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EFFECT OF PLANT POWDERS ON FECUNDITY, EGG VIABILITY AND LONGEVITY OF ADULTS OF *CORCYRA CEPHALONICA* STAINTON (LEPIDOPTERA: PYRALIDAE)

B.L. MEENA, K.L. JEENGAR AND M.C. BHARGAVA

Krishi Vigyan Kendra, Jhalawar, Agriculture University, Kota (Rajasthan) 326 001
E-mail: blmpuat@gmail.com

ABSTRACT

Ten plant powders *viz., dharak* kernel and leaf (*Melia azadirach*), neem kernel and leaf (*Azadirachta indica*), *karanj* kernel (*Pongamia glabra*), *aak* leaf (*Calotropis procera*), *datura* leaf (*Datura alba*), citrus leaf (*Citrus lemon*), *podina* leaf (*Mentha arvensis*) and *tulsi* leaf (*Ocimum sanctum*) @ 1.0, 2.5 and 5.0 g per 100 g seeds were tested to evaluate the effect on fecundity, egg viability and longevity of adults of *Corcyra cephalonica* under laboratory conditions. All the doses of the test compounds were effective in reducing the fecundity. The maximum and minimum per cent reduction in fecundity was 58.53 and 20.91 for seeds treated with *karanj* kernel powder and *tulsi* leaf powder, respectively. The reduction in egg viability varied from 17.46 to 29.41 per cent and 13.78 to 35.17 per cent in different doses and treatments. The maximum reduction in egg viability was observed on seeds treated with *dharak* kernel powder (44.32%) at its highest dose of 5.0g/ 100 g seeds (w/w). The longevity of male and female adults decreased when treated food was given. Assessing the results of different plant powders, it was observed that *dharak* kernel powder and *neem* kernel powder were most effective in reducing the longevity of male and female adults. The kernel powders of *neem*, *karanj* and *dharak* were most effective, while *tulsi* leaf powder was least effective in reducing the fecundity, egg viability and longevity of adults. No adverse effect of tested plant powders was observed on the germination of sorghum seeds up to 150 days after treatment. The results suggest that these plant products have the potential to be used for post-harvest protection against *C. cephalonica*, one of the major pests of stored grains.

Key words: *Corcyra cephalonica,* Reproductive potential, Fecundity, Egg viability, Plant powders.

INTRODUCTION

Amongst the various stored grain insect-pests, rice moth, *Corcyra cephalonica* Stainton (Lepidoptera: Pyralidae) is cosmopolitan in distribution and causes serious damage to the stored grains (Singh and Mishra, 1989; Patel and Patel, 2007 and Yadav *et al.*, 2011). The excreta, exuviae and dead bodies also get mixed up in the food stuff; hence, loss is both quantitative and qualitative, therefore, effective protection strategies for long term storage are required. Presently, control measures for the *C. cephalonica* include chemical insecticide, fumigation and biological control. These methods are expensive and cannot be afforded by the small-scale farmers in developing countries. Success achieved so far in making the stored products free from pests has been largely dependent on pesticides alone. Pesticides are the most powerful tool available for pest control. Despite these credentials, long and indiscriminate use of pesticides is ecologically unsound. Controlling them with chemicals is a serious concern as it leads to environmental contamination and health hazards (Tillman and Mulrooney, 2000).

One of the eco-friendly and economic approaches to keep the stored food grains free from insect attack could be using plant products as grain protectants. Use of naturally occurring or locally available plant materials to protect agriculture produce from insect pests is an age-old common tradition in many parts of the world (Mukanga *et al*., 2010 and Khani *et al.,* 2013). Plants with insecticidal properties offer a cheaper and sustainable alternative to synthetic insecticides, store design, fumigation and thermal distribution methods. The insecticidal specificity of some plant extracts and their lack of negative impacts on the food and the environment make them ideal candidates for incorporation into an integrated pest management

Corresponding address: Dr. B.L. Meena, Krishi Vigyan Kendra, NH-12, In front of Housing Board, Distt.- Jhalawar (Raj.) 326 001

strategy. Exact quantities of active ingredients from these plants that give optimum insecticidal effects are unknown; thus, it is desirable to quantify the amount of the plant derived materials that provide adequate protection against insect pests and to determine how these affect insect behaviour, growth and reproduction (Meena and Bhargava, 2005). Encouraging reports on the use of certain indigenous plant products as grain protectants have been documented (Pathak and Tiwari, 2010 and Yadav *et al*., 2011). The use of powders aromatized with essential oils has a two-fold advantage due to combined effects of mechanical action and blocking the insect's articulations (Ramaswamy *et al.,* 1995; Mukanga *et al.*, 2010).

