Journal of Entomology and Zoology Studies
Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(3): 1728-1732

Received: 25-03-2017
Accepted: 26-04-2017

K Ravi Kumar
Department of Entomology, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad, Telangana, India

C Narendra Reddy
Department of Entomology, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad, Telangana, India

K Vijaya Lakshmi
Department of Entomology, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad, Telangana, India

K Rameash
Department of Entomology, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad, Telangana, India

K Keshavulu
Department of Entomology, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad, Telangana, India

B Rajeswari
Department of Entomology, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad, Telangana, India

Correspondence
K Ravi Kumar
Department of Entomology, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad, Telangana, India

Effect of Nano particles against cigarette beetle (*Lasioderma serricorne* Fabricius) in cured turmeric rhizomes (*Curcuma longa* Linnaeus)

K Ravi Kumar, C Narendra Reddy, K Vijaya Lakshmi, K Rameash, K Keshavulu and B Rajeswari

Abstract
An experiment was conducted to study the effect of different nano particles, viz, Nano silica @ 0.5g kg-1, 0.25g kg-1, 0.175g kg-1 of cured turmeric rhizomes, Nano alumina @ 0.5g kg-1, 0.25g kg-1,0.175g kg-1 of cured turmeric rhizomes, Nano clay @ 0.5g kg-1, 0.25g kg-1, 0.175g kg-1 of cured turmeric rhizomes and Diatomaceous earth @ 5g kg-1 of cured turmeric rhizomes (check) along with control. All the treatments were replicated thrice. Among the three nanocides, nano silica applied at 0.5 and 0.25 g kg^{-1} dosages showed the superior performance of the over other treatments at one day after treatment followed by nano silica at 0.175 g kg^{-1} which caused higher mortality, reduced oviposition and adult emergence of *L. serricorne* and has a great promise in cigarette beetle pest management.

Keywords: Turmeric, cigarette beetle and nano particles

Introduction
Turmeric is a rhizomatous herbaceous perennial plant belonging to the ginger family (Zingiberaceaae), botanically known as *Curcuma longa* Linnaeus, originated from Tropical south Asia (India) (Ravindran *et al.,* 2007) [11]. 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 (INDIASTAT.COM- 2015) [7]. 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}(INDIASTAT.COM- 2015) [7]. 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) [7]. 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.) (Ravindran *et al.,* 2007) [11]. 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) [16]. Cigarette beetle, *Lasioderma serricorne* (Fabricius) (Coleoptera: Anobiidae) is the most serious pest of high value commodities and stored products. It is a generalist feeder, known to successfully feed, develop and breed on a variety of durable commodities including grain based products, spices, tobacco and dried medicinal herbs (Jacob, 1992) [8]. *L. serricorne* was known to develop on a variety of grain based products, spices, tobacco and infest these commodities during storage, and manufacturing (Dimetry *et al*., 2004) [5]. *L. serricorne* was a major pest found in cured tobacco and cigarette products. It also infests many other stored food products (Hagstrum and Subramanyam, 2009) [6]. Majority of the farmers of the region store the cured and dried turmeric rhizomes and fingers for getting better price. During storage cigarette beetle attacks the produce and cause considerable loss to the farmers. The adult beetle lay eggs on the produce and the grubs spoil the produce and make it powdery resulting in deterioration in quality, reduction of nutritive and medicinal values (Ravindran *et al.,* 2007) [11]. The larvae of cigarette beetle tunnel into dry turmeric and also

contaminate the produce with abundant production of frass. The grubs and adults also make extensive holes in the produce. The adults of cigarette beetle do not feed but tunnel through the produce to leave the cocoon making extensive holes (Ravindran *et al.,* 2007).

