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Effect of botanicals on mortality and per cent grain damage of pulse beetle (*Callosobruchus chinensis*) in stored mung bean (*Vigna radiata*)

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Abstract
The stored food grain experiences major threat from insect pests. Among the storage pests, the pulse beetle is considered as one of the major and destructive pest. Infestation of pulse beetle causes both qualitative and quantitative loss in legume seeds. The present study was undertaken to evaluate the effect of botanicals in mung bean and come up with eco-friendly management strategies with botanicals against pulse beetle (*Callosobruchus chinensis*). The various botanical powders used were Neem, Tulasi, Notchi, Adhathoda, Bitter gourd, Black pepper, Turmeric, Ginger and Sweet flag are tested at the rate of 2g/ 100g seeds in a CRD with three replications. The results revealed that highest per cent mortality was recorded in Sweet flag at 72 HAT (31.66%) followed by Notchi (28.33%) whereas no mortality was recorded in control. Per cent grain damage was significantly lower in Sweet flag treated seeds (35.55%) followed by Notchi (42.22%) and the highest grain damage per cent was recorded in control (82.00%). The results obtained will definitely provide a better basis for improving the efficacy of botanicals like plant powders which could be effectively used as grain protectants and thereby reduce the load of toxic chemicals in our food stuff as well as in the environment.

Keywords: Pulse beetle, botanicals, sweet flag, mortality, grain protectants

1. Introduction
Storage of harvested produce started from time immemorial to avoid situations like famine. Legumes are more vulnerable to post harvest losses. Loss occurred during post harvest handling and storage in India is 8.5 per cent [8]. *Callosobruchus chinensis* Linn. (Coleoptera; Bruchidae), pulse beetle is the most widespread and destructive insect pest of economically important leguminous grains such as green gram, red gram, black gram, chick pea, cow pea, peas and lentil [7]. The larvae destroy seeds by feeding inside partially or completely making the seeds unfit for human consumption, resulting in the depletion of embryo, nutritional reserves and consequently with low germination and weak seedlings. The intensity of infestation by pulse beetle is higher in summer than winter mainly due to high temperature and relative humidity. Neem acts as repellent by disrupting the appetite of insects and diminishing their urge to reproduce [10]. Botanicals (plant powders) are also used as grain protectants as these have insecticidal properties against stored grain insect pests as well as safer for human health and environment [4]. It has been reported that certain plant preparations are much safer than chemical insecticides [14]. Therefore, plant materials could be explored to protect stored products against pest infestation. Botanical powders can be used to keep the stored pulses free from pulse beetle attack. Keeping the above views in mind, the present study was designed to evaluate the effect of botanical powders against pulse beetle in storage mung bean.

2. Materials and Methods
2.1 Mass culturing of test insect
Pulse beetles required for this study were mass reared on mung bean in the laboratory. The mass culturing was initiated by confining 10-20 freshly emerged beetles in the glass beakers having 500g of green gram which were then covered with kada cloth and secured tightly with rubber band. With the interval of two generation, 50 per cent of the completely infested grains were replaced with the same quantity of un-infested materials. Such containers were stacked in iron shelves. The fresh seeds were provided regularly and exposed separately for the multiplication of beetles at room temperature of 28-32° C and 65-70 per cent [3]. Mass culturing of *Callosobruchus chinensis* was done at room temperature confined in glass beaker and

observed daily. Fresh adult pulse beetles from the stock culture were utilized for all the experiments.

2.2 Preparation of botanical powders
The botanical leaves *viz*., Neem, Tulasi, Notchi, Adhathoda; seeds *viz*., Bitter gourd, Black pepper and rhizomes *viz*., Turmeric, Ginger and Sweet flag (fresh leaves, fresh seeds and fresh rhizomes) were collected from and kept in the shade for 20 days for air drying. The dried leaves, seeds and rhizomes were then made into powder using electronic grinding machine. The leaf powders, seed powders and rhizome powders of different plants were stored in air-tight containers separately. The dosage of botanicals used under the present study is 2g of botanicals per 100g seeds.

