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Potency of botanical extracts on management of pulse beetle (*Callosobruchus chinensis* L.)

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Abstract

Experiments were conducted to study the efficacy of botanical extract and chemical insecticide on the germination of pulse beetle (*Callosobruchus chinensis*) infested seeds of black gram (*Phaseolus mungo*), gram (*Cicer arietinum)*, and mung bean (*Vigna radiata*). Neem extract (10%) and garlic extract (10%) were used as botanical extract where as 1% sevin 85 SP was used as chemical insecticide. From the foregoing analysis here in, it was observed that neem extract treated pulse seeds were germinated into highest number of normal seedlings in comparison with garlic extract and sevin 85 SP treated seeds when one day and ten days infested seeds were taken under consideration. But there was no significant difference in producing normal seedlings among neem extract, garlic extract and sevin 85 SP in case of thirty days infested pulse seeds due to the fact that adult insect emerged and leaved the pulse seeds at this time. The germination of normal seedlings varied from pulse species to number of days of seed infestation.

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Introduction

Pulses occupy an important role in the diet of the people as well as the agriculture of Bangladesh. Undoubtedly, pulses have been considered as poor man's meat for the under privileged people who cannot afford animal proteins. The pulse beetle, *Callosobruchus chinensis* L. (Coleoptera: Bruchidae) is the most widespread and destructive major insect pest of economically important leguminous grains such as green gram, chickpea, black gram, peas, cowpea, lentil and pigeon pea (Aslam *et al.,* 2002, Park *et al.,* 2003). In the stored products insect pests not only feed on the food grain but also oviposit as well as cause organic changes, bad odors, fermentation and acidification of the food grains which reduces the nutritional value. Due to the attack of the insect, the damaged grains become susceptible to various microorganisms. Moulds grown in the infested food grains produce poisonous chemical substances like Alfa toxin which is previously reported to be associated with the liver cancer of human being (Singh, 1989). Synthetic insecticides, viz. organophosphates and fumigants are mainly used as effective means to control this insect population for the protection of stored food from insect infestation. These chemicals lose their effectiveness gradually due to development of resistance in *Callosobruchus chinensis*. Moreover, toxic residues of these chemicals may pose risk to human health and the environment (Isman, 2006, Rajendran and Sriranjini, 2008). So, it is also not safe to mix insecticides with food grain for protection against insects (Bekele *et al.*, 1995). Therefore, alternative methods such as the use of ash, edible oils and plant products that could be easily used by farmers need to be considered (Isman, 2008). Farmers and researchers often claim the successful use of ash (Ofuya, 1986, Ajayi *et al.,* 1987) and plant extracts (Chiasson *et al.,* 2004, Yankanchi and Patil, 2009) in insect pest control. Botanicals (plant powders) are also used as grain protectants as these have insecticidal properties against stored grain insect pests (Bakkali *et al.,* 2008, Isman and Machial, 2006) as well as safer for human health and the environment (Rahmani *et al.*, 1992). It has been reported that certain plant preparations and traditional methods are much safer than chemical insecticides (Weaver and Subramanyam, 2000, Yankanchi and Patil, 2009). Therefore, plant materials should be explored to protect stored products against pest infestation. The objective of this research work was to find out potentiality of some plant materials over commercially available chemical pesticides to prevent *C. chinensis* infestation during pulse seed storage.

The present research was carried to determine the efficacy of neem (*Azadirachta indica*) and garlic (*Allium sativum*) as protectants against *C. chinensis* infestation of black gram (*Phaseolus mungo*), gram (*Cicer arietinum)*, and mung bean (*Vigna radiata*) in comparison with sevin 85 SP which is widely used as insecticide in Bangladesh.

Materials and methods

The experiments were conducted in the laboratory of the Department of Entomology, Bangladesh Agricultural University, (BAU), Mymensingh.

Collection of test materials

Mature seeds of black gram (*Phaseolus mungo*), mung bean (*Vigna radiata*) and gram (*Cicer arietinum*) were collected from Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh. No insecticide was used on these pulse seeds during storage. Sevin 85 SP, an organo-carbamate group chemical insecticide, was collected from local market of Mymensingh to control pulse beetles (*Callosobruchus chinensis*). Fresh neem leaf and garlic were air dried following grinding and water extraction to make 10% solution of neem leaf extract and garlic extract.

Stock culture of pulse beetle

Some adult pulse beetles were collected along with the infested gram seeds from BINA. The male and female pulse beetles of *C. chinensis* were identified before release following the identifying characteristics of male and female as described by Halstead (1963). They were reared in plastic

containers with black gram, mung bean and gram seeds to maintain a continuous laboratory culture. Just after hatching, the adult beetles were separated from the infested seeds and then transferred to another plastic container with fresh gram, black gram and mung bean seeds for multiplication. The newly emerged pulse beetles from the stock culture were utilized for the whole experiments.

