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Efficacy of wild sage (*Lantana camara*) extracts against almond moth (*Cadra cautella*) in stored wheat (*Triticum aestivum*) seeds*

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The almond moth [*Cadra cautella* (Walker) (Lepidoptera: Phycitidae)] is one of the most economically important stored product pests. If not managed properly, this insect causes serious damage directly from larval feeding on a variety of dried fruits and stored vegetables and wheat (*Triticum aestivum* L. emend. Fiori & Paol.) seeds. Jha (2003) observed 9.8-64.8% damage in different wheat cultivars due to release of *C. cautella* larvae after 70 days of its release. Control of *C. cautella* population world-wide is primarily dependent on repeated application of contact insecticide as space and structural treatment or as protectants.

Global concern with the health and environmental impacts of synthetic pesticides, from both consumers and government agencies has led to heightened restrictions and limitations on the use of these products.Being compounds of natural origin, no problems with persistence in the environment are anticipated (Gebbinck *et al.* 2002). Thus, products based on plant extracts, phyto-oils and purified substances of plant origin can be an alternative to the conventional pesticides (Isman 2001). *Lantana camara* is an evergreen hairy shrub planted as an ornamental hedge, widely found in tropics and sub-tropics and coastal locations of Asia. It is also an important weed pest of tropical crops. Present investigation was aimed to study the effect of leaf extracts of *L. camara* against almond moth infesting 'HS 420' wheat seeds during storage.

Wild sage [*Lantana camara* (Family: Verbenaceae)] and 'HS 420' wheat were procured from Forest Research Institute campus, Dehradun and Regional station, Indian Agricultural Research Institute, Karnal, respectively, for various experiments. Insect culture of almond moth procured from storage laboratory of Entomology Division, IARI New Delhi was maintained at 27±1°C, 65–70% relative humidity on wheat flour. Dried-crushed leaves of *L.camara*, soaked in methanol/hexane for overnight, filtered and concentrated *in vacuo* under reduced temperature and greenish-viscous/ yellowish mass was obtained. The viscous portion was partitioned between hexane and aqueous methanol solvent. Concentration of hexane extract yielded dark viscous material (LC 4). The remaining aqueous methanol fraction concentrated under *vacuo*, and partitioned with ethyl acetate. The liquid phase of greenish viscous material was partitioned with hexane and aqueous methanol and greenish dark viscous material (LC 3) was obtained. Aqueous methanol was partitioned with chloroform yielded solid (LC 3).The same aqueous methanol was then partitioned with ethyl acetate, concentrated under vacuo to obtain of dark colored solid (LC 1). The left over aqueous methanol was then partitioned with butanol to obtain dark colored solid (LC 5).

Five different concentrations 0.5, 1.0, 1.5, 2.0, 5.0 g/kg of different extracts of *L. camara* leaves and *Azadirachtin* technical (50%) were used to treat the 'HS 420' wheat seeds. Required quantity of extracts weighed and dissolved in respective solvent and mixed thoroughly with the seeds in round bottom glass flask. The treated seeds were dried for 24 hr and freshly hatched 10 larvae (0–1 day old) were released in plastic box (200 ml) containing 50 g treated seeds. Each concentration and control with seeds treated with and without solvent was replicated 5 times. After 40 days number of seed damage, weight loss and per cent emergence of normal adults recorded. The seeds were subjected to roll towel method of germination test by maintaining 200 C temperature and 95%relative humidity. Per cent germination recorded and analysis was done by competely randomized

*Short note

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Table 1 Efficacy of *Lantana camara* leaf extracts against *Cadra cautella* infesting wheat

