Bio-efficacy of ground plant powders on the population of *Tribolium castaneum* (Herbst) in stored green gram

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Summary

Tribolium castaneum (Herbst) (Coleoptera: Tenebrionidae) is one of the major insect pests of stored grains. Experiment was conducted for studying the efficiency of ground plant materials for management of *T. castaneum* in stored green gram and effect of plant powders on seed germination in laboratory of Department of Entomology, CoA, CAU, Imphal during the period 2021-2022. Studies on effect of plant powders on management of *T. castaneum* revealed that Black pepper @ 1.5g/kg seed shows maximum mean adult mortality of 100.00 per cent and Sweet flag @ 1.5g/kg seed shows lowest mean adult mortality of 33.33 per cent. Highest seed damage was recorded in Sweet flag @ 1.5g/kg seed (8.00 per cent) and least was in Black pepper @ 1.5g/kg seed (1.67 per cent). Maximum adult emergence was noted in treatment of Sweet flag @ 1.5g/kg seed (8.00 per cent) and lowest was in China berry @ 1.5g/kg seed (1.33 per cent). Evaluation of germination percentage reveals that minimum germination percentage was recorded in Black pepper @ 1.5g/kg seed (91.33 per cent) and maximum was in Indian wormwood @ 1.5g/kg seed (98.67 per cent) but none of the treatment recorded the percentage below the prescribed germination percentage of green gram. Plant powders offers efficient control of red flour beetle and these are available locally and did not show any adverse on the environment and hence can be recommended as alternatives to the chemical insecticides.

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INTRODUCTION

Insect pests that attack grains in storage are responsible for the qualitative and quantitative losses to goods in storage globally[3] that may range from 10 to 40%.[12] Most of this damage is caused by rust-red flour beetle, *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae) causing up to 40% reduction in grain weight.[1,16] The red flour beetle *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae) is an important pest of different stored products. *Tribolium castaneum* is frequently referred to as a secondary pest since it is unable to feed on sound grains.[7] It feeds on endosperm of the seeds leaving them with moldy smell.[10] These insects cause damage by reducing the mass, reducing the physiological quality and germination capacity and increasing the temperature and water content of the grains.[15, 2]

An effective control measure is required to prevent the spoilage of these grains. Synthetic grain protectants are now used in the stored grain sector. These chemicals not only have detrimental impacts on the environment but also seriously harm consumers' health.[17] Additionally, due to their widespread and indiscriminate usage against pests of stored grains, these insects have developed significant tolerance to these chemicals. Due to the negative effects of chemical insect management, it is necessary to investigate natural but equally potent substances that can be utilized to combat these pests without significantly endangering human health or lowering grain quality.[13, 17, 3] Searching for less dangerous chemicals or biologically based products has become a prominent trend in contemporary pest management strategy as a result of growing concern about the risks of synthetic pesticides to the environment and human health.[9] Botanical products being biodegradable and

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effective against pests without harming beneficial insects fit within this strategy.[6]

Being organic and natural, plant-based chemicals might serve as the basis for such discoveries. In this regard, recent investigations have discovered a number of potential plant extracts that display insecticidal properties in grain storage systems.[18, 19] Such botanical extracts may have various modes of action and can help in pest management by repelling the pest away, may act as feeding and oviposition deterrent and at the same time may act as insecticides.[14, 5] In thus study we compared the efficiency of eight different plant powders *viz*., the leaves of china berry, *Melia azedarach;* Basil, *Ocimum tenuiflorum;* Eucalyptus, *Eucalyptus globulus;* Lantana, *Lantana camara;* Chaste tree, *Vitex trifolia;* Indian wormwood, *Artemisia nilagirica* and rhizome of Sweet flag, *Acorus calamus* ,seeds of Pepper, *Piper nigrum* against red flour beetle. The study was conducted on green gram seeds to evaluate adult mortality, percent seed damage, adult emergence and germination percentage.