In case of rice moth, little information is available with regard to the efficacy of indigenous plant materials. The purpose of our study was to make a comparative study of the biocidal effects of plant powders and their effect on some biological parameters of the test insect.

MATERIALS AND METHODS

The experiment was conducted under laboratory conditions in the Department of Agricultural Zoology and Entomology, S.K.N. College of Agriculture, Jobner, Rajasthan ($75^0$28' East longitude, $26^0$05' North latitude). The eggs of rice moth were obtained from the Bio-control Research Laboratory, Pest Control (India) Ltd., Bangalore. *C. cephalonica* eggs (1 cc containing approximately 16000–18000 eggs) were released in 3 kg of broken sorghum grains. The culture was maintained in glass jars lined with black folded thick paper on the sides and blotting paper at the bottom. These glass jars were kept at 28 ± 1^0C and 70 ± 5 percent relative humidity. The chamber was covered with double layer of muslin cloth after releasing freshly emerged active adults. Most of the eggs were laid between the double layer of muslin cloth from where these were collected daily with the help of a soft camel hair brush and kept in separate petri dishes. The time and date of egg-laying were recorded in order to select the eggs of known age that ensured continuous supply of eggs needed for the present study.

For the study of reproductive potential, five pairs of newly emerged adults were released into a jar containing 100g sorghum seeds treated with different doses (1.0, 2.5 and 5.0 g/ 100 g seeds) of all the test compounds *viz*. *dharak* kernel and leaf (*Melia azadirach*), *neem* kernel and leaf (*Azadirachta indica*), *karanj* kernel (*Pongamia glabra*), *aak* leaf (*Calotropis procera*), *datura* leaf (*Datura alba*), citrus leaf (*Citrus lemon*), *podina* leaf (*Mentha arvensis*) and *tulsi* leaf (*Ocimum sanctum*) powders. Each treatment was replicated three times. For recording the fecundity, adults emerged from the larvae developed on treated food, were kept in separate jars for egg laying. The total number of eggs laid by each female was counted daily till the death of female in each treatment. For egg viability, a random sample of 50 eggs were taken from each replication and placed in separate container. The eggs hatched or unhatched were counted with the help of binocular microscope. The longevity of male and female adults and total number of adults that emerged from treated food with different doses of test compounds were recorded. The data obtained were statistically analysed. The response of the test insects in the treated food were corrected using the modified Abbott's formula given as:

$$\text{Corrected Mortality (\%)} = 100 \times \frac{\text{(Number of insects in treatment} - \text{Number of insects in control)}}{\text{(Number of insects in control)}}$$

The data obtained on various characters/parameters were subjected to analysis of variance as applicable for completely randomized design (CRD). The level of significance used in 'F' test was P=0.05; wherever F calculated was significant, critical difference values were calculated for treatment comparisons. The values obtained in percentages were transformed into angular values and subjected to analysis of variance (ANOVA).

RESULTS AND DISCUSSION

In the present investigation, all the doses of different powdered plant products were significantly better in reducing the fecundity over untreated check (Table 1). The per cent reduction in fecundity of test insect on treated seeds increased with the increase in dose level of each treatment. The mean per cent reduction in egg laying capacity ranged from 28.11 to 47.37 in different doses and 20.91 to 58.33 in different treatments. *Karanj* kernel powder (58.53%) was the most effective in reducing the fecundity. These results are in accordance with those of Khan and Thakare (1997) and Patel and Patel (2002), who reported that fecundity of *C. cephalonica* exposed to treated grains was significantly reduced due to *neem* leaves and seed powders. This reduction in fecundity may be attributed to the toxic effect of the tested plant powders in the experiment, the fine powder may also cause physical injury and block the spiracles, thereby affecting the normal physiology of the insects. Deterrence and inhibition on egg hatchability of citrus leaf powder on oviposition of *C. maculatus* was reported by Don- Pedro (1985) and insecticidal action of *neem* seed acetone extract against the life cycle stages of *C. cephalonica* was reported by Pathak and Tiwari (2012). Similarly, Pandey *et al*., (1985) and Naik and Dumbre (1984) reported significant reduction in oviposition of *C. cephalonica* and *C. maculatus* when exposed to *neem* products.

