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RESEARCH ARTICLE

# Bioefficacy of Certain Plant Powders against Pulse Beetle, *Callosobruchus chinensis* L. Infesting Chickpea Seeds

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## ABSTRACT

*Laboratory tests were conducted to evaluate the bioefficacy of three plant powders Piper nigrum (seed), Capsicum annum (fruit) and Lantana camara(leaf) against Callosobruchus chinensis in festing chickpea seeds. Results indicated that P. nigrum and C. annum had significant effect on mortality and egg laying capacity of the test insect. Minimum days taken for 100 per cent mortality was 1.96 in P. nigrum, 4.66 in C. annum and 9.13 in L. camarawhen used in highest concentration. At a conc. of 2gm/100mg, P. nigrumshowed the maximum efficiency on the egg laying followed by C. annum (1q.13 eggs/grain) and L. camara (1.36 egg/grain).*

***Key words:*** *Callosobruchu schinensis, Piper nigrum, Capsicum annum, Lantana camara, mortality $F_1$ individuals.*

## INTRODUCTION

*Cicer arietinum* one of the most important leguminous food crops, cultivated prevalently in the Asian pacific region is a member of the pea family. It is the third most important pulse in the world that is widely cultivated for its nutritious seeds. *Callosobruchus chinensis* the pulse beetle is the most economically destructive and major pest of chickpea which attacks the grain in storage effecting it both qualitatively as well as quantitatively (Ahmed, *et al.*, 2003). They severely damage the grain by causing weight loss, altered nutritional quality and loss of seed viability (Raja, *et al.* 2008; Patel, 2011). About four to 98% loss of pulse seeds may be observed due to infestation by the pulse beetle in storage (Mookherjee, *et al*., 1970). At present, pest control measures mostly rely on synthetic insecticides and fumigants. These chemical protectants have resulted in many serious drawbacks. Their intensive and indiscriminate use causes ecological imbalance, resistance to pesticide, pest resurgence and insecticidal residues in food materials (Ashamo 2007). In view of these problems together with the upcoming International Trade regulations, there is a need to restrict their use globally and implement safe alternatives of conventional insecticides and fumigants to protect stored grains from insect infestation (Yusuf and Ho, 1992; Subramanyam and Hagstrum, 1995). While on one hand the plant based insecticides, are target specific, non-toxic to humans and beneficial organisms, on the other hand they are less prone to insect resistance and resurgence, biodegradable and less expensive grain protectants. Hence in present investigation few plant powder are tested against above pest control.

## MATERIAL AND METHODS

### Mass Breeding and Rearing of the Insect:

The laboratory culture of *C. chinensis*was maintained throughout the year by rearing them under controlled laboratory conditions at the Department of Zoology, P.P.N. College, Kanpur, on a diet of

chickpea grains, in pre-sterilized jars at a constant temperature of 30 ± 2°C and 70 ± 5% relative humidity (Talekar, 1988).

**Raising the Culture of *C. chinensis*:**
For raising the culture of *C. chinensis*, a small population of the Pulse Beetle was obtained from Department of Entomology, CSA University of Agriculture and Technology, Kanpur. The male and female of the Pulse Beetlewere identified following the identifying characters of male and female as described by Halstead (1963). They were then reared in plastic/glass containers containing pre-sterilized chickpeas. This was done to maintain a continuous laboratory culture. During the course of investigation in order to obtain a homogenous population of test insect that did not show much variation in sensitivity within the population, fifteen pairs of insects were picked up from the stock culture and transferred to glass/plastic jars. Jars were covered by a muslin cloth and secured tightly with rubber bands. After 24 hours all the adults were removed and egg laid grains were maintained at required temperature and humidity. Insects that emerged after four weeks were used. Insect eggs were counted with the help of hand lens.

**Stored Chickpea Grains (*Cicerarietinum*):** Healthy and fresh chickpea grains were obtained from the local market after ensuring that they were free from pre storage infestation and eggs. The grains were thoroughly washed and dried to avoid the effect of any pesticide/insecticides before storing them in glass/plastic containers.

