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RESEARCH ARTICLE

Eco-friendly management of pulse beetle (*Callosobruchus chinensis* L.) in stored chickpea (*Cicer arietinum*) under laboratory conditions

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ABSTRACT : An experiment was conducted to know the effect of Eco-friendly management of pulse beetle in chickpea (Vaibhav) storage at ambient conditions. The nine eco-friendly protectants, Dhatura seed powder, Tobacco leaf powder, Bhaitt leaf powder, Leman leaf powder, Ginger rhizome powder, Bitter gourd seed powder, Asafoetida latex, Gunghchi seed powder, and Alocasia leaves powder will be used in the experiment. The different observations *viz.*, per cent moisture contents, per cent infestation and per cent germination were evaluated at 3 to 6 months of storage. The results revealed that all Protectants were statistically significantly superior to untreated check. Per cent infestation being main parameter of protectants, the maximum moisture content, germination per cent and minimum infestation in asafoetida latex and maximum infestation, minimum germination in ginger rhizome powder and minimum moisture contents in alocasia leaf powder after three months storage. Maximum germination, minimum infestation in asafoetida latex and maximum moisture content in gunghchi seed powder, minimum in tobacco leaf powder and maximum infestation, minimum germination in alocasia leaf powder after six months storage period. Eco-friendly protectants can be used as sustainable, safer human and environment, alternative to Protectants for long term storage of pulses.

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Key Words :
Callosobruchus chinensis, eco-friendly, *Cicer arietinum*

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Chickpea (*Cicer arietinum* L.) is one of the most extensively grown *Rabi* pulse crop in India. It is high nutritional value in pulses and is cultivated all over the world. It is ranked third in the important leguminous food items. Its seed contain 38-59 per cent carbohydrate, 3 per cent fibre, 4.8-5.5 per cent oil, 3 per cent ash, 0.2 per cent calcium, and 0.3 per cent phosphorus (Hulse, 1991). Heavy qualitative and quantitative losses occur due to the attack of pulse beetle, *Callosobruchus chinensis* L. in the stored chickpea seeds and other stored grains such as beans, gram and lentil seeds in the developing countries. Invasion of this insect causes reduction in germination of seeds, weight loss and lower market value (Raja and William, 2008; Patel, 2011; Sagheer *et al*., 2013; Islam *et al*., 2013 and Tesfu and Emana, 2013).

Numerous control methods have been used for the control of *C. chinensis* including the use of larval parasitoids as biological control agents, changes in the temperature of storage house and microwave energy use. Synthetic chemicals use is not promising as

this pest feeds internally in the seeds. Similarly, it is impossible to mix synthetic insecticides with food grains due to health threatening chemical residues. The only possible solution is the use of fumigants in the airtight stores. Nevertheless, most of the pulses are stored in homes by the farmers at village level; therefore, fumigants cannot be used as promising agents.

There is a need to find some alternative procedures for the control of *C. chinensis*. These methods should be cheaper, safe to environment and human health and highly effective in use (Regmi and Dhoj, 2011, Park *et al*., 2003; Islam *et al*., 2013; Khan *et al*., 2013; Thein *et al*., 2013 and Haily, 2015). An alternative method found is the use of plant parts and their products as repellents and deterrents such as essential latex and powders of some parts of plants (Sagheer *et al*., 2013; Khan *et al*., 2014 and Hasan *et al.*, 2014).

The present studies were carried out to evaluate the effect of eco-friendly Protectant against pulse beetle, *C. chinensis* reared on chickpea in the laboratory.