Materials and Methods

Rearing of *T. castaneum* (Herbst) culture

For rearing *T. castaneum*, adult insects were collected initially from the nearby stores and godowns. The collected insects were released into the jar (15×10 cm) containing wheat flour and were maintained at 33± 2^{0}C temperature using B.O.D incubator for oviposition. The jar was covered with black cloth to prevent escape of adult beetles. At Pupal stage, those pupae were examined under microscope for sexual differentiation and were done based on the genital structure characteristics. The newly emerged adults were collected and used for the experimental works.

Preparation of plant powders

The leaves of china berry, *Melia azedarach;* Basil, *Ocimum tenuiflorum;* Eucalyptus, *Eucalyptus globules;* Lantana, *Lantana camara;* Chaste tree, *Vitex trifolia;* Indian wormwood, *Artemisia nilagirica* and rhizome of Sweet flag, *Acorus calamus* seeds of Pepper, *Piper nigrum;* malathion were taken. These were cut into pieces and shade dried. The dried materials were grounded with the help of electric grinder and passed through sieve to get fine powder.

Design and details of experiment

Powders of 8 indigenous plants were tested at a dose (1.5gm/ 100 gm seed) on the green gram variety Pant M-6. 100 g of healthy and disinfected seeds of green gram were kept in containers of 250 ml capacity and each was replicated thrice. Each container with seeds was treated with 1.5gm plant powder. One treatment with malathion @ 0.2gm/ 100 gm seed was kept. One untreated treatment was maintained as control. The design will be Completely Randomized Design (CRD).Freshly emerged 10 pairs of adult beetles were released into each container and were covered with muslin cloth.

Observations recorded

The adult mortality of *T. castaneum* was recorded at 10, 20, 30 days after their release in each treatment. All the adults were removed 30 days after their release. The total number of adults emerged in each treatment were counted ninety days after the release. The adult mortality, seed damage and adult emergence were determined by using the following formulae:

$$Percent\ adult\ mortality = \frac{Number\ of\ adults\ died}{Total\ number\ of\ adults\ released\ (20)} \times 100$$

$$Percent\ seed\ damage\ = \frac{Number\ of\ damaged\ seeds}{Total\ number\ of\ seeds\ (100)} \times 100$$

$$Percent\ adult\ emergence\ = \frac{Number\ of\ adults\ emerged\ from\ hatched\ eggs}{Total\ number\ of\ eggs\ hatched\ (100)} \times 100$$

Evaluation of the effect of test plant powders on seed germination

For the study of effect of the plant powders on viability of green gram seeds, a separate experiment was conducted. Green gram seeds both treated and untreated seeds were kept in separate airtight containers without release of adult beetles under room conditions. After 60 days of storage, 50 number of healthy seeds treated with each material were placed in sterilized Petri dishes with filter paper and moistened daily. Each treatment was replicated three times. The number of seeds germinated in each treatment after 4 days was counted and the germination rate was expressed in percentage (%). Per cent germination of the seeds treated with plant powders

and untreated control was estimated by using the following formula.

$$Percent\ seed\ germination\ = \frac{Number\ of\ seeds\ grminated}{Total\ number\ of\ seeds\ (50)} \times 100$$

Data analysis

Mean values of the data obtained from the experiments were subjected to statistical analysis after suitable transformation and significance between the treatments was tested by using analysis of variance.

Results and Discussions

Effect of plant powders on adult mortality of T. castaneum

Statistical Percent adult mortality increases with increase in the duration from 10 to 30 days after release. The overall highest mean adult mortality among plant powders was recorded in black pepper with 100.00 per cent while the least was recorded in Sweet flag with 33.33 per cent. Black pepper was followed by Chinaberry and Indian wormwood with 67.22 per cent mean adult mortality per cent (Table 1.). Khan and Siddiqui (1994)[11] recorded good repellency of *Melia azedarach* seeds and leaves against *Tribolium castaneum* which supports the current study. Govindan *et al*. (2020)[4] concluded that 2 per cent Rhizome powder of Sweet flag was found to be significantly best and caused 100 per cent mortality of *Callosobruchus maculatus.*Thus was in contrary to the mortality of red flour beetle in which rhizome powder of sweet flag showed least effect on adult mortality among the other treatments.