## TEST MATERIALS

**Preparation of Plant Powders and their Application:**
In this investigation three plant powders prepared from seeds of *Piper nigrum,* fruits of *Capsicum annum* and leaves of *Lantana camara* were used. These materials were washed and air-dried in the shade until they become hard and brittle to avoid fungal infection. Dried fruit and leaves were then ground to powder using an electric grinder. The resulting powders were passed through a 50 mesh sieve to obtain a fine powder. The powders were applied in three concentrations 0.5 gm, 1.0 gm and 2.0 gm per 100 gm of chickpea grains. The experiments were performed in pre-sterilized glass/plastic jar to ensure complete removal of any undesirable pest. Nine jars were taken to study the efficacy of each plant powder. These jars were filled with 100 gm of healthy and fresh chickpea grains. Each plant powder was put in separate jars in three replicates at application rate 0.5 gm, 1.0 gm and 2.0 gm (w/w). A mechanical rotary shaker was used to mix the powders with chickpea grains. Fifteen pairs of 1-2 days old adult pulse beetle were then transferred to each jar.The mouth of jars were covered with muslin cloth to prevent entry and exit of any insect. Three untreated jars having 100 gm of chickpea gains and 15 pairs of pulse beetle adults were used as control. All the jars were put in the incubator at 30° ± 2°C temperature and 70 ± 5% relative humidity.

## PARAMETERS STUDIED USING PLANT EXTRACTS

**Effect on Mortality of Adult Pulse Beetle (Days to 100 per cent Mortality):**
In each treated jar, days taken for cent percent mortality of released adults of pulse beetles were counted and compared with untreated (control) to find out the efficacy of all treatments on the longevity of pulse beetles.
Reduction percentage in longevity of adult pulse beetle was calculated by the given formula:
Percentage reduction in longevity of test insect

$$= \left(\frac{L_c - L_t}{L_c}\right) \times 100$$

Here,

$L_c$ = Average days taken for 100 per cent mortality of adult pulse beetle in control
$L_t$ = Average days taken for 100 per cent mortality of adult pulse beetle in treated jars

**Effect on Egg Laying Capacity:**
Twenty grains were randomly selected from each treated jar and eggs present on those grains were counted with help of magnifying glass. Average numbers of eggs laid per grain were calculated for each treatment by the following formula:

$$\text{Eggs per grain} = \frac{\text{Total number of eggs present on studied grains}}{\text{Total number of chickpea grain studied}}$$

The results were compared with control to evaluate the reduction effect of all treatments on egg laying capacity of test insect and percentage of reduction in egg laying capacity was calculated by given formula.
Percentage reduction in egg laying capacity

$$= \left(\frac{E_c - E_t}{E_c}\right) \times 100$$

Here,

$E_c$= Average number of eggs laid per grain in control
$E_t$= Average number of eggs laid per grain in treated condition

## STATISTICAL ANALYSIS

In the present work three different steps for statistical analysis were undertaken *viz.,* Mean, Standard Deviation and't' test for significance (Chandrasekharan and Parthasarthy, 1975).

## RESULTS

**Effect of Powders the Test on the Days to 100 per cent Mortality of Adult of *C. chinensis*:**
The three plant powders studied were found effective at all applied concentrations against *C. chinensis* in comparison to the control (Table 1). *P. nigrum*, however was the most effective and highly significant at all concentrations followed by *C. annum*. Minimum days taken for 100 per cent mortality was 1.96 in *P.nigrum*, while using 2.0 gm/100 gm of chickpea, 4.66 in *C. annum* and 9.3 in *L.camara.* found to be significant only in higher concs.

**Table 1:** Effect of plant powders of *P. nigrum*, *C. annum* and *L. camara* on days to 100% mortality of adult *C. chinensis.*

| Plant powders | | Days taken to 100% mortality of adult *Callosobruchuschinensis* Mean with Standard deviation | Percentage of reduction in longevity of adults |
|---|---|---|---|
| ***P.nigrum*** | 0.5 | 4.50** | 69.30 |
| | 1.0 | 2.83** | 80.69 |
| | 2.0 | 1.96** | 86.63 |
| ***C. annum*** | 0.5 | 7.76** | 47.06 |
| | 1.0 | 6.16** | 57.98 |
| | 2.0 | 4.66** | 68.21 |
| ***L.camara*** | 0.5 | 13.00 | 11.32 |
| | 1.0 | 11.80* | 19.50 |
| | 2.0 | 9.13** | 37.72 |
| **Control** | | 14.66 | -- |

- Table value of t at *df* 4 at P=0.05 is 2.78 and at P=0.01 is 4.60.

**Effect on the Egg Laying Capacity:**
The data presented in Table 2 showed the effects of powders of *P. nigrum, C. annum* and *L. camara* on egg laying capacity of *C. chinensis,* while studying the *Piper nigrum* was found most effective as compared to other two treatments. Increasing concentration of *P. nigrum* showed 2.0, 1.5 and 1.03 mean number of eggs laid per grain, which was slightly different from *C. annum* that showed 2.13,

1.43 and 1.13 when 0.5, 1.0 and 2.0 gm concentrations of powder/100 gm of chickpea was used. However, the weakest response was seen in case of *L. camara* where eggs per grain at the same concentrations were 2.3, 1.9 and 1.36.