EXPERIMENTAL METHODOLOGY

The experiments were carried out during 2013 and 2014 in the storage laboratory of the Department of Entomology at Narendra Deva University of Agriculture and Technology Narendra Nagar, (Kumarganj) Faizabad, India

Rearing of the test insect :

According to Jat *et al*. (2013), the culture of pulse beetle was maintained on chickpea at ambient condition in the Seed Entomology laboratory. Chickpea procured from local market at Kumarganj, it was cleaned, washed, dried and then sterilized at temperature of 50ºC overnight to eliminate the hidden infestation, if any. The nucleus culture of *C. chinensis* was started from a single pair and was multiplied in rearing jars (25cm x 15 cm x 10 cm) by releasing 10 pairs of one day old adults in each glass jar containing 500g seeds for oviposition. After 48h adults were remove from the jars and discarded. The jars were covered with muslin cloth and tied up with rubber bands. These jars were kept at ambient condition in the laboratory. In order to get a continuous fresh supply of adults of *C. chinensis* for experimentation dated culture was maintained at regular time intervals using the above rearing technique. During experimentation a pair of forceps, camel hair brush and aspirator was invariably used for transferring insects in seeds.

Preparation of test plant materials :

Fresh plant leaves of Tobacco, Bhaitt, Leman, Alocasia, and seed of Dhatura, Bitter gourd and Gunghchi were collected from the N.D.U.A.T. campus and nearby the villages, and Asafoetida latex and Ginger rhizome were purchased from nearby market, washed and air-dried in the shade. Dried leaves and seeds were then ground to powder using an electric grinder. Each plant product was labelled and kept in laboratory for future use.

Preparation of the test seed :

The popular variety Vaibhav was used in the experiment. The chickpea variety was collected from Department of Genetic and Plant Breeding, N.D.U.A.T. Kumarganj, Faizabad. The chickpea seeds were subjected to fumigation using Aluminium Phosphate (3g tab.) @ 1 tab. / 3 quintal disinfested before starting the experiment with seven days of exposure periods. These seeds were then packed into polythene bags and later used for the experiment.

Execution of the experiment :

The experiment will be conducted in CRD with 10 treatments including chick and 3 replication. For this experiment 15 kg disinfested seed of Vaibhav and 30 jute bags of 1 kg capacity will be used. In each bag 500 g seed treated with (5 g) eco-friendly seed protectants as per schedule. The freshly emerged *C. chinensis* were taken from culture already maintained for this purpose and were released 10 pairs of 1-3 days old adults in each bag, the mouth of tight with help of thread. The bags were kept on steel racks at ambient conditions in seed section Department of Entomology. Per cent grain moisture, per cent grain infestation and per cent grain germination was calculated three and six months after experiment.

Per cent grain moisture :

Grain moisture content was calculated by randomly selecting 100 grain in each bag, were recorded with help of Steinlite Electronic Moisture Meter three and six months of experiment.

Per cent grain infestation :

The per cent infestation of each variety was calculated by separating healthy grains (without holes)

from the sieved samples and was used for per cent infestation calculations using the formula :

$$\text{Per cent grain infestation} = \frac{\text{(Initial weight - Weight of sount grains)}}{\text{Initial weight}} \times 100$$

Per cent grain germination :

The germination tests were carried out according to International Rules of Seeds Testing (Anonymous, 1976). For assessing the germination of grains mixed with different materials and of untreated grains, a lot of 100 seeds were drawn from each replication and soaked in water for 24 hrs and then placed in petri dishes over a wet filter paper. These petri dishes were kept at a temperature of 28±2ºC and the numbers of germinated grains were counted up to one week and the percentages of germination were calculated :

$$\text{Germination per cent} = \frac{\text{(Number of seeds germinated)}}{\text{Number of seeds kept for germination}} \times 100$$

EXPERIMENTAL FINDINGS AND DISCUSSION

Storage periods of chickpea seed (3 and 6 months) had a significant effect on storage efficacy characters (moisture contents, per cent infestation and per cent germination) as shown in Table 1.

Effect of eco-friendly protectants on seed moisture:

The per cent moisture content in chickpea seeds treated with different eco-friendly protectants at different periods of storage was found to be significant (Table 1). Asafoetida latex and gunghi seed powder showed the maximum moisture contents in compared to all other eco-friendly protectants including the control. The minimum moisture contents in alocasia leaf powder in three months of storage.

