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Deepak Kumar Jaiswal
Department of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh, India

SVS Raju
Department of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh, India

Ingle Deepak Shyamrao
Department of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh, India

Prateek Singh
Department of Horticulture, SHIATS, Allahabad, Uttar Pradesh, India

G Srasvan Kumar
Department of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh, India

Correspondence
Deepak Kumar Jaiswal
Department of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh, India

Effect of some seed protectants on adult emergence of pulse beetle, *Callosobruchus chinensis* (L.) in fresh chickpea seeds under storage conditions

Deepak Kumar Jaiswal, SVS Raju, Ingle Deepak Shyamrao, Prateek Singh and G Srasvan Kumar

Abstract
The experiment was carried out under laboratory conditions in which four seed protectants *i.e.* neem oil 0.03% EC @ 6.00 ppm, deltamethrin 2.8% EC @ 1.40 ppm, U.V. radiation @ 254 nm for 5 minutes and diflubenzuron @ 1.00 ppm were tested against pulse beetle, *Callosobruchus chinensis* L. on fresh chickpea seeds under laboratory conditions as a preventive measure. The standard quantity of each treatment was mixed with 500 grams of disinfected (fresh) chickpea seeds and kept in glass jars covered with muslin cloth and a sample of 25 gram each from those bulk treated fresh chickpea seeds were drawn at 24 h, 48 h, 72 h, 96 h and 120 h after exposure to various treatments and three pairs of newly emerged male and female adults were released. The adults of *C. chinensis* that emerged from different treatments were counted at 30, 60, 90 and 120 days interval of egg laying and kept at room temperature. The minimum adult emergence was observed when the chickpea seeds treated with deltamethrin followed by diflubenzuron and neem oil whereas maximum pulse beetle count was recorded on U.V. irradiated seeds in the samples those were drawn at various intervals of 24 h, 48 h, 72 h, 96 h and 120 hours after 30 days of storage. A similar trend was found even after 60 days, 90 days & 120 days of storage. All the treatments differed significantly among themselves and also differed significantly with control treatment. The losses were increased with increase in storage period.

Keywords: Some seed protectants, adult emergence, pulse beetle, *Callosobruchus chinensis* (L.)

Introduction

Pulses being the richest source of protein play an important role in the diet of rural and urban masses. Pulses provide a balanced diet for millions of people provided it is eaten in proper combination with cereals. They are good substitute of meat, fish and egg. The total pulse grown area is about 25.25 million hectares and production is only 16.47 million tonns (Directorate of economics and statistics, 2016) in India. Among the pulses, chickpea [*Cicer arietinum* (L.)] play a vital role in the expansion of agricultural economics of developing countries like India. Chickpea is an important source of protein, enriched human food and animal feed particularly for the low income population in India. It contains 38-59% carbohydrate and 25.30-28.90% protein which is the maximum nutrients provided by any pulse having no any specific major anti-nutritional factor. Pests both in the field and during storage attack chickpea. During storage this commodity is severely attacked by been beetle, *Callosobruchus chinensis* L. (Coleoptera: Bruchidae). It is an important major insect pest for grain legumes in many tropical and subtropical countries. Even up to 100% loss of pulse seeds was found due to infestation of pulse beetle in several experiments. Most of the cereals and pulses have to be stored by the producer in their home and by the traders and the Governmental agencies in go-downs for one year or more for future use. So, insect pests are the major problem for storing cereals and pulses.

Now a day's agriculture relies heavily on the use of pesticides, so, there is a challenge to reduce pesticide uses while maintaining proficient levels of pest control. Earlier synthetic insecticides had been used and are still being employed for the control of such pests. However, these approaches have several drawbacks that are well known. Synthetic insecticides are deleterious to man, livestock and to the environment. Further, their application may require skilled workers and farmers which is lacking and also, each generation of insects have evolved and developed resistance to several pesticides. In addition, due to non-selective insecticides beneficial insects are being killed thereby causing an imbalance in the ecosystem. Consequently, more target specific and eco-friendly compounds are needed to replace the

