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EFFECT OF INERT MINERALS AND BOTANICALS ON THE GROWTH AND DEVELOPMENT OF *Callosobruchus maculatus* (FABRICIUS) IN STORED BLACK GRAM (*Vigna mungo* L.)

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ABSTRACT

The investigation of "Effect of inert minerals and botanicals on the growth and development of *Callosobruchus maculatus* (Fabricius) in stored blackgram (*Vigna mungo* L.)" was performed in the Laboratory of the Department of Entomology, Agricultural College, Bapatla, during 2020-21. One kilogram of blackgram were taken in three replications and treated with diatomaceous earth, china clay, paddy husk ash, cow dung ash, sweet flag powder, neem kernel powder and spinosad. Ten pairs of freshly emerged adult beetles were released into each jar. A small subsample of 50 g was taken in small plastic jars from these treatments, replication wise and calculated the number of eggs laid per 50 g seed, mean development period and growth index. The results revealed that the number of eggs laid were minimum (5.33 eggs) for 50 g blackgram seeds treated with spinosad and diatomaceous earth (12.00 eggs) followed by sweet flag powder (18.38 eggs) against 54.00 eggs in untreated control. There was no significant difference between treatments and untreated control w.r.t mean development period of *C. maculatus*. The growth index of *C. maculatus* in blackgram seeds treated with spinosad was 0.25 and for diatomaceous earth was 0.54 which were significantly the lowest values when compared to untreated control (2.68).
***Keywords*:** Diatomaceous earth, Growth index**,** Inert minerals, Spinosad, Sweet flag powder

Introduction

Blackgram or urdbean is a major pulse crop that originated in India, which remains the world's leading producer, consumer and importer. Containing about 26% protein, nearly three times higher than cereals. It serves as a crucial source of dietary protein, particularly for the vegetarian population of the country (Directorate of Marketing and Inspection, Ministry of Agriculture and Farmers Welfare, GOI, 2020). Despite its nutritional importance, blackgram is highly susceptible to infestation by bruchids, especially *Callosobruchus maculatus* (Fabricius), a destructive and widely distributed storage insect pest. This insect infests mature pods in the field and continues its damage during storage, Nahdy (1995). The pest lays eggs on the surface of grains and the emerging larvae bore inside, feeding internally. Such infestation results in weight loss, reduced market value, deterioration of quality and nutritional content, poor hygiene and lowered seed viability. Owing to its short life cycle and high reproductive potential, losses in untreated stored grains may reach up to 100% within six months, Mkenda *et al*. (2014).

Although several synthetic insecticides have proven effective in controlling storage pests, their extensive use has raised serious concerns regarding human and animal health. Over the last four decades, the excessive and indiscriminate application of these chemicals has led to problems such as resistance development, pest resurgence, pesticide residues in food and soil and environmental contamination, Mohapatra and Gupta (1998). Consequently, researchers have increasingly focused on safer alternatives, particularly plant-based pest management strategies, Islam *et al*. (2013). As noted by Subramanyam and Roesli (2000), inert dusts act through physical mechanisms by damaging the insect cuticle, causing abrasions and disrupting the protective lipid layer on the body surface, ultimately leading to dehydration and death. Eco-friendly, biodegradable plant-based materials such as *Azadirachta indica* (neem), *Acorus calamus* (sweet flag), *Lantana camara* (phoolakri), *Melia azedarach* (draik), *Piper nigrum* (kali mirch) and *Adhatoda zeylanica* (Basuti) serve as effective and readily available alternatives for controlling storage insect pests. These botanicals are considered safe for the environment and offer sustainable pest management solutions. In recent years, spinosad a biopesticide derived from the soil actinomycete *Saccharopolyspora spinosa* has attracted considerable attention. Due to its minimal non-target and chronic effects, it was classified as a “reduced-risk” pesticide by the EPA in 1993 and later registered in 2005 as a grain protectant at a dosage of 1 mg per kg of active ingredient. It is a neurotoxic compound composed of tetracyclic macrolides, namely spinosyns A and D (collectively known as spinosad). These active components act on the insect nervous system by targeting GABA receptors and post-synaptic nicotinic acetylcholine receptors, thereby disrupting normal nerve signal transmission.

As consumer demand increasingly favors food free from insecticide residues, pest management approaches for stored products are shifting toward safer and more sustainable alternatives. In this context, inert minerals and botanicals are expected to play a significant role in storage pest control. These materials offer safer options for human health, reduce the risk of resistance development in insect populations and comply with strict pesticide regulations. Hence, the present study was undertaken to assess the effect of inert minerals and botanicals on the growth and development of *Callosobruchus maculatus*.