2.3 Mortality studies
Botanical powders (2g) were mixed thoroughly with 100 gram seeds of mung bean in container (250 ml beaker). Ten pairs of 0-24 hour's old adults were released into each container and the containers were capped. The number of dead beetles was recorded after 24, 48 and 72 hours after release (HAR). Insects were counted as dead when they failed to move any part of their body after prodding with fine brush bristle [1]. After each counting, dead bruchids were removed. Number of alive insects was regularly observed. Per cent Mortality was calculated by using the formula:

$$\text{Mortality (\%)} = \frac{\text{Total number of dead pulse beetles}}{\text{Total number of pulse beetles released}} \times 100$$

2.4 Percent of grain damage
Examination of grain damage by the pulse beetles was done by collecting 30 randomly selected pulse grains from each of the treatment considering the number of bored seeds [2]. Then the per cent grain damage was calculated at 50 days after treatment DAT according to the following formula

$$\text{Percent grain damage} = \frac{\text{Number of infested seeds}}{\text{Total number of seeds}} \times 100$$

3. Results
3.1 Mortality studies
During the experimentation at 24 Hours after Treatment (HAT), it has been found that among all the treatments Sweet flag fared better in controlling *C. chinensis* with per cent adult mortality (25.00%) which was found to be on par with Notchi (23.33%) and Neem (21.66%) Among all the treatments Turmeric (13.33%) and Ginger (10.00%) were found to be the least effective with low per cent adult mortality which is significantly different from the untreated control (Table 1). After 48 HAT Sweet flag gives the maximum (26.00%) per cent mortality in controlling *C. chinensis* followed by Notchi (25.00%) and Neem (23.00%). Turmeric (11.66%) and Ginger (5.00%) caused the minimum per cent mortality, while in control no mortality was observed. At 72 HAT the per cent mortality on Turmeric (8.33%) and Ginger (6.66%) was found to be the least effective. Among all the treatments Sweet flag was effective in controlling pulse beetle with a per cent mortality of (31.66%), followed by Notchi (28.33%) and Neem (26.66%) which exhibited better result in per cent mortality of pulse beetle whereas no mortality was observed in control.

3.2 Per cent grain damage
The result on lowest (35.55%) per cent grain damage was recorded in Sweet flag followed by Notchi (42.22%) and Neem (45.55%) (Table 1). The highest per cent grain damage was recorded on Turmeric (66.66%) and Ginger (73.33%) was found to be less effective which was almost significantly different from untreated control (82.00%).

Table 1: Effect of Botanicals on per cent Mortality and per cent Grain Damage of *Callosobruchus chinensis* in Mung Bean

Treatments (2g/ 100g seeds)	Mortality (%) Hours After Treatment (HAT)			Grain Damage (%)
	24	48	72	
T_1 - Neem	21.66 (27.699)^{ab}	23.00 (26.987)^{bc}	26.66 (31.058)^{b}	45.55 (42.402)^{ab}
T_2 – Tulasi	18.33 (25.295)^{b}	18.33 (25.295)^{bc}	21.66 (27.699)^{cd}	57.77 (49.547)^{bcd}
T_3 – Notchi	23.33 (28.843)^{ab}	25.00 (29.988)^{a}	28.33 (32.128)^{ab}	42.22 (40.451)^{ab}
T_4 - Adhathoda	13.33 (21.327)^{c}	18.33 (25.295)^{bc}	13.33 (21.327)^{e}	61.10 (51.409)^{bcd}
T_5 - Bitter Gourd	18.33 (25.295)^{b}	21.66 (27.699)^{ab}	25.00 (29.988)^{bc}	52.22 (46.281)^{abc}
T_6 - Black Pepper	13.33 (21.327)^{c}	16.66 (23.845)^{c}	20.00 (26.554)^{d}	64.44 (53.869)^{cd}
T_7 – Turmeric	13.33 (21.327)^{c}	11.66 (19.877)^{d}	8.33 (16.590)^{f}	66.66 (54.780)^{cde}
T_8 – Ginger	10.00 (18.428)^{c}	5.00 (12.916)^{e}	6.66 (14.580)^{f}	73.33 (58.912)^{de}
T_9 - Sweet Flag	25.00 (29.988)^{a}	26.00 (29.988)^{a}	31.66 (34.217)^{a}	35.55 (36.488)^{a}
T_{10} – Control	0.00 (0.00)^{d}	0.00 (0.00)^{f}	0.00 (0.00)^{g}	82.00 (65.543)^{e}
SEd	1.804	1.736	1.497	5.297
CD (0.05)	3.789	3.646	3.144	11.127