environmentally persistent chemicals having broad-spectrum toxicity which is being phased out.
Therefore, other strategies such as irradiation, phytochemicals, bio-pesticides, insect hormones and natural enemies are being utilized instead of traditional chemical pesticides. Moreover as compared to conventional synthetic insecticides, synthetic pyrethroids have many advantages like low toxicity to mammals and high toxicity to insects but still these approaches are destined to be non-hazardous to human health, eco-friendly, less expensive, and more importantly, are more specific to the target pest population. Ionizing radiations like x-rays and gamma rays (Follett *et al*., 2007 and Tandon *et al*., 2009) [6, 10], and non-ionizing radiations like ultraviolet (U.V) rays (Faruki *et al*,. 2005, 2007 and Begum *et al*., 2007, 2009) [5, 4, 2, 3] and microwave radiation (Zhao *et al*., 2007; Gasemzadeh *et al*., 2010) [11, 7] have been employed to limit reproduction and survival of a variety of insect pest species. Likewise, the chitin synthesis inhibitors (CSI) which regulate the insect population through the disruption of chitin synthesis also play an important role in stored grain pest management. These compounds appear to fit the requirements for third generation pesticides that disrupt the normal development of several species of insects. These compounds are effective suppressors of development for the entire life cycle of insect pests. In this order, to replace the chemicals with alternatives, neem based bio-pesticide formulations have also been scanned for their pesticidal properties.
Keeping these facts in mind, a study was undertaken in which the main objective was to assess the adult emergence of *C. chinensis* in fresh chickpea seeds under storage conditions.

Materials and methods
A laboratory experiment was conducted on assessment of adult emergence of *C. chinensis* L. in chickpea under storage conditions in the department of Entomology and Agricultural Zoology, Banaras Hindu University, Varanasi during year 2016-17.

Rearing and maintenance of culture
The mother culture of the pulse beetle was maintained on locally purchased and disinfected fresh chickpea seeds at 30±1 ºC and relative humidity 70±5% in BOD incubator in the laboratory. The nucleus culture of *C. chinensis* was started from a fifteen pairs of one day old beetles from the initial culture were released in cylindrical jars measuring (25×15×10 cm) containing 500 gram seeds. The jars were covered with muslin cloth and tied with rubber band. The jars were kept at ambient condition in the laboratory in order to get a continuous supply of adults for further experimentation. The insects were handled carefully with the help of a pair of forceps having blunt ends, camel hair brush and aspirator were used invariably for transferring insects in glass jars.

Experimentation
Experiment was carried out for the study of bio-efficacy of commercial neem based bio-pesticide formulation, deltamethrin, U.V. radiation and diflubenzuron as preventive measure on pulse beetle, *C. chinensis* in stored chick pea (fresh seeds). Neem oil 0.03 EC @ 6.00 ppm, deltamethrin 2.8 EC @ 1.40 ppm, U.V. radiation @ 254 nm for 5 minutes and diflubenzuron @ 1.00 ppm were tested as seed protectants against pulse beetle. At a constant dose for each treatment, one kg of fresh chickpea seeds in glass jars (18×20×10 cm) were treated through hand sprayer and exposed under U.V. radiation.

Observation (Adult emergence)
A sample of 25 gm each from those bulk treated fresh chickpea seeds were drawn at 24 h, 48 h, 72 h, 96 h and 120 h after exposure to various treatments and three pairs of newly emerged male and female adults were released. The adults of *C. chinensis* that emerged from different treatments were counted at 30, 60, 90 and 120 days interval of egg laying and removed from respective jars after every counting to avoid the confusion of recounting.

Statistical Rationale
The data obtained were subjected to analysis through completely randomized design and replicated thrice with four treatments along with control to study the effect of these treatments on seed infestation. Observations were recorded at the mentioned intervals and statistical analysis was carried out thereafter.

Results and Discussions
Virtually, the statistical evaluation of plant powders tested over various intervals is summarized in table 1 and depicted in figure 1. In this experiment most of the seed protectants were significantly effective over control with regards to adult emergence.