Nanotechnology (sometimes shortened to "nanotech") is the manipulation of matter at an atomic and molecular scale. Generally, nanotechnology works with materials, devices, and other structures with at least one dimension sized from 1 to 100 nano meters. Thus nanotechnology deals with the targeted nano particles as and when the particles exhibit different physical strength, chemical reactivity, electrical conductance and magnetic properties (Nykypanchuk *et al*., 2008) [10]. Nano particles hold great promise regarding their application in plant protection due to their size dependent qualities, high surface to volume ratio and unique optical properties. Also, researchers believe that nanotechnology will revolutionize agriculture including pest management in the near future (Bhattacharyya *et al*., 2010) [1]. Mohamed Ragaei and Al-kazafy (2014) [9] reported that nanotechnology would provide green and efficient alternatives for the management of insect pests in agriculture without harming the nature.

Nano-technology has become one of the most promising new technologies in the recent decade. Use of inorganic inert dusts is considered as one of the environment friendly alternative to chemical pesticides in stored pest management (Stadler *et al.*, 2012) [15]. They are chemically stable, highly persistent and have low mammalian toxicity. Inert dusts mainly contain synthetic silica (silica dioxide) and natural silica such as diatomaceous earth (DE), kaolinite and silica gel which predominantly consists of amorphous and shapeless silica. They kill the arthropods by removing or adsorbing the epicuticular lipid layers causing excessive water loss through cuticle (Stadler *et al*., 2012). Diatomaceous earth becomes more effective against insects if it possess high amorphous silica content with uniform size distribution (Korunik, 1997). Recently, a novel type of particulate material, nano structured alumina (NSA) has been found to induce mortality on two insect species, rice weevil *Sitophilus oryzae* (L.), and lesser grain borer *Rhyzopertha dominica*, (F.), major pests of stored grain in milling and processing, food warehouses, and foodstuffs (Stadler *et al*.,2012) [15]. Mortality due to NSA was observed at rates comparable to those recommended for commercially available insecticidal dusts, indicating the current interest on nano material based technology for pest management (Stadler *et al.,* 2010) [14]. Preliminary studies have found the insecticidal activity of SNP against many pests reported by Ziaee and Ganji (2016) [17], Boraei and Nilly (2015) [2], Rouhani *et al*. (2013) [12], Debnath *et al.* (2012a) [3] and Stadler *et al.* (2010) [14].

Since the spice is being widely used for consumption, there is a need to test use of biorational approaches for management of *L. serricorne* is need of hour.

In view of serious losses in storing the turmeric from the infestation and a search for the possible biorational, the present investigation was taken up.

Materials and Methods

Management of cigarette beetle by using the nano particleswas carried out at National Bureau of Plant Genetic Resources (NBPGR), Regional Research Station, Rajendranagar, Hyderabad and at laboratory of Department of entomology, Professor Jayashankar Telangana State Agricultural University (PJTSAU), Hyderabad, Telangana During 2014-16.

Management of cigarette beetle by nano particles of silica (10-20 nm), alumina (< 50 nm) and clay (< 100 nm) was tested in turmeric at National Bureau of Plant Genetic Resources (NBPGR), Regional Research Station, Rajendranagar, Hyderabad. Nano silica, nano alumina, nano clay and diatomaceous earth were procured from Sigma Aldrich, USA. Each nano treatment was tested at three concentrations *viz*., 0.5, 0.25 and 0.175 g kg^{-1} of cured turmeric rhizomes, whereas the normal diatomaceous earth was tested at one level *viz*., 5 g kg^{-1} of cured turmeric rhizomes.