Materials and Methods

The experiment entitled “Effect of inert minerals and botanicals on the growth and development of *Callosobruchus maculatus* in stored blackgram was done in the Entomology Department’s laboratory at Agricultural College in Bapatla during 2020-21. The initial population of *C. maculatus* were acquired from the Post Harvest Technology Centre in Agricultural College, Bapatla. To sustain the culture, approximately 200 g of sterilized blackgram seeds were placed in a plastic container and approximately 10 pairs of adults were introduced for oviposition. After ten days, the adults were removed and placed into another container with blackgram seeds. This process was repeated, creating a series of containers to utilize eggs laid in a staggered manner, ensuring a consistent supply of test insects with known ages. The recently emerged adults were transferred to another container for culture multiplication. Mass culturing was done at 75% ± 2 RH and at 32°C. Inert minerals and botanicals like Diatomaceous earth, China clay, Paddy husk ash, Cow dung ash, Sweet flag powder, Neem kernel powder and Spinosad 45 SC (Tracer) were used. Diatomaceous earth, china clay and spinosad was purchased from 20 Microns Nano Minerals Limited, Baroda, Gujarat, Andhra Pradesh, Indus cosmeceuticals Pvt. Ltd. Faridabad, Haryana, Andhra Pradesh and Dow AgroSciences India Pvt. Ltd., respectively. Paddy husk ash and cow dung ash were prepared by drying and burning of paddy husk and cow dung separately. Sweet flag powder and neem kernal powder were prepared by grinding of shade dried rhizomes of sweet flag and dried neem kernels separately. The burnt ashes and obtained powders were sieved through 0.25 mm sieve (250 microns) and stored in airtight container. The dosages of test minerals and botanicals are furnished in Table 1.

Table 1 : Dosages of inert minerals and botanicals

S. No.	Treatments	LD_{50} (mg kg^{-1})
1.	Diatomaceous earth	420
2.	China clay	1620
3.	Paddy husk ash	1020
4.	Cow dung ash	3300
5.	Sweet flag powder	480
6.	Neem kernel powder	520
7.	Spinosad	23

One kilogram of blackgram were taken in three replications and treated with inert minerals and botanicals with the LD_{50} dosages mentioned in the Table 1. Ten pairs of freshly emerged adults were released into each jar. The beetle exhibits sexual dimorphism, with noticeable distinctions between males and females. Females, being larger, are generally darker overall, while males tend to be brown. In females, the plate covering the end of the abdomen is substantial, featuring dark coloration along the sides. In contrast, in males, the plate is smaller and lacks the dark areas, Christopher and Lawrence (2014). The live adults if at all present in treated jars were removed from the jars after an ovipositional period of ten days. Later the eggs were allowed to hatch and incubated until adult emergence. A small subsample of 50 g was taken in small plastic jars from these treatments, replication wise. From this, the number of eggs laid per 50 g seed, mean development period and growth index were calculated. The data obtained were subjected to suitable transformations and subjected to ANOVA (CRD), Snedecor and Cochran (1967).

Mean Development Period (D): The mean development period of the test insect was calculated by using formula.

$$D = \frac{\sum(A \times B)}{C}$$

Where, A= number of adults emerged on n^{th} day; B= 'n' days required for the emergence; and C= total number of adults emerged during the experiment period.

Growth Index: The growth index of the test insect was calculated by using following formula.

$$\text{Growth Index} = \frac{\text{Per cent adult emergence}}{\text{Development period}} \times 100$$

Results and Discussion

The results pertaining to the effect of inert minerals and botanicals on the growth and development of *Callosobruchus maculatus* in stored blackgram are presented in the Table 2.

Table 2 : Effect of inert minerals and botanicals on the growth and development of *C. maculatus*

S. No.	Treatments (mg/Kg)	No of eggs laid per 50 g	Development period (days)	Growth index**
1	Diatomaceous earth	12.00^{ab}	39.10	0.54 (1.22)^{ab}
2	China clay	42.30^{ef}	34.20	1.91 (1.68)^{ef}
3	Paddy husk ash	38.06^{e}	35.00	1.54 (1.57)^{de}
4	Cow dung ash	46.21^{fg}	33.00	2.31 (1.80)^{fg}
5	Sweet flag powder	18.38^{bc}	38.00	0.84 (1.33)^{bc}
6	Neem kernel powder	28.00^{d}	37.30	1.16 (1.43)^{cd}
7	Spinosad (Check)	5.33^{a}	40.00	0.25 (1.11)^{a}
8	Control	54.00^{h}	32.00	2.68 (1.90)^{gh}
SEm(±)		2.62	3.00	0.09
CD (P=0.05)		7.86	NS	0.29
CV%		1.08	1.04	0.80

* Values in parentheses are angular transformed values ** square root transformed values,***log transformed values. In a column means followed by same letter do not differ significantly by LSD (P=0.05).