Values in parenthesis are arc sine transformed and Values with various alphabets differ significantly

4. Discussion
Highest mortality per cent was observed in Sweet flag, Notchi and Neem at the dosage of 2g botanicals in 100g seeds (Figure 1). Present findings are on live with the study of Verma and Anandhi (2010) who reported that Neem leaf powder provided significant mortality of pulse beetle. Similar results were also reported by Ramsingh *et al*., (2001) who reported that rhizome powder of Sweet flag showed a significant effect in killing the pulse beetle within a week at 0.5, 1 and 2% concentrations. Several researchers also reported that the effectiveness of Sweet flag and Neem against *C. chinensis*, recently [5, 13].

The minimum seed damage was recorded in Sweet flag, followed by Notchi and Neem. The positive effect in all the above mentioned powders could be attributed due to the presence of insecticidal and anti-feedant principles. The efficacy of ten plant products as storage treatment against *C. chinensis* on green gram, out of these Sweet flag offered the maximum protection among the different botanicals tested against all the three generations of pulse beetle [11].

Varying activity by different powders indicate that the pest controlling factors are not uniformly present in every aromatic

plant. The rhizome powder of Sweet flag, leaf powder of Neem and Notchi were found to be the most effective treatment which was closely followed by Bitter gourd and Tulasi (intermediate) and the treatments which were recorded to be least effective, among the tested, were turmeric and ginger.

5. Conclusion

The results of the present study emphasized the potential of indigenous botanical powders like Sweet flag, Notchi and Neem could be used for achieving better control as these products are safe, cheap, residue free and eco-friendly materials that would fit into the IPM package of stored grain pests of pulses.

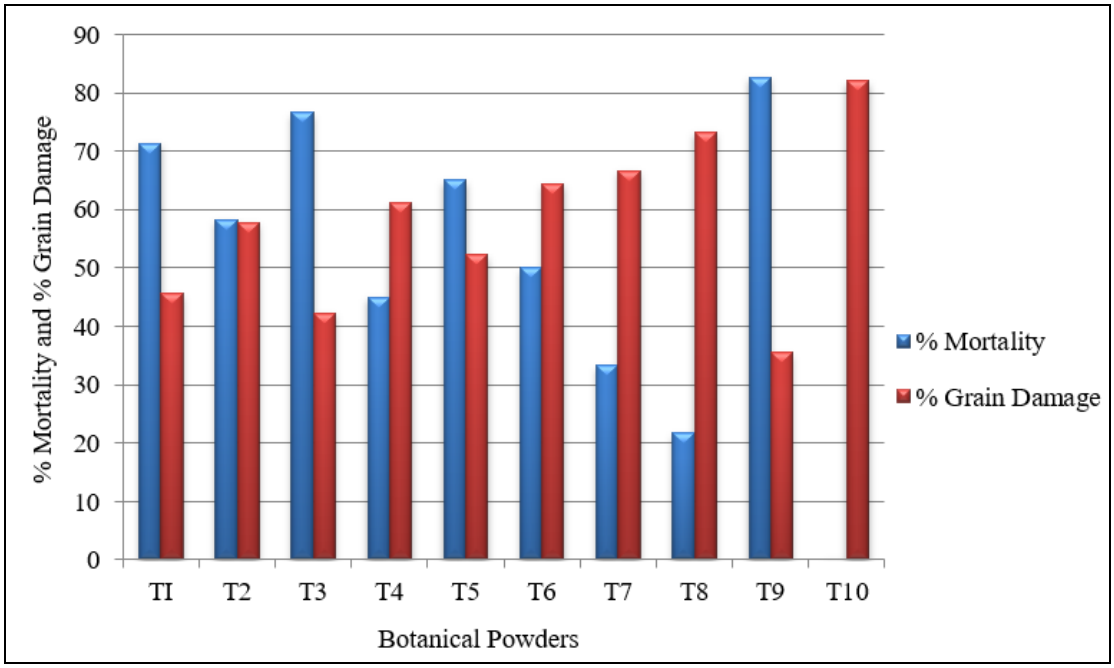

Fig 1: Effect of botanicals on per cent mortality and per cent grain damage of *Callosobruchus chinensis* in mung bean

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