Effect of nanocides on adult mortality of *L. serricorne*

Laboratory bioassays were conducted to test the toxicity of nano particles using dry dust application. Different nano particles, *viz*, Nano silica @ 0.5g kg-1, 0.25g kg-1, 0.175g kg-1 of cured turmeric rhizomes, Nano alumina @ 0.5g kg-1, 0.25g kg-1,0.175g kg-1 of cured turmeric rhizomes, Nano clay @ 0.5g kg-1, 0.25g kg-1, 0.175g kg-1 of cured turmeric rhizomes and Diatomaceous earth @ 5g kg-1 of cured turmeric rhizomes (check) along with control were used against beetle. The thoroughly dried cured turmeric rhizomes were treated with the test nano particles and five pairs of freshly emerged adults were released on to the nano particle treated cured turmeric rhizomes. All the treatments were replicated thrice. Adult mortality was assessed at 1, 2, 3, 4, 5, 6 and 7 days after exposure to the treated cured turmeric rhizomes. After studying the adult mortality, the cured turmeric rhizomes were placed back in the jars and kept undisturbed for the emergence of F_1 progeny and the number of adults emerged from each treatment were recorded and analysed statistically by subjecting to analysis of variance using Completely Randomized Design (CRD). The mortality was observed daily and per cent adult mortality was calculated by using the following formula.

$$\text{Per cent adult mortality} = \frac{\text{Number of adults dead}}{\text{Total number of adults released}} \times 100$$

Results and Discussion

Effect of nano particles on adult mortality of *L. serricorne*

The results indicated that among the three nano treatments nano silica @ 0.5g kg^{-1} and 0.25g kg^{-1} was highly effective and caused cent per cent mortality at one day and two days after treatment (DAT), respectively and significantly on par with each other at one day after treatment, while nano silica applied @ 0.175g kg^{-1} resulted in 86.67 and 96.67 per cent mortality at one day and two days after treatment, respectively and complete mortality was obtained at 3 days after treatment (Table 1). Nano alumina was less effective as compared to nano silica and caused cent per cent mortality at six days after treatment when applied @ 0.5g kg^{-1} while 0.25g kg^{-1} caused complete mortality at seven days after treatment. Lower concentration of 0.175g kg^{-1} caused 93.33 per cent mortality at seven days after treatment. Nano clay used @ 0.5, 0.25 and 0.175 g kg^{-1} recorded 23.33, 16.67 and 10.0 per cent adult mortality at one day after treatment and increased to 93.33, 86.67 and 73.33 per cent, respectively at seven days after treatment. Diatomaceous earth (DE) @ 5g kg^{-1} recorded 6.67 per cent mortality at one day after treatment and it reached to 66.67 per cent mortality at seven days after treatment. Among all the treatments diatomaceous earth was least effective in controlling the pest.

Effect of nano particles on fecundity and adult emergence of *L. serricorne*

The fecundity and adult emergence studies indicated the superior performance of nano silica over other nano treatments (Table 2). The higher dosages of nano silica particles (0.5g kg^{-1} and 0.25g kg^{-1}) resulted in complete mortality of adults at one and two days after treatment (Table 2), hence the egg laying and adult emergence were not observed from the above treatments.

Table 1: Effect of nanocides on adult mortality of *L. serricorne*

Treat-ment	Dosage	Per cent adult mortality						
		Days after treatment (DAT)						
		1	2	3	4	5	6	7
T_1	Nanosilica @ 0.5g kg^{-1}	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
T_2	Nanosilica @ 0.25g kg^{-1}	96.67 (83.84)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
T_3	Nanosilica @ 0.175g kg^{-1}	86.67 (68.82)	96.67 (83.84)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
T_4	Nanoalumina @ 0.5g kg^{-1}	66.67 (54.76)	73.33 (58.98)	80.00 (63.40)	90.00 (71.53)	93.33 (77.69)	100.00 (90.00)	100.00 (90.00)
T_5	Nano alumina @ 0.25g kg^{-1}	56.67 (48.82)	63.33 (52.75)	73.33 (58.98)	83.33 (66.11)	86.67 (68.82)	93.33 (77.69)	100.00 (90.00)
T_6	Nanoalumina @ 0.175g kg^{-1}	33.33 (35.20)	43.33 (41.13)	56.67 (48.82)	60.00 (50.74)	73.33 (58.98)	83.33 (66.11)	93.33 (77.69)
T_7	Nanoclay @ 0.5g kg^{-1}	23.33 (28.76)	33.33 (35.20)	50.00 (44.98)	66.67 (54.76)	76.67 (61.19)	86.67 (68.82)	93.33 (77.69)
T_8	Nanoclay @ 0.25g kg^{-1}	16.67 (23.84)	26.67 (30.98)	36.67 (37.21)	53.33 (46.90)	63.33 (52.75)	70.00 (56.76)	86.67 (68.82)
T_9	Nanoclay @ 0.175g kg^{-1}	10.00 (18.42)	23.33 (28.76)	33.33 (35.20)	40.00 (39.21)	53.33 (46.90)	60.00 (50.74)	73.33 (58.98)
T_{10}	Diatomaceous Earth @ 5g kg^{-1}	6.67 (12.28)	13.33 (21.13)	20.00 (26.55)	36.67 (37.21)	43.33 (41.13)	56.67 (48.82)	66.67 (54.76)
T_{11}	Untreated check	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
CD (P=0.05)		9.51	7.53	3.63	3.88	7.25	6.67	8.34
SE(m)		3.22	2.55	1.23	1.31	2.45	2.26	2.82
CV (%)		13.06	9.09	4.00	3.94	6.91	5.91	6.82

