*Int.J.Curr.Microbiol.App.Sci* (2017) *6*(4): 963-971

*International Journal of Current Microbiology and Applied Sciences*
*ISSN: 2319-7706* **Volume 6 Number 4 (2017) pp. 963-971**
Journal homepage: http://www.ijcmas.com

**Original Research Article** https://doi.org/10.20546/ijcmas.2017.604.121

# Efficacy of Different Grain Protectants on the Effect of Fecundity, Adult Emergence and Weight Loss of Cigarette Beetle (*Lasioderma serricorne* Fabricius) Infestation in Cured Turmeric Rhizomes (*Curcuma longa* Linnaeus)

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**Keywords**

*Vitex negundo*, *Lantana camara*, *Pongamia pinnata*, *Annona squamosa*, *Azadirachta indica*, spinosad, Deltamethrin, Cured turmeric rhizomes, Cigarette beetle and grain protectants.

**Article Info**

***Accepted:***
12 March 2017
***Available Online:***
10 April 2017

**A B S T R A C T**

Leaves of *Vitex negundo*, *Lantana camara*, *Pongamia pinnata*, *Annona squamosa* and seed kernel of *Azadirachta indica* were powdered and admixture at the rate of 10, 10, 5, 5 and 5 g per kg along with two chemical grain protectants *i.e*., spinosad and delatmethrin as checks at concentrations of 1ml per kg and 0.04g per kg of cured turmeric rhizomes, respectively and an untreated check was maintained without any treatment. Among the botanicals, neem seed kernel powder @ 5 g $kg^{-1}$ provided complete protection up to three months of storage, which is equal to that of chemical grain protectants followed by *Vitex negundo* leaf powder @ 10 g $kg^{-1}$ and annona leaf powder @ 5 g $kg^{-1}$ was found to be least effective among the all treatments. Both the chemical grain protectants did not record any fecundity, adult emergence and weight loss up to six months of storage due to their toxic effect on adult mortality. Neem seed kernel powder, after six and nine months of treatment also it was adjudged as the best treatment among the botanicals and it recorded significantly, less progeny development and less infestation, among other botanical powder treatments.

## Introduction

Turmeric is a rhizomatous herbaceous perennial plant belonging to the ginger family (Zingiberaceae), botanically known as *Curcuma longa* Linnaeus, originated from Tropical south Asia (India). It is one of the oldest spices and an important spice bowl of India which had been used since ages. The world production of turmeric stands at around 8, 00,000 tons in which India hold a share of approximately 75 to 80 per cent. India consumes around 80 per cent of its own production. In India the total area under cultivation is 184.4 thousand hectares with production of 830.40 thousand metric tonnes and productivity of 4.50 MT $Ha^{-1}$. Among all the states, Telangana state stands first in area with 43.50 thousand hectares and production of 216.30 thousand metric tonnes while

Himachal Pradesh stands first in productivity with 17.90 MT $Ha^{-1}$ (Indiastat.com- 2015). Various insects have been recorded on dry turmeric, which belong to the order coleoptera, include cigarette beetle (*Lasioderma serricorne* Fab.), drugstore beetle (*Stegobium paniceum* L.), Red flour beetle (*Tribolium castaneum* Herbst) Lesser grain borer (*Rhyzopertha dominica* Fab.), Saw toothed grain beetle (*Oryzaephilus surinamensis* L.) and coffee bean weevil (*Araecerus fasciculatus* DeG.). Among all these insects, the cigarette beetle (*Lasioderma serricorne* Fab.) is serious.

The damage loss by cigarette beetle in turmeric in terms of quantitative weight loss at three and six months after storage was recorded as 7.15 and 22.75 per cent in turmeric (Vidya and Awaknavar, 1994). In view of serious losses in storing the turmeric form the infestation a search for the possible approaches is required.

One of the eco-friendly and economic approaches to keep the stored food grains free from insect attack, would be using the plant products as grain protectants. Use of botanicals with stored products has been in practice since ages which are known to repel insects or deter them from feeding (Yahaya *et al.*, 2013).