All the tested doses (1.0, 2.5 and 5.0 g/ 100 g seeds) of different plant powders were significantly better at 5 percent level in reducing the egg viability over control

Table 1. Effect of powdered plant products in fecundity of adult on treated food of *C. cephalonica*

Dose (Parts per 100 parts of grain w/w)	Per cent reduction in fecundity *										
	Dharak kernel powder	Neem kernel powder	Dharak leaf powder	Karanj kernel powder	Neem leaf powder	Aak leaf powder	Datura leaf powder	Citrus leaf powder	Podina leaf powder	Tulsi leaf powder	Mean
1.0	34.60 (36.03)**	37.98 (38.05)	26.02 (33.67)	46.17 (42.80)	32.38 (34.69)	24.48 (29.66)	21.97 (27.95)	25.50 (30.33)	18.13 (25.20)	13.82 (21.83)	28.11 (32.02)
2.5	46.23 (42.84)	50.48 (45.28)	43.98 (41.54)	58.67 (49.99)	47.90 (43.85)	35.80 (36.75)	30.68 (33.64)	30.60 (33.58)	25.97 (30.64)	22.86 (28.56)	39.08 (38.67)
5.0	56.00 (48.45)	60.67 (51.16)	52.46 (46.41)	70.25 (56.95)	54.13 (47.37)	45.00 (42.13)	38.83 (38.55)	37.90 (38.00)	32.38 (34.69)	26.90 (31.24)	47.37 (43.49)
Mean	45.53 (42.44)	49.70 (44.83)	42.25 (40.54)	58.53 (49.91)	44.72 (41.97)	34.85 (36.18)	30.27 (33.38)	31.22 (33.97)	25.27 (30.18)	20.91 (27.21)	
		S. Em. ±		C.D. (5%)		C.V. (%)					
Treatment		0.38		1.06							
Dose0.21		0.58		3.06							
Treatment x Dose		0.65		1.84							

* Data based on 15 pairs (Three replications of 5 pairs in each). ** Percentage transformed to angles; outside values are its back transformation to percentages.

Table 2. Effect of powdered plant products on reduction in egg viability on treated food of *C. cephalonica*

Dose (Parts per 100 parts of grain w/w)	Per cent reduction in egg viability *										
	Dharak kernel powder	Neem kernel powder	Dharak leaf powder	Karanj kernel powder	Neem leaf powder	Aak leaf powder	Datura leaf powder	Citrus leaf powder	Podina leaf powder	Tulsi leaf powder	Mean
1.0	26.67 (31.09)**	23.98 (29.32)	23.70 (29.13)	17.97 (25.08)	20.33 (26.80)	16.32 (23.83)	13.96 (21.94)	11.64 (19.95)	12.32 (20.55)	10.94 (19.32)	17.46 (24.70)
2.5	34.98 (32.26)	32.33 (34.65)	31.98 (34.44)	28.67 (32.37)	26.67 (31.09)	22.07 (28.02)	20.33 (26.80)	15.34 (23.05)	15.96 (23.55)	14.65 (22.50)	23.93 (29.29)
5.0	44.32 (41.74)	40.67 (39.62)	40.98 (39.81)	36.67 (37.07)	31.98 (34.44)	26.67 (31.09)	22.97 (28.64)	18.31 (25.34)	20.66 (27.03)	15.96 (23.55)	29.41 (32.84)
Mean	35.17 (36.37)	32.13 (34.53)	33.02 (34.46)	27.32 (31.51)	26.18 (30.78)	21.63 (27.71)	18.94 (25.80)	15.00 (22.79)	16.17 (23.71)	13.78 (21.79)	
Control 6.65 (14.95)											
		S. Em. ±		C.D. (5%)		C.V. (%)					
Treatment		0.32		0.91							
Dose0.18		0.50		3.41							
Treatment x Dose		0.56		1.58							

* Data based on 150 eggs (Three replications of 50 in each). ** Percentage transformed to angles; outside values are its back transformation to percentages.