Figures in parentheses are angular transformed values

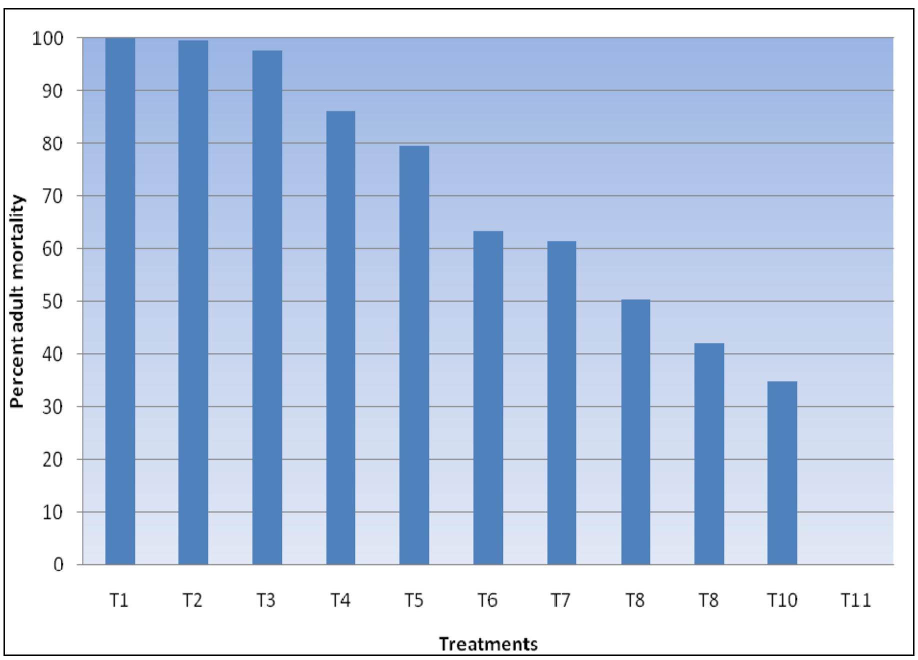

Fig 1: Effect of nanocides on mean adult mortality of *L. serricorne*

T1 Nanosilica @ 0.5g kg^{-1} T2 Nanosilica @ 0.25g kg^{-1} T3Nanosilica @ 0.175g kg^{-1}
T4 Nanoalumina @ 0.5g kg^{-1} T5 Nano alumina @ 0.25g kg^{-1} T6 Nanoalumina @ 0.175g kg^{-1}
T7 Nanoclay @ 0.5g kg^{-1} T8 Nanoclay @ 0.25g kg^{-1} T9 Nanoclay @ 0.175g kg^{-1}
T10 Diatomaceous Earth @ 5g kg^{-1} T11 Control