Table 1: Effect of plant powders on adult mortality of *T. castananeum* in green gram

Treatment (plant powder)	Dosage (gm/100gm seeds)	*Per cent adult mortality of *T. castaneum*			Pooled mean
		10 DAR	20 DAR	30 DAR	
T1=China berry	1.5 gm	43.33 (41.16)**	63.33 (52.80)**	95.00 (79.55)**	67.22 (57.84)**
T2=Black pepper	1.5 gm	100.00 (90.00)**	100.00 (90.00)**	100.00 (90.00)**	100.00 (90.00)**
T3=Basil	1.5 gm	33.33 (35.25)**	71.67 (58.69)**	88.33 (70.11)**	64.44 (54.68)**
T4=Eucalyptus	1.5 gm	28.33 (32.02)**	46.67 (43.09)**	65.00 (53.76)**	46.67 (42.95)**
T5=Chaste tree	1.5 gm	46.67 (43.08)**	70.00 (56.96)**	83.33 (66.14)**	66.67 (55.40)**
T6=Lantana	1.5 gm	50.00 (45.00)**	65.00 (53.76)**	70.00 (56.84)**	61.67 (51.87)**
T7=Indian wormwood	1.5 gm	41.67 (40.20)**	65.00 (53.76)**	95.00 (79.55)**	67.22 (57.87)**
T8=Sweet flag	1.5 gm	16.67 (23.16)**	33.33 (34.72)**	50.00 (45.00)**	33.33 (34.29)**
T9=Malathion	0.2 gm	100.00 (90.00)**	100.00 (90.00)**	100.00 (90.00)**	100.00 (90.00)**
T10=Control	-	6.67 (14.76)**	8.33 (16. 60)**	10.00 (18.43)**	8. 33 (16. 60)**
CD (p=0.05)		7. 18	9. 61	8.25	10.78

**Figures in the parentheses are angular transformed values
*Data represented in the table are mean of three replications

