Biological Forum – An International Journal **16(2): 60-64(2024)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Host Preference of Tobacco Beetle, *Lasioderma serricorne* (Fab). on Different Stored Spices

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(Received: 05 December 2023; Revised: 23 December 2023; Accepted: 04 January 2024; Published: 15 February 2024)
(Published by Research Trend)

ABSTRACT: Spices meet the requirement of carbohydrate, fat, protein, and micronutrient in the diet. Spices are low volume and high value commodities in the multi-billion-dollar trade and transactions among the agriculture commodities. Insects are the major causal agents for postharvest losses of stored spices and their products in storehouses. The tobacco beetle, *Lasioderma serricorne* Fab., is a major pest of stored spices, and its host preference of tobacco beetle to different spices *viz.*, fennel, coriander, ajwain, cumin, turmeric rhizome, red chilli powder, mustard and black pepper was investigated in the storage laboratory of the Department of Entomology at the Odisha University of Agriculture and Technology. Results showed that coriander was the most preferred host for oviposition, and the shortest developmental period and highest adult longevity were also observed on coriander. The longest life cycle was observed on black pepper. Fennel and coriander had the highest weight loss due to infestation, while black pepper had the lowest. Coriander and fennel were categorized as highly susceptible, while mustard and black pepper were categorized as highly resistant.

Keywords: Tobacco beetle, *Lasioderma serricorne*, host preference, spices, biology.

INTRODUCTION

Spices have been an essential part of culinary art for centuries. They not only add flavor, color, and fragrance to the dishes but also offer several health benefits. Spices meet the requirements of carbohydrate, fat, protein, and micronutrients in the diet also aid in digestion by enhancing the secretion of saliva. In addition, spices possess anti-inflammatory, antioxidant, anti-carcinogenic, and anti-atherosclerotic properties that have been proven to be beneficial for biological systems (Krishnaswamy, 2008).

India, the land of spices, is the largest producer, consumer, and exporter of spices globally, with 50 different spices grown within the country (Pruthi, 2011). India accounts for 46% of the total volume and 23% of the total value of spice exports worldwide (Spice Board, 2021). However, despite being a major player in the multi-billion-dollar trade and transactions among agriculture commodities, post-harvest losses are a significant concern. Insects are the primary cause of these losses, accounting for 2.5 percent of them, followed by rodents, fungi, and other microbes, which together contribute about 17 to 25 percent of the powder converted from the seed (Malhotra, 2007). Tobacco beetle, *Lasioderma serricorne* (Fabricius) (Coleoptera: Anobiidae), is a serious pest found to cause damage, develop, and breed on a wide range of high-value stored commodities, including spices and tobacco, during manufacturing, storehouses, and retail stores (Dimetry *et al.*, 2004). This is the major pest of tobacco, besides causing damage to coriander, fennel, cumin, ajwain, and dill seeds (Kant *et al.*, 2013), turmeric (Nischala and Prasad 2017). Also, this insect infests red chili powder and loungchilli (Memon *et al.*, 2017).

In order to carry out any successful management practices for a pest, detailed and explicit knowledge of the insect's biological parameters has become the indispensable foundation upon which other IPM strategies function. Besides, accurate knowledge about the preference of the insect towards which it causes comparatively more losses is required. The present study focuses on the host preference of the tobacco beetle by studying its biology, feeding preference, growth index and percent weight loss caused by tobacco beetle on different stored spices and categorizing them based on the index of susceptibility.

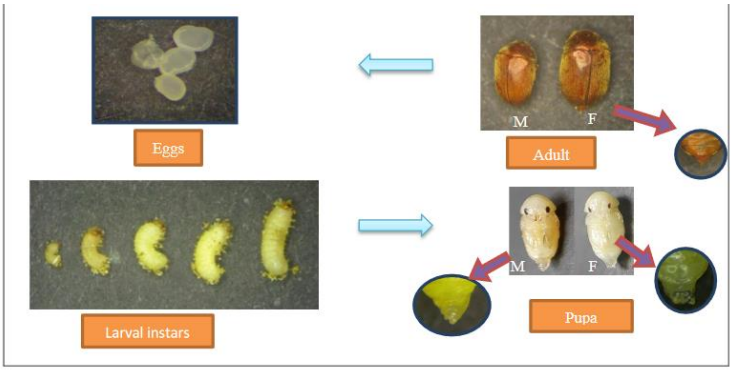
MATERIALS AND METHODS

Different spices, such as coriander (*Coriandrum sativum*), turmeric rhizome (*Curcuma longa*), red chilli powder (*Capsicum annum*), fennel (*Foeniculum*

vulgare), mustard (*Brassica nigra*), black pepper (*Piper nigrum*), ajwain (*Trachyspermum ammi*) and cumin (*Cuminum cyminum*), were acquired from the local market for the experimental purpose. The purchased commodities were kept at 55 °C in a hot air oven for 4 hours to kill the infestation of insects and other pathogens.