Table 2: Effect of nanocides on fecundity and adult emergence of *L. serricorne*

Treatment	Dosage	Fecundity (50 g of cured turmeric rhizomes)	Number of adults emerged
T_1	Nanosilica @ 0.5g kg-1	0.00 (1.00)	0.00 (1.00)
T_2	Nanosilica @ 0.25g kg-1	0.00 (1.00)	0.00 (1.00)
T_3	Nanosilica @ 0.175g kg-1	2.33 (1.82)	0.00 (1.00)
T_4	Nanoalumina @ 0.5g kg-1	8.67 (3.10)	2.67 (1.91)
T_5	Nanoalumina @ 0.25g kg-1	12.33 (3.65)	5.33 (2.51)
T_6	Nanoalumina @ 0.175g kg-1	17.67 (4.32)	7.33 (2.87)
T_7	Nanoclay @ 0.5g kg-1	15.67 (4.08)	8.00 (2.99)
T_8	Nanoclay @ 0.25g kg-1	19.33 (4.50)	9.33 (3.220)
T_9	Nanoclay @ 0.175g kg-1	29.33 (5.50)	17.00 (4.24)
T_{10}	Diatomaceous Earth @ 5g kg-1	38.67 (6.29)	24.67 (5.06)
T_{11}	Untreated check	76.33 (8.79)	73.00 (8.60)
C.D. (P=0.05)		0.20	0.24
SE(m)		0.07	0.08
CV(%)		3.06	4.61

*Figures in parentheses are square root transformed values

The lower dosages of nano silica (0.175g kg^{-1}) which caused cent per cent mortality of adults at three days after treatment resulted in very low oviposition (2.33 eggs) by the beetle. The few eggs laid by the insect also did not develop in to adults at three days after treatment with nano silica @ 0.175 g kg^{-1}. In nano alumina and nano clay treatments the fecundity ranged from 8.67 to 17.67 and 15.67 to 29.33 eggs, respectively from different dosages of nano alumina and nano clay. The adult emergence observed in the above treatments at different dosages varied from 2.67 to 7.33 in nano alumina and 8.00 to 17.00 in nano clay treatments showing the less efficacy of nano alumina and clay treatments over nano silica. Diatomaceous earth was least effective in protecting the cured turmeric rhizomes against cigarette beetle damage and the fecundity and adult emergence observed from the dosages of diatomaceous earth was 38.67 and 24.67 respectively.

The overall mean adult mortality (Fig. 1) results obtained from different nanocide treatments showed superior performance of nano silica over other treatments and nano silica applied @ 0.5g kg^{-1} and 0.25g kg^{-1} was adjudged as the best treatment which resulted in complete mortality and prevented the subsequent development of the pest. The results were in accordance with the findings of Ziaee and Ganji (2016) [17] who reported that silica nanoparticles applied against adults of *Rhyzopertha dominica* and *Tribolium confusum* at different doses of 50, 100, 200 and 300 mg kg^{-1} on wheat and barley had shown the mortality of both the insect species have increased with increasing concentrations and time of exposure. Similarly, Boraei and Nilly (2015) [2] also reported that the toxicity of silica nano particles at different concentrations against three main stored grain insects *viz*., *Sitophilus oryzae*, at 2.5 g kg^{-1}, *R. dominica* at 1.5 g kg^{-1} and *Callosobruchus maculatus* at 1g kg^{-1} had shown 100 per cent mortality of insects also further indicated that the complete reduction in F_1 progeny obtained at the same concentrations for all the three pests. The results are in agreement with further findings by Rouhani *et al.* (2013) [12] with nano silica applied @ 2.5 g kg^{-1} against *C. chinenis*., Debnath *et al.* (2011) [4] with nanosilica applied @ 2 g kg^{-1} against *S. oryzae* have achieved 100 per cent mortlity and Stadler *et al.* (2012) [15] with nano alumina @ 125, 250, 500 and 1000 ppm against *S. oryzae* have obtained complete mortality at 15 days after treatment. Salem *et al*. (2015) [13] reported nano aluminum oxide against *Tribolium castaneum* have caused mortality and inhibited the number of progeny.