Plant derived materials are more readily bio-degradable, less likely to contaminate the environment and may be less toxic to mammals. In light of the adverse effects of insecticides on the environment, these methods of pest control are now attracting greater attention and research input. Hence, the present laboratory experiment was taken up to evaluate the efficacy of five botanical powders along with two chemical checks against *L. serricorne* infestation at Department of Entomology, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad during 2014-15.

## Materials and Methods

### Experimental setup

The experiment was carried out at the laboratory of Department of entomology, Professor Jayashankar Telangana State Agricultural University (PJTSAU), Hyderabad, Telangana During 2015.

To test the efficacy of grain protectants against *L. serricorne*, 500 grams of cured turmeric rhizomes of the local variety "Duggirala" was used for the experiment. Thoroughly dried cured turmeric rhizomes were treated with botanical powders of neem seed kernel powder, pongamia leaf powder, annona leaf powder @ 5 g kg-1 and *L. camara* leaf powder, *V. negundo* leaf powder @ 10 g kg-1 of cured turmeric rhizomes while deltamethrin was mixed with cured turmeric rhizomes @ 0.04 ml kg-1 and spinosad @ 1 ml kg-1 of cured turmeric rhizomes. An untreated check was also maintained without mixing with any treatment. After treating the cured turmeric rhizomes with required concentrations of each treatment, they were transferred to the containers. From the treated cured turmeric rhizomes of each treatment, 50 grams of cured turmeric rhizomes were taken from each replication and they were transferred to glass jars at 3, 6 and 9 months after treatment and two pairs of freshly emerged adults were released into each jar and the treatments were replicated thrice. The performance of the grain protectants against *L. serricorne* was assessed based on the fecundity, adult emergence, weight loss due to infestation in each treatment and the data was subjected to statistical analysis.

## Results and Discussion

### Effect of grain protectants on fecundity of *L. serricorne*

The fecundity of test insect exposed to the cured turmeric rhizomes treated with

botanical powders and insecticides showed significant variation among the treatments.

Among the various grain protectants used in the study chemical treatments were found significantly superior over the botanicals irrespective of the duration of storage. After three months of treatment the cured turmeric rhizomes treated with both chemical, *viz.*, deltamethrin and spinosad were highly effective and did not allow the beetle to lay the eggs as against 76.00 eggs recorded in the control. Among the botanical powders neem seed kernel powder and vitex leaf powder were the best treatments, when used @ 5 g $kg^{-1}$ and 10g $kg^{-1}$, which recorded very less fecundity of 1.33 and 3.67 eggs, respectively than the other treatments. The next best treatments were pongamia leaf powder (5 g $kg^{-1}$) and lantana leaf powder (10 g $kg^{-1}$) which recorded 9.33 and 14.67 eggs, respectively. Annona was the least effective and resulted more fecundity (19.67 eggs) @ 5g $kg^{-1}$ of concentration.

After six months of treatment also the same trend continued where both chemicals completely prevented the egg laying. Among the botanicals, neem seed kernel powder recorded less fecundity (5.00 eggs) @ 5 g $kg^{-1}$ followed by vitex leaf powder and pongamia leaf powder which recorded 10.67 and 17.67 eggs @ 10 and 5 g $kg^{-1}$ concentrations, respectively. In lantana leaf powder and annona leaf powder treatments the fecundity recorded were 22.67 and 30.33, respectively.

The fecundity observed after nine months of treatment showed that very few eggs were recorded in deltamethrin treated @ 0.04 ml $kg^{-1}$ (2.33). In spinosad treatment significantly more number of eggs was recorded (6.33) @ 1ml $kg^{-1}$ of cured turmeric rhizomes as compared to deltamehrin treatment. Neem seed kernel powder continued to remain as the best treatment among the botanical powders where significantly few eggs (11.67) were recorded @ 5 g $kg^{-1}$ concentrations at nine months after treatment. The other botanical powder treatments were found ineffective in which the fecundity of the cigarette beetle increased significantly and varied from 18.33 to 45.33 eggs.