Insect culture: To provide a continuous supply of the tobacco beetle, *Lasioderma serricorne*, throughout the experiment, the mass multiplication of the test insect was carried out in the storage laboratory, Department of Entomology, College of Agriculture, OUAT, Bhubaneswar. Sexual differences in adults were identified by examining the genital apodeme. The adult female apodeme was long and V-shaped, and the males were small and U-shaped.

Biology: To study the different life stages of *L. serricorne*, 50 grams of eight different spices were taken in separate plastic containers (length 6cm and diameter 8 cm). Recently emerged five pairs of adults were incubated in each container and stored in the BOD at 30 ± 2°C and 70 percent relative humidity. The released adult beetles were removed after 7-day period, and adult longevity was recorded.



Host preference: For ovipositional preference, 10 g of each spice selected as a food source was taken on a petri plate. A single pair of tobacco beetles was released on the petri plates. Fecundity was calculated by counting the eggs laid by an individual female daily until their death. For feeding preference, the petri plates of size 1.5cm x 15cm were taken and equally separated into eight chambers, with the small plastic cup in the center for the release of insects. In each separate compartment, 10 grams of eight spices were kept. In order to provide an equal choice of selection and feeding, fifty adult insects from the insect culture were taken and released in the center. About 50 g of each spice was taken in a plastic container, and 10 pairs of two- to three-day-old beetles taken for the insect culture were released in each container. Observations were recorded initially and finally after 90 days of adult release. Percent weight loss was calculated. The number of eggs laid and the number of adults that emerged from the eggs were noted. The adult emergence percentage was calculated.

$$\text{Adult emergence \%} = \frac{\text{No. of adult emerged}}{\text{Total number of eggs laid}} \times 100$$

The mean development of the test insects for eight spices was worked out by following the Howe (1957) formula.

$D = \Sigma (A \times B) \div C$

Where, D = mean developmental period (days)

A = number of adults emerged on n^{th} day

B = n days required for adult emergence.

C = the total number of adults that emerged during the experiment.

The growth index of the test insect for each spice was calculated using the formula given by Howe (1957).

$$\text{Growth index} = \frac{N}{AV}$$

Where, N = adult emergence percent

AV = mean developmental period (days).

The index of susceptibility of eight stores was obtained by using the formula given by Dobie (1977).

$$I = \frac{\log eF}{D} \times 100$$

I = Index of susceptibility

F = Total number of adults emerged from egg laid

D = mean developmental period (days)

Categorization of stored spices. Based on the susceptibility of *L. serricorne*, eight different spices used in the experiment were grouped into four categories: susceptible, highly susceptible, resistant, and highly resistant. The mean value of the individual spices was compared with the mean value of all spices and the standard deviation by following the scale adopted by Patel *et al.* (2002) for categorization of test spices.

S. No.	Category of resistance	Scale of resistance
1.	Highly Susceptible (HS)	$\overline{X}_i > (\overline{X} + sd) < (\overline{X} + 2\ sd)$
2.	Susceptible (S)	$\overline{X}_i > \overline{X} < (\overline{X} + sd)$
3.	Resistant (R)	$\overline{X}_i > \overline{X} - sd < \overline{X}$
4.	Highly Resistant (HR)	$\overline{X}_i < (\overline{X} - sd) > (\overline{X} - 2\ sd)$

RESULT AND DISCUSSION

The incubation period on different test spices varied between them, with the shortest on coriander (7.23 days) and the longest on black pepper (10.76 days) at a constant temperature of 30ºC ± 1ºC and a relative humidity of 70 ± 1 percent. Naveena and Roseleen (2019) also recorded the incubation period of cigarette beetles on turmeric powder, chilli powder, and turmeric

rhizome to be 9.40 ± 0.40 days, 7.4 ±0.5 days, and 7.2 ± 0.49 days, respectively.

The total larval period was the shortest when reared on coriander (31.55 days), followed by fennel (32.88 days), and the longest on black pepper (50.33 days). Suneethamma *et al.* (2017) also reported the average larval duration to be the lowest on coriander with 27.83 days, followed by 28.90 days on fennel, which supports our present findings. The pupal period was observed to have the longest duration in black pepper (12.12 days), followed by mustard (11.44 days), and the shortest was observed in coriander (8.56 days), followed by fennel (8.78 days), as reported by Zanuncio *et al.* (2014), who reported that the tobacco beetle completed its pupal period in 4.6 to 18.3 days.

