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POTENTIAL OF PLANT MATERIALS FOR THE MANAGEMENT OF COWPEA BRUCHID *CALLOSOBRUCHUS ANALIS* (COLEOPTERA: BRUCHIDAE) IN GRAM *CICER ARIETINUM* DURING STORAGE

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Present research was carried out to identify alternatives to synthetic insecticides to control cowpea weevil *Callosobruchus analis* (F.) population in gram seed (*Cicer arietinum* L.), during storage. The efficacies of three plant materials such as *Nicotiana tabacum*, *Citrullus colocythis* and *Aloe vera* were assessed to determine their insecticidal activities against survival of bruchid *C. analis* on seeds of gram varieties viz., CM-98 and Jubiha-1. These plant materials tested reduced weevil infestation and emergence as compared with untreated control seeds. Seeds treatment with *A. vera* followed by *N. tabacum* reduced maximum pest damage over *C. colocythis,* which proved least effective to control *C. analis* population. Consequently, the tested plant materials should be given due consideration for effective gram protection as a component of integrated pest management approach in storage.

Keywords: *Callosobruchus analis*, Biopesticides, *Cicer arietinum,* Gram, Pest.

1. Introduction

Gram (*Cicer arietinum* L.) is a staple food and contains 19.75% protein content [1]. It is subjected to a variety of insect pests attack. The cowpea weevil *Callosobruchus analis* (F.), (Coleoptera: Bruchidae) is the most common pest of stored gram. Among different legume seeds, the gram is most preferred host for oviposition and development of the bruchid *Callosobruchus* under common storage conditions [2]. It has been reported that seed quality of chickpea during storage is significantly affected in the damaged seed [3]. Protein quality of gram with different levels of *Callosobruchus* infestation observed that an increase in the infestation levels by bruchids led to deterioration in the protein quality of chickpea [4]. High infestation level of *Callosobruchus* results in decreased energy, starch, total sugars and non-reducing sugars [5]. Sarwar *et al.* [6] determined the total percentage of damage by this weevil from 38-62% among different chickpea genotypes.

Since the insecticide resistance has limited the effectiveness of many chemical insecticides, intensive efforts have been made to find out alternate methods of pest control [7]. Alternative sources of potentially suitable insecticides include botanical insecticides, antifeedants and insect growth regulators of their natural origin having non-neurotoxic modes of action and low environmental persistence [8]. The use of naturally occurring plant materials to protect agricultural products against a variety of insect pests is an old-age practice in some parts of the world [9]. Moreover, botanicals are preferred over other methods since they are easily available for large or small storages, biodegradable and least toxic to non-target organisms [10]. Certain plants possess secondary metabolites, which act as antifeedants, oviposition deterrents, larvicidal and insect growth regulators [11]. Extracts from different plants have been confirmed useful against a wide range of insect pests [12-14]. The application of biopesticides should be encouraged because of greater environmental protection and food safety concerns. Plant products have proved useful in industrialized countries for the protection of grain from storage pests [15], but these can also play a much greater role in the production and postharvest protection of food in developing countries [8]. Such botanicals used have well-known volatile and act as natural fumigants that kill adult pests and their progeny [16]. Considering the economic significance of

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gram, the severity of damage caused and the problems associated with the use of synthetic insecticides, need was felt to evaluate natural methods for the control of *C*. *analis* in storage. The present study investigated the efficacy of botanical insecticides against *C*. *analis* for a sustainable pest control strategy.

2. Materials and Methods

The *Callosobruchus analis* used in this study was originated from laboratory culture maintained at Nuclear Institute of Agriculture, Tandojam, without exposure to any insecticides. The culture was placed into desiccators having sterilized gram seeds as rearing diet at 60-65% relative humidity and 25°C, kept in darkness. Freshly emerged adult weevils were used in the present experimentation.

The plant species used as pesticide sources in the experiments were *Nicotiana tabacum* (Tobacco), *Citrullus colocythis* (Toomba) and *Aloe vera* (Kawar) collected from the field. The materials used were shade dried, powdered and sieved to obtain the finest particles. Two varieties of gram viz., CM-98 and Jubiha-1 seeds were used in this study, cultivated at the same institute. The damaged gram seeds and seeds with emergence holes or egg on the testa were considered infested and were removed. The uninfected seeds were sterilized by freezing for three weeks to kill any residual organism or insect pest.

The experiment was laid out in a Completely Randomized Design replicated three times. One set of the sterilized Petri dishes (9 cm × 1 cm) containing 25 gm of gram seeds were treated with 1 gm of the plant powders separately for each botanicals against *Callosobruchus*. Dry leaf powder was applied either as a layer above the grain mass or mixed with the grain. The other set of Petri dishes contained untreated gram to serve as control. Both sets of Petri dishes were then infested with 5 pairs of newly emerged adult bruchids of both sexes. The Petri dishes were kept in the laboratory at 25-28°C and 65-75% relative humidity. The trial was repeated using the same quantity of the grains and plant dusts for all treatments.

Healthy and damaged seeds were counted from each Petri dish after 60 days of post pest infestation. The damage caused (percent infestation, percent weight losses and frass weight) and emergence of the adult weevils were recorded to evaluate the efficacy of botanicals. The weevils were considered dead when there was no response after verifying from the abdomen by touching with a pin. The data obtained were subjected to analysis of variance and LSD values were obtained at 5% level using Statistix 8.1® software.