All the grain protectants used in the present study significantly reduced the fecundity of *L. serricorne* than the untreated control. Among the botanicals, neem seed kernel powder and vitex leaf powder applied @ 5 and 10 g $kg^{-1}$ to cured turmeric rhizomes were most effective in reducing the fecundity of the insect and the two treatments were significantly different from each other. Similar results were obtained by Hossain *et al*., (2014) who reported that neem seed kernel powder was effective in reducing the fecundity and giving complete protection from *C. chinensis* while, Khalequzzaman and Osman (2009) revealed that seed kernel powder of *Azadirachta indica*, leaves of *Vitex negundo* and *Annona squamosa* were effective against the control of *Callosobruchus maculatus* and *C. chinensis* adults in increasing the mortality and reducing the oviposition. The results were in agreement with the findings of Senguttuvan *et al*., (1995) and Singh *et al*., (1996) who reported that the neem seed kernel powder was superior and adjudged as the best treatment for the control of most of the stored product pests in different commodities.

Among the chemical treatments deltamethrin due to its quick knock down effect might have caused maximum mortality of adults and there by resulting in less fecundity. Similar findings were reported by Kavallieratos *et al*., (2015) who found complete mortality and reduction in progeny of *Rhyzopertha dominica*, *Sitophilus granarius* and *Tribolium castaneum* when deltamethrin applied @ 0.5 ppm. Dealtamethrin was effective protectant as reported by Paudyal *et al*., (2016) and Anankware *et al*., (2014). Patil *et al*., (1994) who found deltamethrin @ 12.5 ppm has

drastically reduced fecundity of *Callosobruchus maculatus* in pigeonpea seeds. Similarly, spinosad also gave complete protection up to six months because it was proved as an excellent ovipositional deterrent. Similar findings reported by Ranaware and Kapadia (2011). Nadaf *et al.,* (2010) found that spinosad and deltamethrin recorded no fecundity by *C. serratus* in groundnut pods for the first two months (Table 1).

## Effect of grain protectants on adult emergence

All the doses of different grain protectants were found to be significantly superior in decreasing the adult emergence. The adults emerged from the cured turmeric rhizomes treated with botanicals and chemicals showed significant variations among the treatments. As observed in the fecundity studies the chemical treatments gave superior performance than botanicals. No adult emergence was observed from cured turmeric rhizomes treated with deltamethrin and spinosad at both concentrations after 3 months of treatment. Neem seed kernel powder proved to be equally effective that of chemical protectants in preventing the adult emergence. Vitex leaf powder treatment @ 10 g $kg^{-1}$ resulted in few emergences of adults of 1.67 and ranked as the second best treatment after neem seed kernel powder. The treatments of lantana leaf powder @ 10 g $kg^{-1}$ and pongamia leaf powder @ 5 g $kg^{-1}$ recorded 4.67 and 7.67 adults, respectively at three months after treatment. Annona leaf powder was least effective and resulted in 13.33 adults @ 5 g $kg^{-1}$ concentration.

Similar trend was observed even after 6 months of treatment. Deltamethrin and spinosad were equally effective and completely prevented the adult emergence. Neem seed kernel powder @ 5 g $kg^{-1}$ showed superior performance than the other botanical treatments which resulted in few adults of 2.33, the adult emergence observed in the vitex leaf powder @ 10 g $kg^{-1}$, lantana leaf powder @ 10 g $kg^{-1}$ and pongamia leaf powder @ 5 g $kg^{-1}$ treatments were ranged from 6.33 to 16.67 adults. Annona leaf powder @ 5 g $kg^{-1}$ was ineffective in preventing the adult emergence which resulted in more number of adult emergence (25.33) than the rest of the treatments.

After nine months of treatment spinosad @ 1 ml $kg^{-1}$ was significantly less effective when compared to deltamethrin treatment @ 0.04 ml $kg^{-1}$ which resulted in the lowest adult emergence of 0.33 adults. In the rest of the treatments adult emergence varied from 5.33 to 38.67 as against 81.67 adults recorded from untreated check.