Efficacy of different botanical extracts and chemical insecticide against pulse beetle

Two plant extracts, 10% neem leaf extract and 10% garlic extract, and chemical insecticide, 1% Sevin 85 SP, were applied individually against pulse beetle (*C. chinensis*) in petridish containing tweenty black gram, mung bean and gram seeds for each. Newly emerged pulse beetles were released in each petridish. Petridish containing only water was used as a control treatment. The petridishes were kept in the laboratory without any disturbances. Infested seeds were taken under germination test after one day, twenty days and thirty days respectively. The observations were made on three parameters viz. normal, deformed seedlings and non -germinated seeds and the treatments were replicated three times.

Statistical Analysis

Data obtained from the experiments on the efficacy of botanical extracts and chemical (Sevin 85 SP) on the germination of pulse beetle infested seeds were statistically analyzed in accordance with one factor Completely Randomized Design (CRD) and treatment mean values were compared by Duncan's Multiple Range Test (DMRT). All statistical analysis was done through MStat package programme in a computer.

Results

Effect on one day infested seed germination

Neem leaf extract always showed more powerful insecticidal effect than garlic extract and the chemical pesticide sevin 85 SP. In case of black gram and gram all neem treated seeds were germinated in a normal fashion while 95% neem leaf treated mung bean seeds were germinated as normal seedlings (table 1). Garlic extract and sevin 85SP showed same effect on normal seed germination of black gram. But garlic extract treated normal seed germination was higher than sevin 85 SP in case of mung bean and gram. Lowest number of normal seedlings of black gram was obtained from control (water) treated seeds, although interestingly, more normal seedlings of mung bean and gram were obtained from control treated seeds than garlic and sevin 85 SP.

Table 1. Effect of botanical extracts and chemical on germination of one day infested seeds.

Seeds	**Black gram**			**Mung bean**			**Gram**		
Treatment	Normal seedlings	Deformed seedlings	Non germinated seeds	Normal seedlings	Deformed seedlings	Non germinated seeds	Normal seedlings	Deformed seedlings	Non germinated seeds
Neem (10%)	100 a	0.00 d	0.00 c	95 a	5 c	0.00 d	100 a	0.00 c	0.00 b
Garlic (10%)	90 b	5 b	5 b	87.5 bc	7.5 b	5 a	91.25 ab	6.25 b	2.5 a
Sevin 85 SP (1%)	90 b	3.75 c	6.25 a	83.75 c	13.75 a	2.5 b	86.25 b	11.25 a	2.5 a
Control	83.75 c	10 a	6.25 a	91.25 ab	7.5 b	1.25 c	92.5 ab	5 b	2.5 a
Level of significance	**	**	**	**	**	**	*	**	**
LSD 0.05	0.958	0.108	0.233	0.956	0.438	0.084	1.693	0.275	0.137

** Significant at 1% level of probability

*Significant at 5% level of probability

Effect on ten day infested seed germination

All black gram and mung bean infested seeds were germinated into normal seedlings when treated with neem leaf extract whereas 95% normal seedlings were found in case of gram (Table 2). This is result is higher than the garlic extract, sevin 85 SP and control. Garlic extract had lowest effect on normal seed germination of ten days infested pulse seeds than sevin 85 SP and control. Though sevin 85 SP and control had same effect on normal seed germination of mung bean but it was different for black gram and gram. Sevin 85 SP showed slightly lower effect than control in black gram seed germination and higher effect in gram seed germination.

Table 2. Effect of botanical extracts and chemical on germination of ten day infested seeds.

Seeds	**Black gram**			**Mung bean**			**Gram**		
Treatment	Normal seedlings	Deformed seedlings	Non germinated seeds	Normal seedlings	Deformed seedlings	Non germinated seeds	Normal seedlings	Deformed seedlings	Non germinated seeds
Neem(10%)	100 a	0.00 c	0.00 c	100 a	0.00 d	0.00d	95 a	0.00 c	5 b
Garlic(10%)	87.5 c	8.75 a	3.75 a	85 b	10 a	5 b	85 b	6.25 b	8.75 a
Sevin 85 SP (1%)	92.5 b	3.75 b	3.75 a	90 b	1.25 c	8.75 a	91.25 ab	6.25 b	2.5 c
Control	93.75 b	5 b	1.25 b	90 b	7.5 b	2.5 c	87.5 ab	10 a	2.5 c
Level of significance	**	**	**	**	**	**	*	**	**
LSD 0.05	0.737	0.266	0.228	1.089	0.200	0.233	1.524	0.296	0.257

** Significant at 1% level of probability

*Significant at 5% level of probability

Table 3. Effect of botanical extracts and chemical on germination of thirty day infested seeds.