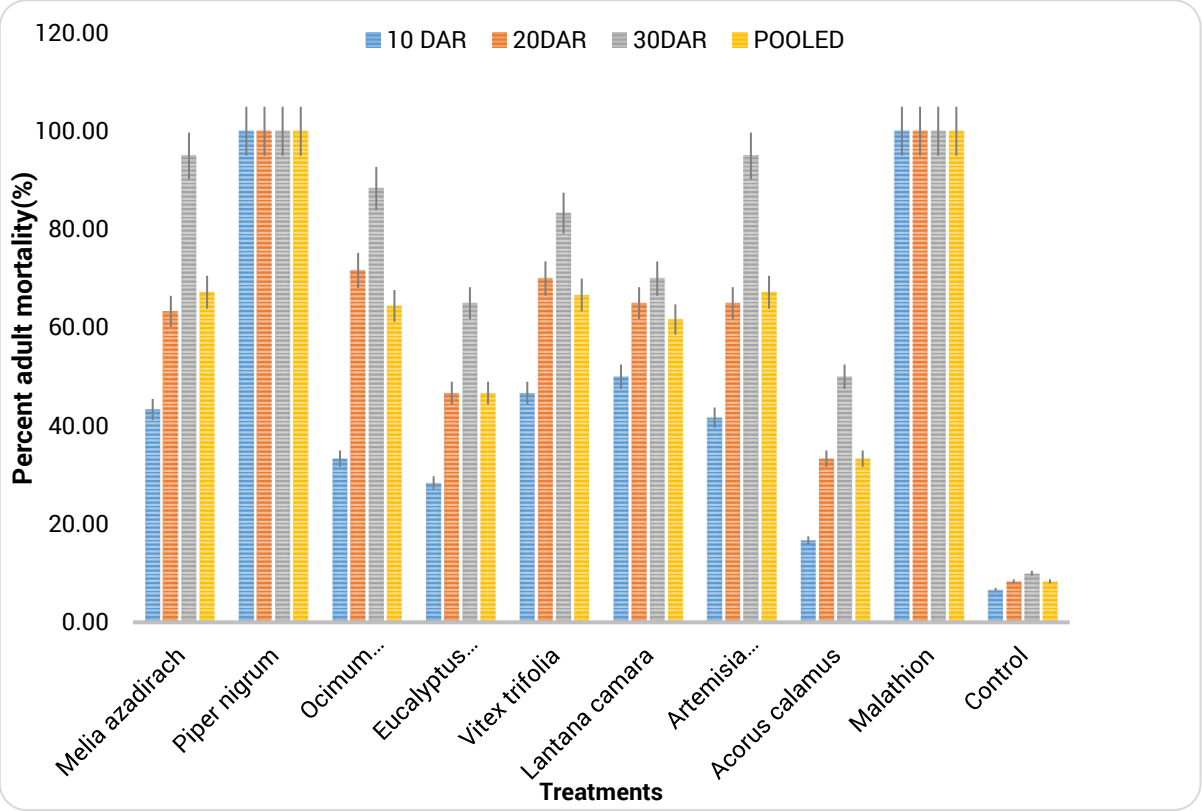

Fig. 1: Graphical representation of adult mortality of *T. castaneum*

Effect on grain seed damage and adult emergence of *T. castaneum* at 90 DAR

During The control treatment (untreated) recorded maximum seed damage of 36.00 per cent. Among the treatments, highest seed damage of 8.00 percent was recorded in Sweet flag Black pepper recorded least seed damage of 1.67 per cent among the plant powder treatments and Malathion 5% D recorded lowest seed damage of 0.00 per cent among all the treatments. Among treatments with plant powders, the maximum adult emergence (8.00 per cent) was noted in the seeds treated with sweet flag powder; minimum adult emergence was observed in China berry (1.33 per cent) which differs significantly from other treatments. Umoetok and Gerard (2003)[20] reported that sweet flag powder does not cause significant mortality of *T. castaneum* which supports the present conclusion of study that treatment with sweet flag recorded highest seed damage and highest adult emergence. Iqbal *et al.* (2015)[8] also mentioned that extracts of neem showed lower number of adults in their studies on effect of plant extracts development of red flour beetle.

Table 2: Effect of plant powders on seed damage and adult emergence by *T. castaneum* on greengram

Treatment	Dosage (gm/ 100 gm seed	*Per cent seed damage (%)	*Per cent adult emergence (%)
T1=China berry	1.5 gm	2.33 (1.68)	1.33 (1.34)
T2=Black pepper	1.5 gm	1.67 (1.46)	2.00 (1.56)
T3=Basil	1.5 gm	3.00 (1.86)	4.67 (2.24)
T4=Eucalyptus	1.5 gm	4.00 (2.11)	4.00 (2.00)
T5=Chaste tree	1.5 gm	6.00 (2.54)	3.00 (1.81)
T6=Lantana	1.5 gm	3.33 (1.95)	4.67 (2.26)
T7=Indian wormwood	1.5 gm	3.67 (2.04)	3.67 (2.02)
T8=Sweet flag	1.5 gm	8.00 (2.91)	8.00 (2.91)
T9=Malathion	0.2 gm	0.00 (0.71)	0.00 (0.71)
T10=Control	-	36.00 (6.04)	25.00 (5.05)
CD(p=0.05)		0.46	0.71