Conclusions
Among the three nanocides, nano silica applied at dosage of 0.5 g kg^{-1} and 0.25 g kg^{-1} caused immediate mortality and reduced oviposition and adult emergence of *L. serricorne*.

Acknowledgement
At the very outset, I submit the commodious and indefinite thanks to my family members, friends and teachers for successful accomplishment of three years in this college and to present this diminutive piece of work. I am grateful to Professor Jayashankar Telangana state agricultural University and Government of Telangana for the financial help in the form of stipend during my study period which can't be forgettable.

References
1. Bhattacharyya A, Bhaumik A, Rani PU, Mandal S, Epidi TT. Nano-particles - A recent approach to insect pest control. African Journal of Biotechnology. 2010; 9(24):3489-3493.
2. Boraei DM, Nilly AH. Entomotoxic effect of aerosil nano particles against three main stored grain insects. International Journal of Advanced Research. 2015; 3(8):1371-1376.
3. Debnath N, Mitra S, Sumistha D, Goswami A. Synthesis of surface functionalized silica nanoparticles and their use as entomotoxic nanocides. Powder Technology. 2012a; 221(5):252-256.
4. Debnath N, Sumistha D, Dipankar S, Ramesh C, Somesh Ch, Bhattacharya, Arunava G. Entomotoxic effect of silica nanoparticles against *Sitophilus oryzae* (L.). Journal of Pesticide Science. 2011; 84:99-105.
5. Dimetry NZ, Barakat AA, El-Metwally HE, Risha EME, Abd El Salam AME. Assessment of damage and losses in some medicinal plants by the cigarette beetle (*Lasioderma serricorne* Fabricius). Bulletin of the National Research Centre. 2004; 29(5):325-333.
6. Hagstrum D, Subramanyam B. Stored product Insect Resource. AACC Press, Wahington, DC. 2009, 62-67.
7. Indiastat. 2015. www.Indiastat.com.
8. Jacob S. Host preference of the cigarette beetle, *Lasioderma serricorne* Fabricius to few stored spices. Plant Protection Bulletin. 1992; 44(2):16-17.
9. Mohamed Ragaei, Al-kazafy HS. Nanotechnology for insect pest control. International Journal of Science, Environment and Technology. 2014; 3(2):528-545.
10. Nykypanchuk D, Maye MM, Van der Lelie D, Gang O. DNA guided crystallization of colloidal nanoparticles. *Nature*. 2008; 451(1):549-552.
11. Ravindran PN, Nirmal Babu K, Sivaraman K. Turmeric-The genus Curcuma. CRC Press. 2012, 183-185
12. Rouhani M, Samih MA, Kalantari S. Insecticidal effect of

silica and silver nanoparticles on the cowpea seed beetle, *Callosobruchus maculatus* F. (Coleoptera: Bruchidae). Journal of Entomological Research. 2013; 4(4):297-305.

13. Salem AA, Hamzah AM, Nariman ME. Aluminum and Zinc Oxides nanoparticles as a new method in controlling the red flour beetle, *Tribolium castaneum* (Herbest) compared to malathion insecticide. J. Plant Prot. and Path. 2015; (1):129-137.
14. Stadler T, Buteler M, Weaver DK. Novel use of nano structured alumina as an insecticide. Pest Management Science. 2010; 66(2):577-579.
15. Stadler T, Buteler M, Weaver DK, Sofie S. Comparative toxicity of nano structured alumina and a commercial inert dust for *Sitophilus oryzae* (L.) and *Rhyzopertha dominica* (F.) at varying ambient humidity levels. Journal of Stored Product Research. 2012; 48:81-90.
16. Vidya H, Awaknavar JS. Host suitability of different spices to cigarette beetle, *Lasioderma serricorne* Fab. (Anobiidae: Coleoptera). Insect Environment. 2004; 10(4):176-177.
17. Ziaee M, Ganji Z. Insecticidal efficacy of silica nanoparticles against *Rhyzopertha dominica* F. and *Tribolium confusum* Jacquelin du Val. Journal of Plant Protection Research. 2016; 56(3):250-256.