Concentration (g/kg)	Mean weight (g)	Weight loss(%)	damaged seeds	Seed damage (%)	Number of adults	Number of adults	Adult emergence (%)
1	2	3	4	5	6	7	8
				LC1			
0.5	48.43	3.14(10.12	80.20	4.71(12.49)	18.00	3.60	36.00(36.58)
1.0	48.50	3.00(9.89)	72.20	4.24(11.89)	16.00	3.20	32.00(34.46)
1.5	49.60	0.80(5.11)	58.70	3.45(10.63)	10.00	2.00	20.00(26.56)
2.0	49.72	0.56(4.29)	46.60	2.74(9.53)	8.00	1.60	16.00(23.56)
5.0	49.72	0.56(4.29)	40.00	2.35(8.89)	4.00	0.80	8.00(16.36)
Solvent	48.49	3.02(9.92)	110.00	6.47(14.63)	41.00	8.20	82.00(65.02)
Control	48.33	3.34(10.46	116.00	6.82(15.04)	44.00	8.80	88.00(69.81)
Mean	49.27	2.06(7.72)	74.81	4.39(11.87)	20.14	4.02	40.88(38.95)
SEm ±	0.61	0.60	2.41	0.80	0.89	0.61	0.87
CD (*P*=0.05)	1.42	1.40	5.57	1.85	2.05	1.42	2.01
				LC2			
0.5	48.64	2.72(9.39)	70.60	4.15(11.52)	16.00	3.20	32.00(34.46)
1.0	49.10	1.80(7.50)	68.00	4.00(11.48)	12.00	2.40	24.00(29.34)
1.5	49.31	1.38(6.39)	45.20	2.65(9.26)	8.00	1.60	16.00(23.56)
2.0	49.32	1.36(6.31)	28.00	1.64(7.10)	4.00	0.80	8.00(16.36)
5.0	49.62	0.76(5.00)	4.00	0.23(2.75)	00.00	00.00	00.00(00.00)
Solvent	48.49	3.02(9.59)	110.00	6.36(14.51)	41.00	8.20	82.00(64.95)
Control	48.33	3.34(10.46	116.00	6.82(15.04)	44.0 0	8.80	88.00(69.94)
Mean	48.97	2.05(7.80)	63.11	3.69(10.20)	17.85	3.57	35.71(34.08)
SEm ±	0.71	1.10	1.20	0.97	0.75	0.66	0.89
CD (*P*=0.05)	1.64	2.55	2.78	2.25	1.74	1.53	2.06
				LC3			
0.5	48.50	3.00(9.55)	86.70	5.10(13.02)	30.00	6.00	60.00(50.88)
1.0	49.00	2.00(6.56)	46.00	2.70(9.35)	18.00	3.60	36.00(36.67)
1.5	49.56	0.88(5.39)	29.00	1.70(7.50)	13.00	2.60	26.00(30.67)
2.0	49.60	0.80(5.13)	13.00	0.76(5.00)	5.00	1.00	10.00(18.44)
5.0	49.66	0.68(4.73)	2.60	0.15(2.22)	00.00	00.00	00.00(00.00)
Solvent	48.49	3.02(9.92)	110.00	6.47(14.63)	41.00	8.2	82.00(65.02)
Control	48.33	3.34(10.46	116.00	6.82(15.04)	44.00	8.8	88.00(69.81)
Mean	49.02	1.96(7.39)	57.61	3.38(9.53)	21.57	4.3	43.14(38.78)
SEm ±	0.56	1.30	2.13	0.70	0.69	0.69	0.89
CD (*P*=0.05)	1.29	3.01	4.93	1.63	1.59	1.59	2.36
				LC4			
0.5	49.50	1.00(4.63)	36.60	2.15(8.27)	7.00	1.40	14.00(21.95)
1.0	49.87	0.29(2.92)	25.20	1.48(6.68)	3.00	0.60	6.00(14.06)
1.5	49.87	0.26(2.92)	25.00	1.47(6.65)	00.00	00.00	00.00(00.00)
2.0	49.87	0.26(2.92)	17.20	1.01(4.83)	00.00	00.00	00.00(00.00)
5.0	50.00	0.00(0.00)	00.00	00.00(00.00	00.00	00.00	00.00(00.00)
Solvent	48.49	3.02(9.92)	110.00	6.47(14.63)	41.00	8.20	82.00(64.93)
Control	48.32	3.34(10.46	116.00	6.82(15.04)	44.00	8.80	88.00(69.81)
Mean	49.41	1.20(4.82)	47.15	2.77(8.01)	13.57	2.71	27.14(24.39)
SEm ±							
CD (*P*=0.05)	0.56		3.40	1.17	0.64	0.50	0.62
				LC5			
0.5	48.52	2.96(9.82)	69.40	4.08(11.41)	21.00	4.20	42.00(40.42)
1.0	48.54	2.92(9.75)	65.00	3.82(11.21)	14.00	2.80	28.00(31.96)
1.5	48.58	2.84(9.58)	60.00	3.52(10.58)	14.00	2.80	28.00(31.96)
2.0	49.28	1.44(6.56)	9.50	0.55(4.26)	8.00	1.60	16.00(23.56)
5.0	49.65	0.70(4.80)	8.00	0.47(3.93)	00.00	00.00	00.00(00.00)
Solvent	48.49	3.02(9.92)	110.00	6.47(14.63)	41.00	8.20	82.00(64.95)
Control	48.33	3.34(10.4	116.00	6.82(15.04)	44.00	8.80	88.00(69.81)