Fig.1. clearly indicates percentage of reduction in longevity of test insect which represents maximum effectiveness of *Piper nigrum* and the minimum effect of *Lantana camara* while *Capsicum annum* behaved as an intermediary. The percentage reduction values varied from 11.32 to 86.63. Increase in concentration of all powders increases percentage of reduction in longevity of test insect in all treatments.

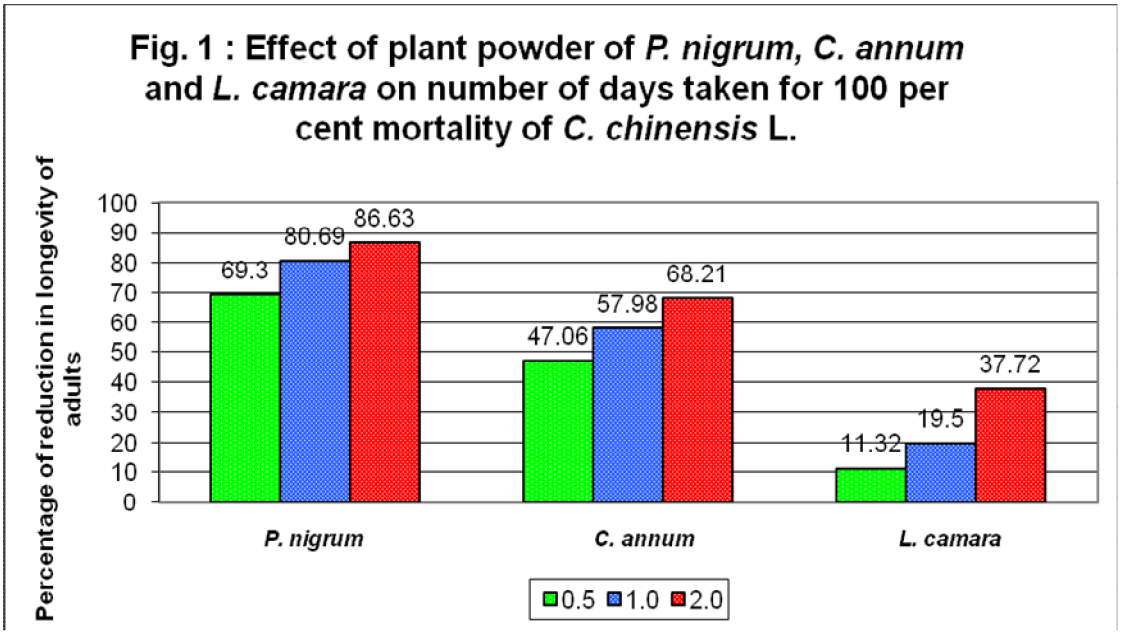


**Fig.1:** Effect of Plant Powder of *Piper nigrum*, *Lantana camara* and *Capsicum annum* on number of days taken for 100 % mortality of *C. chinensis* L.

**Table 2:** Effect of plant powders of *Piper nigrum*, *Capsicum annum* and *Lantana camara* on egg laying capacity of *Callosobruchu schinensis.*

| Plant powders | | No. of eggs laid/ grain Mean with Standard deviation | Percentage of reduction in longevity of adults |
|---|---|---|---|
| ***P.nigrum*** | 0.5 | 2.0* | 48.18 |
| | 1.0 | 1.50** | 61.13 |
| | 2.0 | 1.03** | 73.31 |
| ***C. annum*** | 0.5 | 2.13* | 44.81 |
| | 1.0 | 1.43** | 62.95 |
| | 2.0 | 1.13** | 70.72 |
| ***L.camara*** | 0.5 | 2.30* | 40.41 |
| | 1.0 | 1.90** | 50.77 |
| | 2.0 | 1.36** | 64.76 |
| **Control** | | 3.86 | -- |

- Table value of t at *df* 4 at P=0.05 is 2.78 and at P=0.01 is 4.60.

Fig.2. represents percentage of reduction in egg laying capacity of *C. chinensis* on treatment with powders of test plants. *Piper nigrum* (2%) showed maximum reduction percentage (73.31%) in egg

laying capacity of test insects, while *Lantana camara* showed minimum reduction percentage (64.76%) at the same concentration. All the three treatments were found significantly effective in controlling egg laying capacity of test insect.