Table 1: Efficacy of certain treatments as a preventive measure on adult emergence of *C. chinensis*

Treatments	Mean number of adult emergence over control at different hours of exposure after																			
	30 DAS					60 DAS					90 DAS					120 DAS				
	24 HAT	48 HAT	72 HAT	96 HAT	120 HAT	24 HAT	48 HAT	72 HAT	96 HAT	120 HAT	24 HAT	48 HAT	72 HAT	96 HAT	120 HAT	24 HAT	48 HAT	72 HAT	96 HAT	120 HAT
Deltamethrin	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
Diflubenzuron	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	3.00 (1.86)	0.33 (0.88)	0.67 (1.00)	1.00 (1.10)	5.00 (2.32)	12.00 (3.52)	1.00 (1.22)	1.33 (1.18)	2.00 (1.56)	8.67 (2.99)	22.67 (4.81)	0.00 (0.71)	5.67 (2.47)	8.67 (3.00)	13.33 (3.68)	34.33 (5.88)
Neem oil	4.00 (2.11)	9.00 (3.07)	17.00 (4.17)	25.00 (5.02)	41.00 (6.43)	12.00 (3.51)	19.00 (4.41)	29.00 (5.42)	39.00 (6.28)	59.00 (7.70)	28.00 (5.34)	43.00 (6.58)	69.00 (8.33)	88.00 (9.40)	96.00 (9.82)	21.00 (4.63)	31.00 (5.61)	45.00 (6.73)	59.00 (7.71)	72.00 (8.50)
U.V. Radiation	12.00 (3.50)	21.00 (4.63)	33.00 (5.76)	39.00 (6.27)	44.00 (6.66)	23.00 (4.84)	43.00 (6.58)	68.00 (8.27)	69.00 (8.33)	81.00 (9.01)	69.00 (8.33)	89.00 (9.46)	97.00 (9.87)	102.00 (10.12)	121.00 (11.02)	46.00 (6.81)	71.00 (8.45)	89.00 (9.46)	90.00 (9.51)	105.00 (10.26)
Untreated	30.00 (5.52)	33.00 (5.78)	37.00 (6.12)	44.00 (6.67)	49.00 (7.04)	60.00 (7.78)	64.00 (8.03)	72.00 (8.51)	78.00 (8.86)	85.00 (9.24)	110.00 (10.51)	114.00 (10.70)	120.00 (10.97)	127.00 (11.29)	133.00 (11.55)	95.00 (9.76)	96.00 (9.82)	98.00 (9.92)	102.00 (10.12)	109.00 (10.46)
S.E (m)	0.185	0.128	0.232	0.226	0.183	0.189	0.227	0.226	0.169	0.244	0.162	0.260	0.166	0.222	0.159	0.179	0.146	0.220	0.212	0.266
C.D	0.592	0.407	0.742	0.722	0.583	0.602	0.723	0.721	0.540	0.779	0.518	0.830	0.531	0.708	0.509	0.571	0.466	0.703	0.675	0.848

*Figures in parenthesis are angular transformed values. DAS: Days after storage, HAT: Hours after treatment