Continued

Table 1 concluded

1	2	3	4	5	6	7	8
Mean	48.76	2.46(8.69)	62.55	3.67(10.15)	20.28	4.03	40.57(37.52)
SEm ±	0.71	0.82	1.91	0.88	1.15	0.60	0.53
CD (*P*=0.05)	1.63	1.89	4.40	2.04	2.66	1.40	1.23
				Raw powder			
0.5	48.50	3.00(9.89)	70.80	4.16(11.72)	30.00	6.00	60.00(50.88)
1.0	48.95	2.10(8.17)	54.00	3.17(10.18)	20.00	4.00	40.00(39.17)
1.5	49.00	2.00(7.95)	50.00	2.30(8.58)	18.00	3.60	36.00(36.76)
2.0	49.00	1.50(6.73)	42.00	2.47(8.92)	10.00	2.00	20.00(26.08)
5.0	49.25	0.60(4.43)	39.00	2.30(8.58)	7.33	1.40	14.00(21.98)
Solvent	48.49	3.02(9.92)	110.00	6.47(14.63)	41.00	8.20	82.00(64.95)
Control	48.33	3.54(10.3)	116.00	6.82(15.04)	44.00	8.80	88.00(69.81)
Mean	48.88	2.25(8.20)	68.85	3.95(11.09)	24.33	4.85	48.52(44.23)
SEm ±	0.47	1.09	1.83	0.89	0.92	0.83	2.30
CD (*P*=0.05)	1.08	2.52	4.23	2.13	2.05	1.92	5.30
				Azadirachtin			
0.5	49.66	0.68(4.64)	45.33	2.66(9.28)	8.00	1.60	16.00(23.56)
1.0	50.00	0.00(00.0)	00.00	00.00(00.00	00.00	00.00	00.00(00.00)
1.5	50.00	0.00(00.0)	00.00	00.00(00.00	00.00	00.00	00.00(00.00)
2.0	50.00	0.00(00.0)	00.00	00.00(00.00	00.00	00.00	00.00(00.00)
5.0	50.00	0.00(00.0)	00.00	00.00(00.00	00.00	00.00	00.00(00.00)
Acetone	48.49	3.02(9.92)	110.00	6.47(14.60)	41.00	8.2	82.00(65.02)
Control	48.33	3.34(10.5)	116.00	6.82(15.04)	44.00	8.8	88.00(69.81)
Mean	49.49	1.00(3.57)	38.76	2.27(5.56)	13.28	2.65	26.57(22.62)
SEm ±	0.50	0.41	1.82	0.67	0.61	0.53	0.68
CD (*P*=0.05)	1.16	0.96	4.21	1.54	1.42	1.23	1.56

Figures in parentheses are angular transformed values

design and the significance was tested at 5 % level.

Results showed that weight loss was maximum in control (3.34%) and acetone treatments (3.02%) and it was decreased as treatment concentrations were increased in all the treatments (Table 1). When percentage weight loss of wheat seeds after treatment with various extracts were compared at lowest concentration of 0.5 g/kg, it was observed that only 1% loss occurred with LC 4 extract. Minimum weight loss was observed with azadirachtin, followed by LC 4 extracts, whereas with other extracts loss ranged between 2.00 and 3.26%. As the dose increased to 1.0 and 1.5 g/kg again activity of LC 4 was best among the various extracts of *L. camara* and minimum percentage weight loss was observed. Although the percentage weight loss was reduced much as treatment concentration increased to 2.0 and 5.0 g/kg but the activity of LC 4 gave lowest percentage weight loss.

Patel and Patel (2002) also observed that mixing of *L. camara* powder in stored rice @ 2% was effective to reduce weight loss (17.70%) compared to control (22.7%) due to *C. cephalonica* infestation. Dwivedi and Garg (2003) also reported that application of different concentration of *Lantana* flower extract significantly reduced weight loss (14.47%) when compared with control (50.24%). Present data showed that 6–7% seed damage was observed with control and it was reduced with the treatments of extracts in dose dependent manner. Although seed damage was observed with various extracts at 0.5 g/kg dose but it was lowest with extract LC 4 (2.14%) compared to control (6.82%) whereas per cent seed damage with other extracts ranged between 4 and 5%. As the treatment doses were increased to 1 g/kg along with extract LC 4, LC 3 also showed reduced percentage weight loss. At maximum treatment dose of 5 g/kg seed damage was not observed with extract LC 4 and seed damage was observed only as 0.15 and 0.23% with extract LC 3 and LC 2, respectively. At highest dose extract LC 5 also showed only 0.47% seed damage. With extract LC 1 and raw powder treatment significant reduction of seed damage could not be observed.