All the eco-friendly protectants were increased moisture contants significantly as compared to untreetad control. Amongst them maximum increased in bhaitt leaf powder followed by alocasia leaf powder and gunghahi seed powder, respectively, but all these eco-friendly protectants cause of par statistically. Eco-friendly protectants also increased of moisture over control, after six months storage.

The results divulged eco-friendly protectants to be the beast anticipating treatment in maintained the moisture contents in storage period. Regmi and Dhoj (2011) studied the eco-friendly protectants of *X. armatum* was better performance in maintaining moisture per cent in chickpea seed against *C. chinensis* during storage period. Ubairah *et al.* (2014) reported that the increase in moisture per cent in chickpea seed during storage time. Tabatabaei (2013) and Azadi and Younesi (2013) reported that the proper storage and optimum seed moisture contants can affect the grain quality. Mukhopadhyay *et al.* (2010) tested effect of moisture in seed viability and germination during storage under ambient condition. Basavegowda *et al.* (2013) reported that the effect of moisture in seed quality of chickpea during storage.

Table 1 : Seed moisture content, infestation per cent and per cent germination of various eco-friendly seed protectants after 3 and 6 months of storage against *C. chinensis* under laboratry conditions

Treatments	Protectants	After three months storage			After six months storage		
		Moisture (%)	Infestation (%)	Germination (%)	Moisture (%)	Infestation (%)	Germination (%)
T_1	Dhatura seed powder	10.75	1.48	95.02	10.94	4.58	87.12
T_2	Tobacco leaf powder	9.44	1.69	92.74	9.77	23.45	76.02
T_3	Bhaitt leaf powder	9.67	1.57	93. 23	10.33	20.20	78.91
T_4	Leman leaf powder	9.94	2.09	90.71	10.18	24.89	73.32
T_5	Ginger rhizome powder	10.56	2.83	87. 14	10.71	31.17	66.72
T_6	Bitter gourd seed powder	10.75	2.36	89. 48	10.95	27.05	71.51
T_7	Asafoetida latex	10.85	1.02	97.21	11.14	2.88	90.36
T_8	Gunghchi seed powder	10.81	1.33	95.95	11.15	4. 29	87.88
T_9	Alocasia leaf powder	9.26	2.71	88.89	9.88	30.53	68.87
T_{10}	Untreated control	10.65	2.94	84.63	10.68	43.65	55.83
S.E. ±	-	0.29	0.08	1.11	0.27	0.58	1.63
C.D. (P=0.05)	-	0.87	0.23	3.28	0.81	1.72	4.80

Effect of eco-friendly protectants on seed infestation :

Significant differences in pulse beetle infestation were observed with in chickpea seed treated with eco-friendly protectants at different storage intervals (Table 1). All the three commercially available eco-friendly protectants *viz.,* asafoetida latex, gunghahi seed powder and dhatura seed powder recorded less insect infestation (1.5 %) and on par with bhaitt leaf powder and tobacco leaf powder but found significantly superior to other eco-friendly protectants and untreated control up to three months of storage.

Asafoetida latex proved to be superior to other eco-friendly protectants with lowest insect infestation on par with gunghachi seed powder and dhatura seed powder compared to high infestation recorded with untreated chick. Whereas eco-friendly protectants *viz.,* bhaitt leaf powder, tobacco leaf powder, leman leaf powder, bittergard seed powder and alocasia leaf powder proved ineffective against pulse beetle in chickpea and recorded high insect infestation.

