38.17)	30.6 (33.58)	34.5 (35.97)	32.2 (34.94)	
10	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	12.2 (20.44)	0.0 (0)	0.0 (0)	0.0 (0)	8.6 (17.05)	0.0 (0)	12.3 (20.53)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	15.3 (23.03)	2.5 (9.10)	
5	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	6.6 (14.89)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	9.3 (17.76)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	12.5 (20.70)	0.0 (0)	
0	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	3.3 (10.47)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	3.3 (10.47)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	6.6 (14.89)	0.0 (0)	
SE(M) \pm	3.61	1.85	2.86	2.73	2.04	1.90	1.11	1.81	3.72	3.52	2.23	2.62	3.41	3.45	4.15	2.86	2.05	3.55	
CD 5%	7.83	3.92	5.93	5.71	4.17	3.81	2.46	3.86	7.86	7.41	4.91	5.53	6.92	7.05	8.61	5.78	4.21	7.46	
1* = 60 % RH																			
2* = 70 % RH																			

Table 4. Effect of plant oils on the 2 days old adults of Almond moth, *cadra cautella* at varying temperature and humidity

Treatment (dose) in µl.	Adult mortality (%)																	
	After 12 hrs exposure						After 24 hrs exposure						After 48 hrs exposure					
	20 °C	25 °C	30 °C	20 °C	25 °C	30 °C	20 °C	25 °C	30 °C	20 °C	25 °C	30 °C	20 °C	25 °C	30 °C	20 °C	25 °C	30 °C
RH	1*	2*	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
100	28.4 (26.85)	24.3 (29.53)	26.2 (30.79)	20.4 (26.85)	27.5 (31.53)	25.4 (30.26)	35.6 (37.23)	28.3 (32.14)	40.5 (39.52)	38.2 (38.17)	52.6 (46.49)	48.8 (44.31)	42.6 (40.47)	44.3 (41.73)	70.6 (57.17)	68.6 (55.92)	81.3 (64.38)	78.6 (62.44)
50	15.3 (23.03)	12.3 (20.53)	21.4 (27.56)	17.8 (24.95)	20.2 (26.71)	22.5 (28.32)	32.8 (34.94)	15.6 (23.26)	35.7 (36.69)	34.3 (35.85)	32.8 (34.94)	40.5 (39.52)	34.2 (35.79)	31.3 (34.02)	38.2 (38.17)	41.3 (39.99)	68.6 (55.92)	69.2 (56.25)
25	9.9 (18.34)	6.6 (14.89)	12.3 (20.53)	9.6 (18.05)	12.6 (20.79)	8.4 (16.85)	10.2 (20.79)	10.2 (18.63)	23.8 (29.20)	18.6 (25.55)	15.8 (23.42)	14.3 (22.22)	15.2 (22.95)	12.4 (20.62)	32.6 (34.82)	34.8 (36.15)	30.6 (33.58)	29.5 (32.90)
10	3.3 (10.47)	0.0 (0)	3.3 (10.47)	3.3 (10.47)	6.6 (14.89)	3.3 (10.47)	6.6 (14.89)	3.3 (10.47)	9.8 (18.24)	9.6 (18.05)	9.6 (18.05)	12.3 (20.53)	8.2 (16.64)	9.1 (17.56)	16.6 (24.04)	14.4 (22.30)	22.2 (28.11)	20.3 (26.78)
5	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	3.5 (10.28)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	9.2 (17.66)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	9.2 (17.66)	0.0 (0)
0	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	3.3 (10.47)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	6.7 (15.00)	0.0 (0)	0.0 (0)
SE(M) ±	2.15	3.62	0.92	1.05	2.12	0.98	1.17	1.85	1.13	1.14	2.14	1.11	1.83	1.52	1.15	1.16	1.96	1.93
CD 5%	4.63	7.85	2.13	2.52	4.56	1.92	2.46	3.72	2.31	2.35	4.60	2.21	3.64	3.98	2.38	2.42	4.25	4.11
1* = 60 % RH																		
2* = 70 % RH																		