After 40 days of treatment number of emerged adults were recorded and results showed that as the doses of LC 4 increased from 0.5 g/kg to 1 g/kg, the adult emergence reduced from 14% to 6% and no emergence was observed at 1.5 g/kg as compared to 88% emergence in control. Adult emergence was reduced with higher doses of other extracts and with highest treatment dose of 5 g/kg except LC_1 extract and raw powder treatment adult emergence could not be observed with any of the extracts. Singh *et al.* (1996) who tried 3% of *L. camara* extract against *Rhyzopertha dominica* found it and most effective in term of reducing adult emergence. Per cent germination of wheat seeds after treatment with extracts of *L. camara* was compared at various treatment doses and it was observed that although the per

Table 2 Effect of different fraction, raw powder of *L. camara* and azadirachtin on germination of wheat seeds

Dose (g/kg)	LC1	LC2	LC3	LC4	LC5	Raw powder	Azadirachtin
0.5	90.00	90.50	92.50	91.50	92.50	92.00	95.25
	(71.62)	(72.10)	(74.23)	(73.10)	(74.23)	(73.63)	(77.50)
1.0	89.50	87.50	90.00	90.50	91.00	91.25	93.00
	(71.14)	(69.34)	(71.62)	(72.10)	(72.60)	(72.85)	(74.72)
1.5	88.50	88.00	87.00	88.25	88.75	88.00	89.50
	(70.26)	(69.81)	(68.91)	(70.03)	(70.49)	(69.81)	(71.14)
2.0	86.50	86.50	86.00	86.25	86.50	86.75	88.50
	(68.49)	(68.51)	(68.09)	(68.30)	(68.51)	(68.72)	(70.22)
5.0	85.00	85.80	85.00	85.50	84.50	85.00	86.00
	(67.25)	(67.93)	(67.25)	(67.66)	(66.88)	(67.25)	(68.07)
Control	90.00	91.25	95.00	92.00	91.00	89.00	90.58
	(71.62)	(72.85)	(77.16)	(73.63)	(72.60)	(70.68)	(72.18)
Acetone	89.00	90.00	92.25	90.50	91.25	90.75	89.00
	(70.68)	(71.62)	(73.96)	(72.10)	(72.85)	(72.35)	(70.68)
Mean	88.35	88.46	89.67	89.21	89.35	88.96	90.19
	(70.14)	(69.91)	(71.60)	(70.99)	(71.03)	(70.75)	(72.05)
SEm±	0.50	1.05	0.71	0.58	0.64	0.58	0.46
CD (*P*=0.05)	1.17	2.43	1.65	1.34	1.49	1.33	1.07

Figures in parentheses are angular transformed values

cent germination after treatment was reduced compared to control but it was >85%. At the lowest dose of 0.5%, germination was up to 92%.

Thus, extract LC 3 and LC 4 were found to be very effective against all the stages of *C. cautella*. These 2 extracts were most effective to check the damage of seeds and development of insects. The extracts of *L. camara* was positively toxic to insects. It showed ovicidal activity also. The greater efficacy of high concentrations of extracts and plant powder with seeds could be combined effect of greater concentration as well as closer proximity of active ingredient to the target insects.

SUMMARY

An experiment was conducted during 2007–08 to evaluate the seed protectant activity of *Lantana camara* leaves extracts against almond moth [*Cadra cautella* (Walker)]. Wheat seeds were treated with different extracts/fractions with 0.5, 1.0, 1.5, 2.0, 5.0 g/kg and freshly emerged larvae were released based on parameters, like per cent weight loss, per cent seed damage and per cent adult emergence. Efficacy of extracts of *L. camara* on wheat seeds were studied to control infestation of *C. cautella* and it was found that per cent weight loss and seed damage was reduced as the treatment concentration was increased. Among the various extracts LC 4 hexane extract (hexane fraction) showed maximum reduction in percentage weight loss. At higher doses of 2 and 5 g/kg all extracts showed reduced per cent seed damage but efficacy of extract LC 4 showed significant low per cent seed damage with doses 0.5, 1.0, 1.5gm/kg. Adults emergence could not be observed with highest treatment concentration (5 g/kg) of all the extracts.

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