The present research findings are in agreement with the findings of earlier researchers who have reported the efficacy of some botanicals against pulse beetle in chickpea (Venkatesham *et al*., 2014). Herbal control of stored grain pest *Bruchus chinensis* on cowpea conducted by Chaudhari (2013) showed that the infestation by the *Bruchus chinensis* was reduced on asafoetida treated cowpea. Verma *et al*. reported that the plant based eco-friendly protectants preservatives for insect control. Studies conducted by Gupta *et al*. (2015) showed that tobacco leaf powder could effectively protect green gram seed from damage of *C. chinensis*. They also found that tobacco leaf powder was effective in reducing the damage. Manzoor *et al*. (2011) tested dhatura extract against *C. chinensis* in the laboratory and found that 10 mg/g extract gave 31.67 per cent mortality of different stages of the pest up to seven day.

Toxicity of plant based protectants have also been reported by earlier workers with various lemon extracts which have repellent, antifeedant and toxic effects against a number of stored grain insect pests (Poornasundari and Danie, 2015). Khalequzzaman and Osman Goni (2009) found that toxic effect of tobacco leaf powder was observed up 7 days. Between 70.00c±5.77 to 96.66a±3.33 per cent mortality rates were recorded of *C. chinensis*. Present findings are similar with the study of Maji *et al*. (2014) who reported that ginger rhizome powder provided (72.66 %) mortality of pulse beetle. The current research of plant based insecticide against *C. chinensis* in pulse storage Rugumamu (2015); Tesema *et al*. (2015); Singh (2011); Zia *et al*. (2011) and Singh (2011) showed that plant based insecticide could be very effective protectants of stored seed against *C. chinensis*.

Effect of eco-friendly protectants on seed germination :

Among the different eco- friendly protectants, seeds treated with asafoetida latex registered the highest seed germination (97.21 and 90.36 %, respectively at three, six months after storage, respectively). Except ginger rhizome powder (87.14%), all other eco-friendly protectants recorded highest seed germination (>88.89%) compared to untreated check (84.63%) after three months of storage of chickpea (Table 1). The data of six months of storage indicated that eco-friendly protectants *viz.,* asafoetida latex was recorded high germination (>90%) and proved significantly superior to other protectants, gunghchi seed powder (87.88%) and dhatura seed powder (87.12%) or both maintained the seed germination above seed certification standards. Bhaitt leaf powder (78.91%), tobacco leaf powder (76.02%), leman leaf powder (73.32%), bitter gourd seed powder (71.51%), alocasia leaf powder (68.87%) and ginger rhizome powder (66.72 %) was statistically significant to untreated check (55.83%). Similar reports of higher germination of chickpea seeds due to eco-friendly management was reported by (Haile**,** 2015). The better germination in cowpea seed treated with asafoetida against *C. chinensis* in 8 months of storage, Srivastava *et al*. (2012-13). These findings are in accordance with the findings of earlier workers. Tabu *et al*. (2012) generally treatment of chickpea seeds with botanicals inert dusts and edible oils did not show any adverse effect on germination of seeds 90 days after treatment. It also showed that plant materials tested against *C. maculatus* did not show any adverse effect on germination capacity of the cowpea seeds Asawalam and Anaeto (2014). The perusal of the data obtained on the effect of grain protectants on germination of pigeonpea seeds suggested that absolutely there was no negative effect of these grain protectants on the germination of the seeds Vishwamithra *et al*. (2013). Biswas and Biswas (2005) reported various plant based oils including karanj oil as

very effective in reducing the adult emergence of *C. chinensis* without impairing the seed germination in gram.

Conclusion :

The plant based protectants of dhatura seed powder, tobacco leaf powder, bhaitt leaf powder, lemon leaf powder, ginger rhizome powder, bitter gourd seed powder, asafoetida latex, gunghchi seed powder and alocasia leaves powder was found to be significantly reducing the insect infestation, loss in germination and increased per cent moisture contents in comparison to control. The maximum germination, minimum infestation in asafoetida latex and maximum moisture content in gunghchi seed powder, minimum in tobacco leaf powder and maximum infestation, minimum germination in alocasia leaf powder after six months storage period. The plant based protectants is eco-friendly, sustainable, safer human and environment and beast management of bruchid in chickpea and other related pulses.

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