The results obtained from the fecundity and adult emergence studies clearly indicated the superior performance of neem seed kernel powder in protecting the cured turmeric rhizomes with less fecundity and adult emergence than the other botanical treatments. The chemical grain protectants not only prevented the fecundity of *L. serricorne* but also adversely affected the adult emergence. The neem seed kernel powder also showed the superior performance though it is significantly inferior with deltamethrin and spinosad in preventing the adult emergence of the insect. The few eggs laid on neem seed kernel powder could not complete their development, resulting in no adult emergence up to three months. Admixing powders of different plants gave promising levels of cigarette beetle control in terms of reduction in the number of eggs laid. The reduced oviposition may be due to the result of inhibition of egg laying or was the consequence of reduced longevity. Many of the plants *A. indica* kernel powder (Sowunmi and Akinnusi, 1983) which farmers use as protectants have a strong smell which, it is

believed, repels or kills insect. Neem materials having the biactive compounds, such as azadirachtin, affect behavior, growth, development, survival and reproduction of stored product insects has been reported by many findings (Mordue and Blackwell, 1993; Saxena *et al*., 1989, Singh 1993). Although the sensitivity of stored product insect pests to neem materials varies, almost all the species were sensitive to neem. The results were in agreement with Sharma and Bhargava (2012) who reported significant reduction in adult emergence of *L. serricorne* when cumin seeds were treated with neem seed extract and also Khalequzzaman and Osman (2009) who reported that neem seed kernel powder was effective in reducing the adult emergence of *C. maculatus* and *C. chinensis* in cowpea and. Deltamethrin recorded as an effective grain protectant than spinosad in reducing fecundity and adult emergence of cigarette beetle. Kavallieratos *et al*., (2015) who revealed delatmethrin as an effective grain protectant against *Rhyzopertha dominica*, *Sitophilus granarius* and *Tribolium castaneum* in the reduction in adult emergence while Blanc *et al*., (2004) reported spinosad as an effective grain protectant in controlling and reducing adult emergence of cigarette beetle, *Lasioderma serricorne* in tobacco (Table 2).

## Effect of grain protectants on weight loss due to infestation by *L. serricorne*

A perusal of data on the per cent weight loss due to infestation by *L. serricorne* after three months of treatment revealed that no weight loss was observed in the cured turmeric rhizomes treated with neem seed kernel powder, deltamethrin and spinosad after three months of treatment which were on par with each other. Neem seed kernel powder (0.00 per cent) proved to be superior to vitex leaf powder (1.45 per cent) in reducing the weight loss. In rest of the treatments weight loss ranged from 3.27 to 10.33 per cent while the highest weight loss of 51.56 per cent was recorded in the untreated check (Table 3).

After six months of treatment per cent weight loss was not observed in both the chemical treatments, but neem seed kernel powder recorded a weight loss of 1.76 per cent which was significantly lower than vitex leaf powder (4.53 per cent) and the other treatments. In the remaining treatments the weight loss ranged between 7.68 and 15.19 per cent. Annona leaf powder @ 5 g $kg^{-1}$ recorded 15.19 per cent and was the least effective among the botanicals in reducing the weight loss. However, the highest per cent weight loss was recorded in untreated control (55.28).

The lowest per cent weight loss was observed in deltamethrin treatment @ 0.04 ml $kg^{-1}$ of cured turmeric rhizomes (0.25) after nine months of treatment. The per cent weight loss of 1.34, 3.15 and 7.25 was recorded in spinosad (1 ml $kg^{-1}$), neem seed kernel powder (5 g $kg^{-1}$) and vitex leaf powder (10 g $kg^{-1}$) treatments, respectively which were significantly different from each other. In the remaining treatments, the weight loss ranged between 12.07 and 21.41 per cent while the highest weight loss of 59.76 per cent was recorded in untreated control.

The overall observations on studies of grain protectants against *L. serricorne* revealed that the cured turmeric rhizomes treated with grain protectants adversely affected the development of the test insect and reduced the infestation of the cured turmeric rhizomes and recorded less weight loss when compared to untreated control. Among the botanicals, neem seed kernel powder @ 5 g $kg^{-1}$ provided complete protection up to three months of storage, which is equal to that of chemical grain protectants.