3. Results and Discussion

Data of laboratory trials tabulated in Table 1 demonstrated that different tested botanicals were the most promising for pest control as compared to untreated gram. Severe pest infestation occurred in cultivar Jubiha-1 that supported the more development of pest than CM-98.

3.1. Percent Infestation

The percent infestation was significantly lower in *A. vera* (43 & 47%) and *N. tabacum* (50 & 57%) treated samples than in *C. colocythis* and untreated samples of both the varieties (Table 1).

3.2. Percent Weight Losses

On an average, 26 to 37% weight losses were recorded with plant powders treated trials in variety CM-98 and 32-42% in variety Jubiha-1 treated samples, whereas, weight losses ranged between 46-53% in the untreated samples of gram.

3.3. Frass Weight

Frass weight was very much reduced in treated samples as compared with untreated control. Very few amounts of frass were obtained (0.54 and 0.93 gm) in *A. vera* and *N. tabacum* treated samples of cultivars CM-98 and Jubiha-1, respectively, while, it was 1.14-1.28 gm in *C. colocythis* and 1.70 and 1.93 gm in untreated samples of both cultivars.

3.4. Adult Emergence

The *C. analis* adult emergence was 81-103 in treated samples of CM-98. Total eggs developed and adults emerged (92-129) were less in treated samples of Jubiha-1 as compared with control emergence of 130-169 adults in both cultivars.

The present laboratory results clearly demonstrated that various botanical dusts containing certain volatiles/ alkaloids adversely affected the survival of the weevil *C*. *analis* in treated gram. Earlier, many plant derived materials were observed possessing repellant and

Table 1. Comparisons of different plant powders against cowpea bruchid *Callosobruchus analis* F.

Variety	Treatment	Percent infestation	Percent weight loss	Frass weight (gm)	No. of adults emerged
CM-98	*Nicotiana tabacum*	50.4 b	33.7 b	0.69 c	92.0 b
	Citrullus colocythis	64.9 a	37.8 b	1.14 b	103.0 b
	Aloe vera	43.4 b	26.3 c	0.53 c	81.0 b
	Control	75.1 a	46.2 a	1.70 a	131.0 a
	LSD value	14.39	5.593	0.389	24.21
Jubiha-1	*Nicotiana tabacum*	57.0 c	33.5 c	0.93 c	110.0 bc
	Citrullus colocythis	69.8 b	42.7 b	1.28 b	129.0 b
	Aloe vera	47.1 c	32.0 c	0.82 c	92.0 c
	Control	91.9 a	53.1 a	1.93 a	169.0 a
	LSD value	10.17	5.372	0.275	35.98

Means followed by a common letter do not differ significantly at 5% level ($P \leq 0.05$).

insecticidal activities against the insects of the stored food products [17-19]. Complete mortality (100%) of pest was found in samples treated with botanicals [20]. Tooba *et al.* [21] reported that a mixture of plant materials proved to be very effective for the protection of stored grains. Some plants derived insecticides can affect a limited range of pest insects, but have no harmful effects on nontargeted organisms and environment.

During the present investigations, plant materials *A. vera*, *N. tabacum* and *C. colocythis* proved more efficient for the control of *C. analis.* Similar to current findings, Abdullah and Muhammad [20] reported that plant powders adversely affected survival and egg laying capacity, higher ovicidal effects, reduced oviposition rates, and reduced life span of adult weevils. The striking effects of plant powders could be attributed to the presence of their toxic components and irritating smell which prevented physical contact of adult weevils with grains and caused suffocation or starvation of pest. Nevertheless, presently identified *A. vera* and *N. tabacum* used in this study were found significantly more effective than *C. colocythis* in suppressing emergence of *C. analis.* This shows that both powders (*A. vera* and *N. tabacum*) were contained more toxic ingredients for *C. analis* mortality. Some previous researchers had also indicated synergistic effects of *A. vera*, a member of the Lily family, and *N. tabacum* against pest infestation. Saoo *et al.* [22] reported antiviral activity of *Aloe* extract; while, Saccu *et al.* [23] from the leaves of *Aloe* found bittering agents such as isoaloeresin, aloins and anisole. Hu *et al.* [24] determined trolox and ethanol components showing stronger antioxidant activities in extracts of *A. vera.* Further, nicotine sulfate, produced as an extract from tobacco *N. tabacum* and its waste, was tested against a range of insect pests. The results indicated the good potential of *N. tabacum* as botanical pesticide in the management of crop pests [25]. This is due to the occurrence of nicotine and two closely related alkaloids, nornicotine and anabasine, which are synaptic, poisons that mimic the neurotransmitter acetylcholine. As such, they cause symptoms of poisoning similar to those seen with organophosphate and carbamate insecticides [26]. Consequently, due to the existence of various toxicants in plant powders, effectual plant materials can be used as one of the component in Integrated Pest Management of gram seeds during storage.

4. Conclusion

Conclusively, this study indicated that bioinsecticides like *A. vera*, *N. tabacum* and *C. colocythis* affected the incidence of insect pest and could provide reasonable protection to gram seed against *C. analis* during storage. More extensive study is necessary to determine the relative

amounts of these materials quantitatively required for pest control strategy by uses of these chemicals. Further research work is also needed to reveal the complexity of physiological activity exerted by toxic compounds on insect and to evaluate their mammalian toxicity. The variety CM-98 due to its higher tolerance for holding lower pest incidence under storage conditions, and having an appropriate seed size, is expected to be utilized for cultivation in gram growing areas.

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