Figures in the parentheses are square root transformed values

*Data represented in the table are mean of three replications

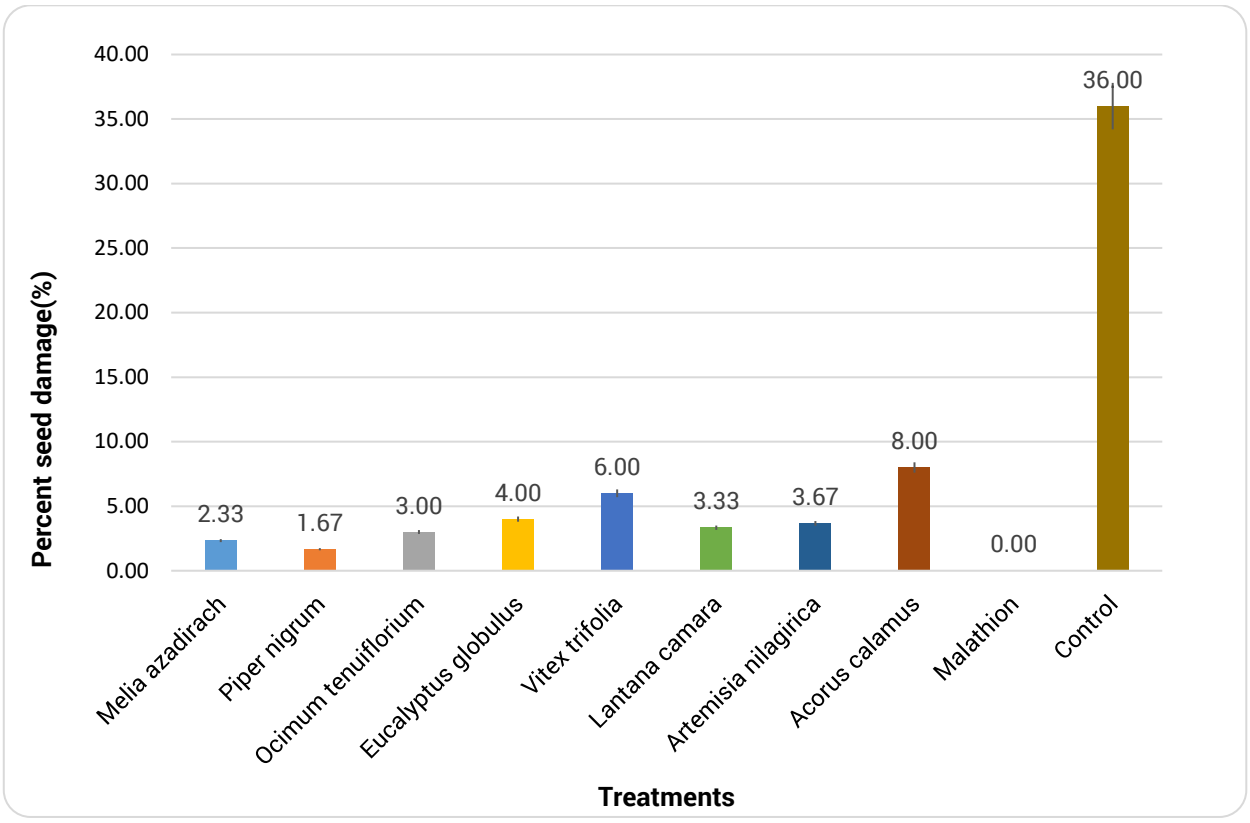

Fig. 2: Graphical representation of effect of plant powders on seed damage of greengram