**Table.1** Effect of grain protectants on fecundity of *L. serricorne*

| Treatment | Dosage | Fecundity (50 g of cured turmeric rhizomes) | | |
|---|---|---|---|---|
| | | 3 MAT | 6 MAT | 9 MAT |
| $T_1$ – *Vitex negundo* leaf powder | 10 g $kg^{-1}$ of cured turmeric rhizomes | 3.67 (2.15) | 10.67 (3.41) | 18.33 (4.39) |
| $T_2$ – *Lantana camara* leaf powder | 10 g $kg^{-1}$ of cured turmeric rhizomes | 14.67 (3.95) | 22.67 (4.86) | 33.67 (5.88) |
| $T_3$ – *Azadirachta indica* seed kernel powder | 5 g $kg^{-1}$ of cured turmeric rhizomes | 1.33 (1.52) | 5.00 (2.44) | 11.67 (3.55) |
| $T_4$ – *Pongamia pinnata* leaf powder | 5 g $kg^{-1}$ of cured turmeric rhizomes | 9.33 (3.20) | 17.67 (4.31) | 26.67 (5.25) |
| $T_5$ – *Annona squamosa* leaf powder | 5 g $kg^{-1}$ of cured turmeric rhizomes | 19.67 (4.54) | 30.33 (5.59) | 45.33 (6.80) |
| $T_6$ – Deltamethrin (Check) | 0.04 ml $kg^{-1}$ of cured turmeric rhizomes | 0.00 (1.00) | 0.00 (1.00) | 2.33 (1.79) |
| $T_7$ – Spinosad (Check) | 1 ml $kg^{-1}$ of cured turmeric rhizomes | 0.00 (1.00) | 0.00 (1.00) | 6.33 (2.68) |
| $T_8$ – Untreated check | Untreated check | 76.00 (8.77) | 79.67 (8.98) | 83.33 (9.18) |
| CD(P=0.05) | | 0.21 | 0.25 | 0.43 |
| SEm ± | | 0.07 | 0.08 | 0.14 |

Values in parenthesis are transformed values

**Table.2** Effect of grain protectants on adult emergence of *L. serricorne*

| Treatment | Dosage | Number of adults emerged | | |
|---|---|---|---|---|
| | | 3 MAT | 6 MAT | 9 MAT |
| $T_1$ – *Vitex negundo* leaf powder | 10 g $kg^{-1}$ of cured turmeric rhizomes | 1.67 (1.62) | 6.33 (2.69) | 10.33 (3.36) |
| $T_2$ – *Lantana camara* leaf powder | 10 g $kg^{-1}$ of cured turmeric rhizomes | 7.67 (2.94) | 16.67 (4.20) | 28.67 (5.44) |
| $T_3$ – *Azadirachta indica* seed kernel powder | 5 g $kg^{-1}$ of cured turmeric rhizomes | 0.00 (1.00) | 2.33 (1.79) | 5.33 (2.51) |
| $T_4$ – *Pongamia pinnata* leaf powder | 5 g $kg^{-1}$ of cured turmeric rhizomes | 4.67 (2.36) | 11.33 (3.50) | 20.67 (4.65) |
| $T_5$ – *Annona squamosa* leaf powder | 5 g $kg^{-1}$ of cured turmeric rhizomes | 13.33 (3.78) | 25.33 (5.13) | 38.67 (6.29) |
| $T_6$ – Deltamethrin (Check) | 0.04 ml $kg^{-1}$ of cured turmeric rhizomes | 0.00 (1.00) | 0.00 (1.00) | 0.33 (1.13) |
| $T_7$ – Spinosad (Check) | 1 ml $kg^{-1}$ of cured turmeric rhizomes | 0.00 (1.00) | 0.00 (1.00) | 3.33 (2.06) |
| $T_8$ – Untreated check | Untreated check | 67.33 (8.26) | 73.67 (8.61) | 81.67 (9.09) |
| CD(P=0.05) | | 0.27 | 0.37 | 0.32 |
| SEm ± | | 0.09 | 0.12 | 0.10 |