Adult longevity was found to vary with sex and the host on which they fed. The longevity of female adults was comparatively longer than that of males. The female longevity was in the range of 11.45 to 24.11 days, with the longest in coriander (24.11 days) and the shortest in black pepper (11.45 days), followed by mustard (13.11 days). The male longevity ranged from 10.33 days to 19.67 days, with the longest observed on coriander, followed by fennel and red chilli with 19.67, 18.33, and 17.67 days, respectively, whereas the shortest was in black pepper with 10.33 days. Naveena and Roseleen (2019) reported male and female longevity to be 11 days, 13 days and 11.20 ± 0.55 and 12.40 ± 0.60 days, respectively.

The life cycle varied with sex and different spices, being the shortest in coriander followed by red chilli powder and fennel with 70.23, 70.88, and 72.01 days, respectively and the longest in black pepper (84.21 days) in female. In male life cycle was the shortest in coriander (67.23 days) and fennel (68.34 days) and red chilli powder (68.88 days). The longest life cycle was recorded in black pepper (82.54 days). The result drew support from Naveena and Roseleen (2019) finding who reported life cycleof tobacco beetle on turmeric powder to be 62.80 ± 2.06 days for males and 64.00 ± 2.26 for females.

Table 1: Effect of different stored spices on developmental stages of *Lasioderma serricorne* Fab.

Sr. No.	Host	Egg period (days)	Total Larval period (days)	Pupal period (days)	Total dev. Period (days)	Adult longevity (days)		Life cycle (days)	
						Female	Male	Female	Male
1.	Fennel	7.57	32.89	8.78	48.90	21.56	18.33	72.01	68.34
2.	Coriander	7.23	31.55	8.56	47.68	24.11	19.67	70.23	67.23
3.	Ajwain	8.23	41.33	9.78	59.34	16.56	13.67	75.67	72.67
4.	Cumin	8.21	36.21	9.56	53.98	18.67	15.33	71.65	68.31
5.	Turmeric	8.46	39.44	9.89	57.79	15.78	12.67	72.46	70.46
6.	Mustard	9.11	46.45	11.44	67.01	13.11	11.00	80.01	76.67
7.	Red chilli powder	7.88	34.45	8.89	51.22	19.78	17.67	70.88	68.88
8.	Black pepper	10.77	50.33	12.11	73.21	11.45	10.33	84.21	82.54
SE(m)±		0.215	32.89	0.309	0.577	0.749	1.047	1.386	1.367
C.D (P=0.05)		0.65	1.40	0.94	1.75	2.26	3.17	4.19	4.13

Studies on the ovipositional preference of tobacco beetles on stored test spices revealed that coriander was the most preferred one for oviposition, with maximum ovipositional days (7.20 days), followed by fennel (6.60 days). Dimetry *et al.* (2004) also reported that coriander was found to be the most suitable for oviposition and maximum fecundity of 45.40 eggs was on coriander, followed by fennel (43.60 eggs), while Hegde and Awaknavar (2005), who reported that the highest number of eggs was on coriander, followed by fennel, and the lowest in black pepper, fully corroborated our present investigation.

Investigation on the feeding preference of *L. serricorne* revealed that adult beetles were more oriented towards coriander with 21.33 percent, followed by fennel with 19.33 percent, and the least orientation was observed in black pepper and mustard with 4.67 percent and 5.33 percent, respectively. Results on the weight loss caused by tobacco beetle showed the maximum weight loss in fennel with 31.62 percent, followed by coriander (25.87 percent and red chilli powder (16.05 percent) whereas, the minimum weight loss was recorded on black pepper (2.89 percent), followed by mustard (6.81 percent) while, Chaudhari *et al.* (2021) observed the maximum weight loss in fennel (60.24 percent) and the lowest in fenugreek (3.62 percent).

Table 2: Effect of different spices on ovipositional and feeding preference of *Lasioderma serricorne* Fab.

Sr. No.	Host	Ovipositional period (days)	Fecundity (eggs/ female)	Orientation of adult in favour of spices	Per cent orientation of adult in favour of spices	Weight loss (%)
1.	Fennel	6.60	43.60 (6.68) *	9.67 (3.26) **	19.33 (26.05) **	31.62 (34.18) *
2.	Coriander	7.20	45.40 (6.81)	10.67 (3.42)	21.33 (27.49)	25.88 (30.55)
3.	Ajwain	4.80	23.80 (4.98)	6.67 (2.77)	13.33 (21.40)	14.98 (22.61)
4.	Cumin	4.40	30.27 (5.59)	6.33 (2.71)	12.67 (20.83)	13.02 (21.12)
5.	Turmeric	4.20	24.13 (5.01)	2.08 (3.33)	6.67 (14.92)	10.60 (18.91)
6.	Mustard	3.60	20.67 (4.65)	2.67 (1.91)	5.33 (13.293)	6.81 (15.07)
7.	Red chilli powder	5.80	32.73 (5.80)	8.33 (3.05)	16.67 (24.08)	16.05 (23.55)
8.	Black pepper	3.40	16.87 (4.20)	2.33 (1.82)	4.67 (12.41)	2.89 (9.67)
	SE(m)±	0.418	0.171	0.075	0.720	1.264
	CD (P=0.05)	1.21	0.52	0.23	2.18	0.82

Figures in parentheses are transformed values (**square root, √x+0.5 and *arc sine).