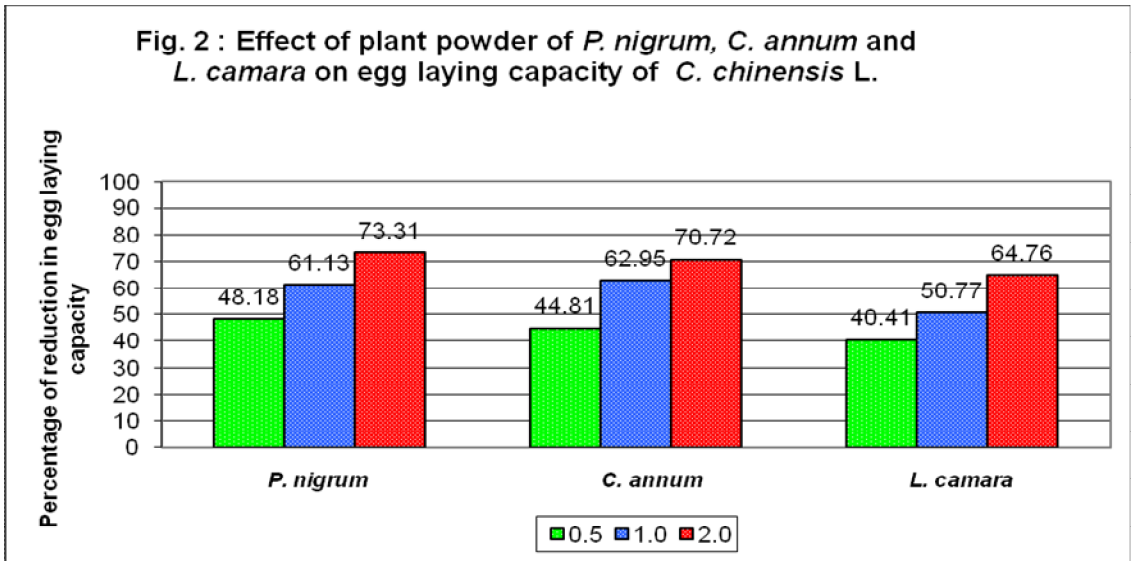


**Fig.1:** Effect of Plant Powder of *Piper nigrum*, *Lantana camara* and *Capsicum annum* on egg laying capacity of *C. chinensis* L.

## DISCUSSION

Similar to our findings, the effect of *P. nigrum* was studied by Issa, *et al.,* (2011) on the mortality of *Sitophilus zeamais*. They found more than 95% mortality with 0.5 gm powder per kg of grain, suggesting it to be a good botanical for stored grains. These findings have further been substantiated by the study of Swella, *et al.,* (2007) who evaluated the effectiveness of natural protectants against *C. maculatus* in cowpea seeds. Ratnasekera and Rajapakse (2012) reported that of the four powders used for control of *Callosobruchus* sp., clove powder was the most effective for adult mortality followed by root dust of papaya. All the above results are in conformity with the present findings. Ashouri and Shayesteh (2009) studied the effect of black pepper and *C. annum* fruit powder and reported that *C. annum* was less effective as compared to *Piper* when used against *Sitophilus zeamais* and *Rhizopertha dominica.* This finding is in consonance with the present work. Hossain, *et al.,* (2008) pointed out that *P. nigrum, Cinnamonnum zealanicum, Amonum sublatum, Nigella sativa* and *Capsicum frulescens* caused 100% mortality of *C. maculatus* (F.). Shukla, *et al.* (2007) used *Eupatorium cannabinum* and *Murraya koenigii* against *C. chinensis* and reported reduced longevity. They, however, concluded mortality to be a result of reduced respiration caused by occlusion of spiracles and tracheae consequently leading to suffocation. Effects of some Nigerian plant powders, extracts and oils as insect protectants have been observed in the treatment of cowpea and maizeweevils (Ashamo, 2007; Lale 1992; Oni and Ileke, 2008). Abdullhai and Muhammad (2004) also demonstrated increased mortality and significant control on egg layingof *C. maculatus* by *Piper guineense.* Similarly, Aslam, *et al.,* (2002) reported that black pepper *P. nigrum* caused 100% mortality of *C. chinensis* after 3.75 days of treatment. Gupta (2007) observed that red pepper was highly effective in reducing the larval population in *H. armigera* which was possibly a result of poor egg laying. Dwivedi and Garg (2003) reported reduced egg laying capacity with *L. camara* on *Corcyra cephalonica* and Singh, *et al.,* (1996) observed the same in *Rhizopertha dominica*. Khanna (1995) observed that *P. guineense* seed powder at low concentration reduced oviposition and adult emergence. All these above reports are in support of our findings.

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