Values in parenthesis are transformed values

**Table.3** Effect of grain protectants on weight loss by *L. serricorne*

| Treatment | Dosage | Weight loss (%) | | |
|---|---|---|---|---|
| | | 3 MAT | 6 MAT | 9 MAT |
| $T_1$ – *Vitex negundo* leaf powder | 10 g $kg^{-1}$ of cured turmeric rhizomes | 1.45 (6.84) | 4.53 (12.13) | 7.25 (15.59) |
| $T_2$ – *Lantana camara* leaf powder | 10 g $kg^{-1}$ of cured turmeric rhizomes | 7.02 (15.35) | 11.50 (19.81) | 17.59 (24.78) |
| $T_3$ – *Azadirachta indica* seed kernel powder | 5 g $kg^{-1}$ of cured turmeric rhizomes | 0.00 (0.00) | 1.76 (7.61) | 3.15 (10.21) |
| $T_4$ – *Pongamia pinnata* leaf powder | 5 g $kg^{-1}$ of cured turmeric rhizomes | 3.27 (10.34) | 7.68 (16.08) | 12.07 (20.30) |
| $T_5$ – *Annona squamosa* leaf powder | 5 g $kg^{-1}$ of cured turmeric rhizomes | 10.33 (18.73) | 15.19 (22.92) | 21.41 (27.55) |
| $T_6$ – Deltamethrin (Check) | 0.04 ml $kg^{-1}$ of cured turmeric rhizomes | 0.00 (0.00) | 0.00 (0.00) | 0.25 (2.82) |
| $T_7$ – Spinosad (Check) | 1 ml $kg^{-1}$ of cured turmeric rhizomes | 0.00 (0.00) | 0.00 (0.00) | 1.34 (6.59) |
| $T_8$ – Untreated check | Untreated check | 51.56 (45.87) | 55.28 (48.01) | 59.76 (50.60) |
| CD(P=0.05) | | 1.28 | 1.58 | 1.18 |
| SEm ± | | 0.42 | 0.52 | 0.39 |

Figures in parentheses are transformed values

Khalequzzaman and Osman (2009) reported that among the plant materials tested in cowpea seeds against *Callosobruchus maculatus* and *C. chinensis* for weight loss, neem seed kernel powder recorded lowest percentage of weight loss than vitex leaf powder. Hossain *et al*., (2014) reported that seed kernel powder of *Azadirachta indica* as grain protectant against *Callosobruchus chinensis* resulted in reducing mortality, adult emergence and weight loss of seed than the untreated control. Similar findings also reported by Chebet *et al*., (2013) against larger grain borer, *Prostephanus truncates*. Neem, *A. indica* seed kernel applied to pea seeds reduced damage by *Callosbruchus chinensis* over a three month storage period by reducing $F_1$ adult emergence (Kumari *et al*., 1990). Rajapakse *et al*., (1998) observed that *A. indica* gave significant reduction of oviposition and adult emergence of *C. maculatus*. The results were in agreement with further findings of Jotwani and Sircar (1965) who reported that the *Azadirachta indica*, neem kernel powder when mixed with wheat seed at a proportion of one to two per cent has satisfactorily protected the seed from the damage of *Rhyzopertha dominica*, *Trogoderma granarium* and *S. oryzae* while Yadav (1973) reported that neem kernel powder protected the legumes against the infestation of *Callosobruchus chinensis* and *Callosobruchus maculates*. Among botanicals, vitex leaf powder proved as the second best treatment after neem seed kernel powder in reducing the infestation of cigarette beetle. Sahaf *et al*., (2008), Ram and Gopal (2001) reported that *vitex nedundo* can be used as an effective grain protectant against many stored products pests. In the present study, annona leaf powder was found to be least effective among the all treatments. Similarly Khalequzzaman and Osman (2009) reported that *A. squamosa* leaf powder recorded highest percentage of weight loss than neem seed kernel powder in cowpea against bruchids. Both the chemical treatments did not record any weight loss up to six months of storage due to their toxic effect on adult mortality. The results were in agreement with the findings of Mishra and Pandey (2014), Jyothsna (2014), Vishwamitra (2011) and Getchell and Subramanyam (2008)

who proved the effectiveness of spinosad and deltamethrin against different stored product pests.

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**How to cite this article:**

Ravi Kumar, K., C. Narendra Reddy, K. Vijaya Lakshmi, K. Rameash, K. Keshavulu and Rajeswari, B. 2017. Efficacy of Different Grain Protectants on the Effect of Fecundity, Adult Emergence and Weight Loss of Cigarette Beetle (*Lasioderma serricorne* Fabricius) Infestation in Cured Turmeric Rhizomes (*Curcuma longa* Linnaeus). *Int.J.Curr.Microbiol.App.Sci.* 6(4): 963-971. doi: https://doi.org/10.20546/ijcmas.2017.604.121