Oviposition: The number of eggs laid by *C. maculatus* on blackgram seeds differed significantly due to the treatment with inert minerals and botanicals. Maximum number of 54 eggs were laid on untreated 50 g blackgram seeds which were significantly different from all other treatments. The least number of eggs (5.33) were recorded on seeds treated with spinosad which was on par with diatomaceous earth treated seeds which recorded 12 eggs per 50 g. It was followed by sweet flag powder with 18.38 eggs which was on par with diatomaceous earth. The neem kernel powder and paddy husk ash treatments recorded 28.00 and 38.06 eggs, respectively which were significantly different from other treatments. Whereas, seeds treated with china clay recorded 42.30 eggs that was statistically on par with paddy husk ash. Similarly, seeds treated with cow dung ash recorded 46.21 eggs and statistically on par with china clay.

These results were in accordance with the findings by Sanon *et al*. (2010) who reported that the number of eggs laid by *C. maculatus* decreased from 150 to 25 with increase in the dosage of spinosad from 0.31 to 2.5 mg kg^{-1}, respectively. Whereas, in control number of eggs laid were 210. Present results were also in accordance with the findings by Badii *et al*. (2014) where all DE formulations (probe-A, Damol-D_1, fossil shield and diatomenerde) had significant effect on the oviposition by female *C. maculatus* when applied @ 0.5, 1.0, 1.5 and 2.0 g kg^{-1} of groundnut seeds. The mean number of eggs laid was significantly reduced in all DE treatments compared with the control (87) and minimum number of eggs were recorded at the dose of 1.0 g kg^{-1} seed. Similarly, Kaur *et al*. (2019) when treated the pea seeds with sweet flag powder and neem @ 5.0, 3.0 and 1.0 g per 100 g seeds found that on day seven, minimum number of eggs (3.11 eggs per 5 females) were laid by five pairs of *C. chinensis* in sweet flag powder followed by neem leaf powder (5.89 eggs per 5 females) which were significantly different from untreated control (97 eggs per 5 females). Similarly, Adebayo R.A. and Ibikunle O. (2014) found that the application of rice husk ash, cow dung ash and powdered clay @ 1.0 g per 20 seeds of cowpea showed that the number of eggs laid on untreated cowpea seeds (2.38) was significantly higher from those obtained from seeds treated with rice husk ash (1.76).

Development Period: The results revealed that there was no significant difference among all the treatments and control regarding the mean development period of *C. maculatus*. Spinosad and diatomaceous earth treated blackgram seeds showed maximum development period of 40 and 39 days, respectively. Whereas, cow dung ash and untreated control showed minimum development period of 33 and 32 days, respectively. The shortest development period and better growth was observed in untreated control. The longest development period with delayed growth was observed in spinosad and diatomaceous earth. The mean developmental period of sweet flag powder, neem kernel powder, paddy husk ash and china clay was 38.00, 37.30, 35.00 and 34.20 mean days, respectively where there was no significant difference between the treatments.

These results obtained were supported by the findings of Kemabonta and Anikwe (2010) who reported that there was no significant difference in the developmental period between the control (22.3 days) and the DE treatments 21.0, 21.8 and 22.0 days when applied @ 0.5, 1.0 and 1.5 g per kg, respectively on cowpea seeds. This was because, DE is a contact poison, it kills the insects by locally absorbing the epicuticular lipid layers leading to high rate of water loss through the cuticle. The larvae and pupae of *C. maculatus* developed inside the seeds and are protected from any inert dust. Hence, there was no significant effect on development period.

Growth Index: The growth index of *C. maculatus* was the highest *i.e.*, 2.68 was observed in untreated control which significantly differed from other treatments except cow dung ash with growth index of 2.31 which was on par with untreated control. The lowest growth index of *C. maculatus* was 0.25 which was noticed in blackgram seeds treated with spinosad which was on par with growth index of 0.54 when treated with diatomaceous earth. The growth index of *C. maculatus* in sweet flag powder, neem kernel powder, paddy husk ash and china clay treatments were 0.84, 1.16, 1.54 and 1.91, respectively which significantly differed from the spinosad, diatomaceous earth and untreated control.

Among the inert minerals, the lowest growth index was found in diatomaceous earth which was on par with the spinosad (insecticide check) but shown significant difference with the other inert minerals. Among botanicals, both sweet flag powder and neem kernel powder treatments recorded the lowest growth index which were on par with each other. Lower growth index in effective treatments can be attributed to lower number of eggs laid due to higher mortality of adults, which in turn reflected on the lowest per cent adult emergence which resulted in lower growth index on the effective minerals and botanicals.

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