Seeds	**Black gram**			**Mung bean**			**Gram**		
Treatment	Normal seedlings	Deformed seedlings	Non germinated seeds	Normal seedlings	Deformed seedlings	Non germinated seeds	Normal seedlings	Deformed seedlings	Non germinated seeds
Neem(10%)	75 a	10 ab	15 b	80 a	0.00 b	20 a	75 a	10 a	15 b
Garlic(10%)	72.25 a	12.75 bc	15 b	72.5 a	6.25 a	21.25 a	73.75 a	7.5 ab	18.75 ab
Sevin 85 SP (1%)	72.5 a	12.5 a	15 b	71.25 a	6.25 a	22.5 a	73.75 a	6.25 bc	20 a
Control	72.5 a	5 c	22.5 a	71.25 a	7.5 a	21.25 a	75 a	3.75 c	21.25 a
Level of significance	NS	**	**	NS	**	NS	NS	**	*
LSD 0.05	-	0.631	0.706	-	0.472	-	-	0.566	0.868

** Significant at 1% level of probability

*Significant at 5% level of probability

Effect on thirty day infested seed germination

Neem leaf extract treated pulses seeds had higher normal seedlings than other treatments in case of black gram, mung bean and gram. But it was not significantly varied from other treatments (table 3). All treatments showed a very close result for normal seedlings generation. However, non-germinated seeds were higher than the one and ten days infested seeds also.

Discussion

We have found that plant materials are preferable for preventing *C. chinensis* infestation than chemical pesticides in some circumstances. Among all treatments neem leaf extract always had more powerful effect in prevention of *C. chinensis* infestation during pulse storage. Garlic extract showed a very similar effect as sevin 85 SP.

Maximum numbers of normal seedlings were found when neem leaf extracts were used as a treatment. However, numbers of normal seedlings were not significantly varied at thirty days infested pulse seeds because of emergence of adult and leaving the pulse seeds, botanical extracts and chemical sevin 85 SP could do no effect on interrelation between germination and infestation. Although germination of seeds into normal seedlings varies among the pulse species and the number of days of infested seeds, it is notable that botanical extracts can play a very competitive role with chemical insecticide for the protection of storage of pulses from the *C. chinensis*. Even some botanical extracts like neem has more powerful insecticidal effects than the synthetic pesticides like sevin 85 SP. Though the concentrations of botanical extracts are much higher than the chemical insecticide it is assumable that the botanical extract from neem or garlic has no side effect to environment or human. However, garlic extract has good insecticidal activity but it would be more expensive than neem leaf due the use garlic as spice in many countries like Bangladesh, India, and Pakistan etc. Therefore, we prefer neem extract than garlic not only for the more powerful insecticidal effect but also for their cheap price and local availability.

Neem has been reported and preferred as bioinsecticide for so long by many researchers. According to Jotwani and Sircar (1965), green gram, chick pea, cowpea, and pea could be protected from damage by the *Callosobruchus* species for 8-11 months by mixing powdered neem kernel with grains at 1 or 2 to 100 parts. Green gram was completely protected against pulse beetles when soaked for 20 minutes in a 1% solution of neem oil extractive (Attri and Prasad, 1980). Ali *et al.* (1983) reported that the oil of neem at 1 ml/100 g seed killed all the pulse beetle grubs and adults, and no eggs were laid on treated seed. Rahman and Talukdar (2006) documented neem oil as the best insect protectant in their study. Several researchers also reported the effectiveness of Neem against *C. chinensis* recently (Tabu *et al.*, 2012, Hasan *et al.*, 2012). Maximum mortality of pulse beetle was caused by the powder of neem and garlic as compared to other botanicals such as bitter gourd (Hasan *et al.*, 2012). But this mortality of pulse beetle was increased with the increase in exposure time.

Botanical extract for the storage of foods and seeds is not a recent approach. It is used as a protectant from many years ago. The advent of synthetic pesticides has made the extinct of botanical extracts. But residual toxicity, environmental hazards and pest resistance have made botanical extracts a prime alternative choice again. Botanical extract based pest control technology is constrained by a number of socioeconomic factors. Farmers have insufficient data on product effectiveness under farm conditions to convince them of the benefits. Besides, extension workers often do not have information to provide guidelines on correct use and timing. Therefore, extensive research work and detail economic analysis from root levels to macro levels are needed so that governments and other institutions can formulate policies on botanical extract use.

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