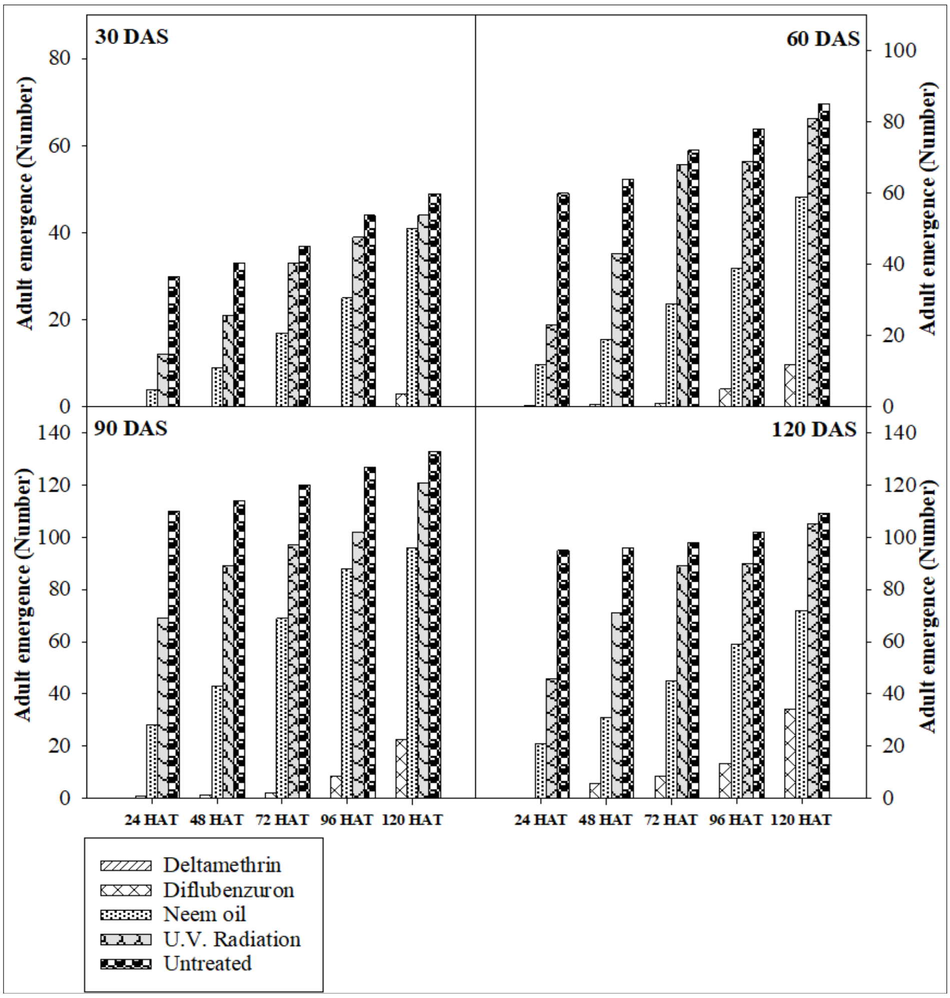

Fig 1: Efficacy of certain treatments as a preventive measure on adult emergence of C. chinensis

After one month of storage no adult emergence in deltamethrin 2.8 EC @ 1.40 ppm treated grain and negligible adult emergence in diflubenzuron 25% WP @ 1.00 ppm treated grain were observed that clearly indicates that deltamethrin and diflubenzuron either killed the released adults or delayed the adult emergence. However, neem oil @ 6.00 ppm and U.V. radiation @ 254 nm intensity recorded considerable number of adult emergence in increasing pattern (24 HAT to 120 HAT) which might be due to low impact of the treatments and high per cent survival of adults after one month of storage.

Further, it was also observed that the population build-up was initially slow, however it increased suddenly after first and second months showing multiple increase in the population of pulse beetle over the initial infestation. Even after two months of storage no adult emergence in deltamethrin 2.8 EC @ 1.40 ppm treated seed and least adult emergence in diflubenzuron 25% WP @ 1.00 ppm treated seed were observed. However, neem oil @ 6.00 ppm and U.V. radiation @ 254 nm intensity recorded considerable number of adult emergence in increasing pattern (24 HAT to 120 HAT) after two months of storage.

Even after three months of storage deltamethrin 2.8 EC @ 1.40 ppm continued to be best protectant of the stored chickpea showing no adult emergence. Diflubenzuron 25% WP @ 1.00 ppm continued to be the second best effective treatment showing least adult emergence. The effectiveness of treatments such as neem oil @ 6.00 ppm and U.V. radiation @ 254 nm intensity reduced drastically resulting into adult emergence of 96.00 and 121.00, respectively in increasing pattern (24 HAT to 120 HAT).

During the subsequent months the population build-up slowed down in chickpea and even after four months of storage deltamethrin 2.8 EC @ 1.40 ppm was found to be the only treatment giving cent per cent protection (no adult emergence). The treatment diflubenzuron 25% WP @ 1.00 ppm seed was found to be second best in protecting chickpea up to four months of storage. Neem oil @ 6.00 ppm and U.V. radiation @ 254 nm intensity as preventive measures gave minimum protection against bruchid and maximum adult emergence were found in increasing pattern in all the treatments even after four months of storage.

The present findings are in close accordance with the results of Srivastava and Jha (2007) [9], and Lal and Dikshit (2001) [8] who reported full protection of pulses with deltamethrin against *C. chinensis.* From the present study, it can be concluded that deltamethrin 2.8 EC @ 1.40 ppm and diflubenzuron 25% WP @ 1.00 ppm seed can be used for successful protection of chickpea seeds up to four months of storage.

Conclusions

The results in compilation demonstrate that deltamethrin is a promising treatment followed by diflubenzuron and neem oil for longer storage of chickpea seeds as far as adult emergence is concerned. While, U.V. irradiated seeds recorded maximum adult emergence and showing poor results. Therefore, it is worthwhile to study extensively to control *C. chinensis* through deltamethrin and diflubenzuron.

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