The maximum adult emergence percentage was recorded in coriander (71.67 percent), followed by fennel (68.34 percent), and red chilli powder (61.67 percent), whereas the lowest adult emergence was recorded in black pepper (36.67percent), followed by mustard (45.00 percent). This finding was well corroborated by Dimetry *et al.* (2004), who recorded the highest adult emergence percentage on coriander.

The growth index of the tobacco beetle was found to be the highest in coriander (1.12), followed by fennel (1.05), and the lowest was observed in black pepper (0.50), followed by mustard (0.62). Hegde and Awaknavar (2005) also recorded the tobacco beetle growth index to be highest in coriander followed by fennel, which corroborated our present findings.

The index of susceptibility was also recorded maximum in coriander (4.66), followed by fennel (4.40), red chilli powder (3.99), cumin (3.71), ajwain (3.26), and turmeric rhizome (3.26), whereas the minimum was in black pepper (2.13), followed by mustard (2.58). El-Fouly *et al.* (2021) reported the susceptibility index of tobacco beetle varied with different host ranging from 3.03 to 8.08 with minimum on fenugreek (3.03) and maximum on wheat germ (8.08) which was in line with the present findings.

Table 3: Effect of different spices on Adult emergence, Growth index and index of susceptibility of *Lasioderma serricorne.* Fab.

Sr. No.	Host	Adult emergence (%)	Mean developmental period (days)	Growth index	No of adults emerged	Index of Susceptibility
1.	Fennel	68.34 (55.98) *	53.40	1.05	223.82 (2.35) **	4.40
2.	Coriander	71.67 (57.98)	51.68	1.12	257.27 (2.41)	4.66
3.	Ajwain	55.00 (47.88)	61.34	0.78	99.96 (1.99)	3.26
4.	Cumin	53.33 (46.92)	56.23	0.84	123.08 (2.09)	3.71
5.	Turmeric	51.67 (45.97)	59.79	0.77	90.10 (1.95)	3.26
6.	Mustard	45.00 (42.11)	68.26	0.62	59.25 (1.76)	2.58
7.	Red chilli powder	61.67 (51.78)	54.72	0.95	152.75 (2.18)	3.99
8.	Black pepper	36.67 (37.20)	74.71	0.50	39.36 (1.59)	2.13
	SE(m)±	2.679	0.745	0.047	0.046	0.082
	CD (P=0.05)	8.10	2.25	0.14	0.14	0.25

Figures in parentheses are transformed values (*arc sine and **log).

Based on the index of susceptibility, coriander (4.66) and fennel (4.40) recorded more than 4.37, hence being recognized as highly susceptible. Red chilli powder (3.99) and cumin (3.71) were less than 4.37 but more than 3.50 and therefore categorized as susceptible to tobacco beetle. Turmeric rhizome (3.26) and ajwain (3.26) were categorized as resistant, as both were more than 2.63 and less than 3.50. The indices of susceptibility of black pepper (2.12) and mustard (2.58) were less than 2.63; hence, they were recognized as highly resistant to the attack of tobacco beetle.

Table 4: Categorization of stored spices based on index of susceptibility.

Category of resistance	Scale	Test spices
Highly susceptible	$\overline{X}_i > 4.37$	Coriander (4.66) & Fennel (4.40)
susceptible	$\overline{X}_i > 3.50 < 4.37$	Red chilli powder (3.99) & Cumin (3.71)
Resistant	$\overline{X}_i > 2.63 < 3.50$	Turmeric rhizome (3.26) &Ajwain (3.26)
Highly resistant	$\overline{X}_i < 2.63$	Mustard (2.58) & Black pepper (2.12)

CONCLUSIONS

From the present investigation, it may be concluded that among the spices tested in this study, coriander and fennel were reported to be the most preferred hosts for the tobacco beetle, *L. serricorne* as the beetle completed the life cycle earlier with a shorter developmental period and a higher feeding and fecundity rate, rendering maximum weight loss, indicating a higher growth index and index of susceptibility**.**

FUTURE SCOPE

The physical and chemical characteristics that confer resistance to black pepper against tobacco beetle infestations can be identified and integrated into effective integrated pest management strategies.

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How to cite this article: Raja M.Y.S., Mishra P.R., Mohanty S., Padhi J. and Sathis G. (2024). Host Preference of Tobacco Beetle, *Lasioderma serricorne* (Fab). on Different Stored Spices. *Biological Forum – An International Journal*, *16*(2): 60-64.