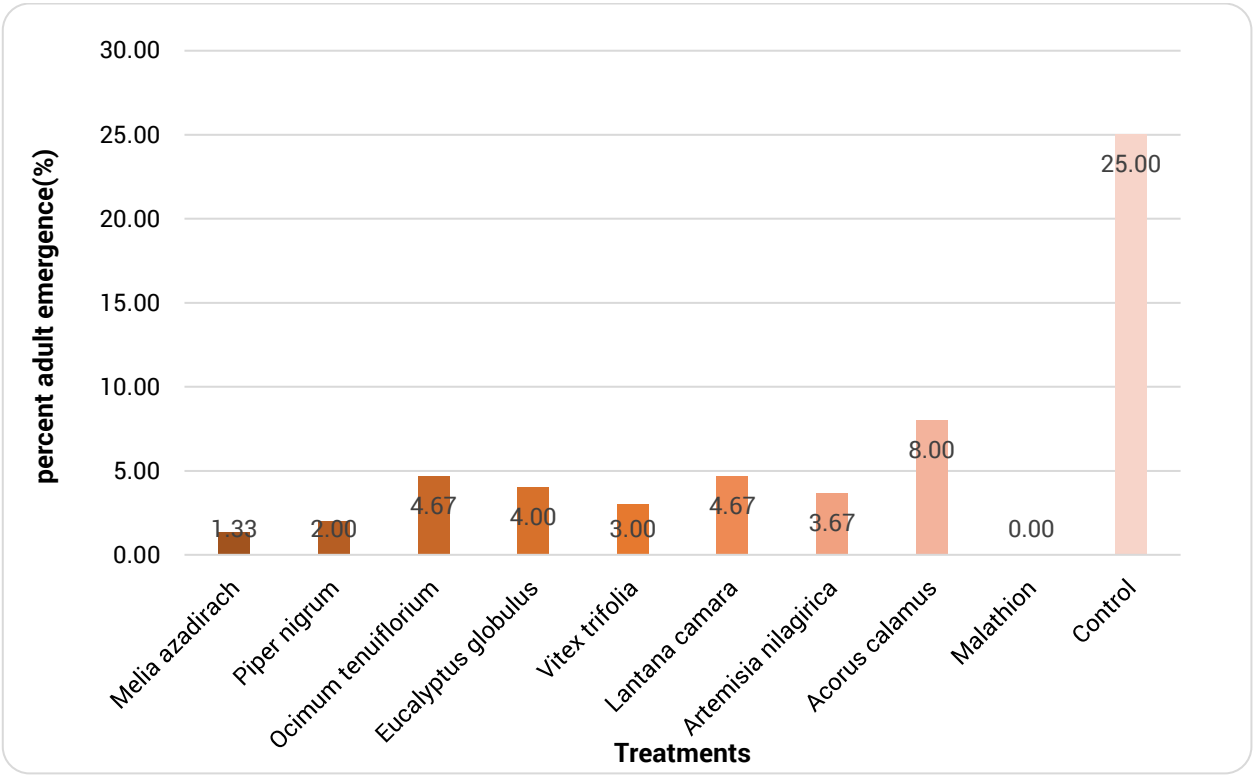

Fig. 3: Graphical representation of percent adult emergence of *T. castaneum* in greengram

Effect of plant powders on germination of treated green gram seeds

Least germination of 91.33 per cent was recorded in Black pepper. Highest germination percentage was recorded in Indian wormwood (98.67 per cent), it was at par with China berry (97.33 per cent) which was higher than germination percentage of 90 per cent which was reported by Miah *et al*. (2013)[21] in green gram seeds treated with neem oil. None of the treatment recorded germination percentage less than 90%.

Table 3: Effect of plant powders on seed germination of greengram

Treatment	Dosage (gm/ 100 gm seed)	*per cent germination after 4 days of germination test (%)
T1=China berry	1.5 gm	97.33 (9.87)
T2=Black pepper	1.5 gm	91.33 (9.56)
T3=Basil	1.5 gm	96.00 (9.80)
T4=Eucalyptus	1.5 gm	93.33 (9.66)
T5=Chaste tree	1.5 gm	97.33 (9.86)
T6=Lantana	1.5 gm	93.33 (9.66)
T7=Indian wormwood	1.5 gm	98.67 (9.93)
T8=Sweet flag	1.5 gm	95.33 (9.76)
T9=Malathion	0.2 gm	97.33 (9.87)
T10=Control	-	97.33 (9.87)
CD (p=0.05)		0.21

Figures in the parentheses are square root transformed values
*Data represented in the table are mean of three replications

Conclusion

Current study reported that among the tested plant powders black pepper recorded highest adult mortality of red flour beetle and least was recorded in sweet flag. Adult emergence was also highest in sweet flag while it was least in treatment china berry. Germination percentage of treated green gram seeds ranges from maximum to minimum of 98.67 to 91.33 per cent respectively. Further investigation into this study will be helpful for better utilization of these plant powders for insect pest control in storage.

Declaration of interests

The authors have no conflict of interest to declare.

Data sharing

All relevant data are within the manuscript.

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