Table 3. Effect of powdered plant products on longevity of male and female adults on treated food of *C. cephalonica*

Dose (Parts per 100 parts of grain w/w)	Longevity of male and female adults (days)*																	
	Dharak kernel powder		*Neem* kernel powder		*Dharak* leaf powder		*Karanj* kernel powder		*Neem* leaf powder		*Aak* leaf powder		*Datura* leaf powder		Citrus leaf powder		*Podina* leaf powder		*Tulsi* leaf powder		Mean	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1.0	5.60	7.10	5.20	6.85	5.80	7.45	5.95	7.00	6.00	7.70	6.20	7.95	6.33	6.90	6.00	8.00	6.50	8.10	6.60	8.33	6.02	7.54
2.5	5.00	6.28	4.90	6.00	5.35	6.75	5.65	6.55	5.45	6.90	6.00	6.80	6.20	6.75	5.90	7.65	6.30	7.35	6.45	7.85	5.71	6.89
5.0	4.85	5.40	4.15	4.45	5.05	5.85	5.00	5.90	5.15	6.55	5.60	6.30	5.85	6.45	5.65	6.60	6.00	6.70	6.10	6.90	5.35	6.12
Mean	5.18	6.26	4.72	5.77	5.40	6.68	5.53	6.48	5.53	7.05	5.93	7.02	6.12	6.70	5.85	7.44	6.27	7.38	6.38	7.69		
Control (male) 6.60 , (female) 8.33																						

	Male			Female		
	S. Em. ±	C.D. (5%)	C.V. (%)	S. Em. ±	C.D. (5%)	C.V. (%)
Treatment	0.06	0.16	3.22	0.10	0.29	4.54
Dose	0.03	0.09		0.06	0.16	
Treatment x Dose	0.10	0.28		0.18	0.51	

* Data based on 75 individuals (Three replications of 25 in each) M = Male, F = Female

(Table 2). The results revealed that in untreated seeds 6.65 per cent reduction in egg viability occurred; whereas, the mean per cent reduction in egg viability varied from 17.46 to 29.41 and 13.78 to 35.17 for different doses and treatments, respectively. The maximum reduction in egg viability was observed on seeds treated with *dharak* kernel powder (44.32%) at highest dose 5.0 g/ 100 g seeds (w/w). Pandey *et al.* (1985) and Meena and Bhargava (2010) reported significant reduction in egg hatchability of *C. cephalonica* by the treatments of *neem* kernel powder and *neem* leaf powder at the dose level of 1.0 g/ 100 g seeds.

It is apparent from the data that the longevity of male and female adults gradually decreased with the increase in dose level of the treatments. It was observed that *dharak* kernel powder and *neem* kernel powder were most effective in reducing the longevity of male and female adults (Table 3). Pandey *et al.* (1985), Khan and Thakare (1997) and Jain and Kumar (2001) found significant effect of *neem* kernel powder and *neem* leaf powder (5%) on the longevity of male and female adults of *C. cephalonica*. Pacheco *et al.* (1995) and Rajapakse and Vanemden (1997) have also demonstrated the effectiveness of treatment with *neem*, soybean and castor oils at the rate of 0, 5 and 10 ml/ kg seed against *Callosobruchus maculatus* in reducing longevity and egg lying without affecting the germination of seeds. Yadav *et al.* (2011) also reported the efficacy of different botanicals like *neem*, *karanj*, castor, *tulsi* in both powder and oil form on the development of *C. cephalonica*.

In the present study, the effect of ten plant powders on germination of sorghum seeds revealed no significant harmful effect as observed after 0, 90 and 150 days of treatment. There was no adverse effect of any of the tested dose of the plant powders on the germination of sorghum seeds at any interval. Earlier, Prakash *et al.* (1984), Yadav and Bhatnagar (1987) and Chiranjeevi (1991) found no adverse effect of different plant powders on germination of different grains. Pacheco *et al.* (1995) and Rajapakse and Vanemden (1997) have also demonstrated the effectiveness of treatment with different plant oils against *Callosobruchus maculatus* in reducing longevity and egg lying without affecting the germination of seeds.

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