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Bio-efficacy of Some Plant Extracts Against Chickpea Beetle, *Callosobruchus chinensis* Linnaeus (Coleoptera: Bruchidae) Attacking Chickpea

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Abstract.- The study was carried out to determine potential insecticidal effect of ten plant extracts against stored chickpea beetle, *Callosobruchus chinensis* L. Experiment was carried out under completely randomized design in the laboratory. The plant materials used for extraction included leaves of olive (*Olea europea*), tea (*Thea chinensis*), bhang (*Canabis sativa*), elephanta (*Elephantia* sp.), neem (*Azadirachta indica*), dharek (*Jacaranda mimosifolia*) and fruit of garlic (*Allium sativum*), cloves (*Syzygium aromaticum*), black pepper (*Piper nigrum*) and red chillies (*Capsicum annum*). Results indicate that black pepper was the most effective treatment in controlling chickpea beetle attack followed by cloves, neem and garlic.

Key Words: Efficacy, plant extracts, chickpea beetle, chickpea.

INTRODUCTION

The chickpea beetle, *Callosobruchus chinensis* (L.) has been reported to cause serious damage to pulses in Bangladesh, India and many countries of the world (Qayum, 1977; Farooq, 1978; Islam, 1980; Saleem and Saleem, 1982; Ahmad, 1984). As many as 18 insect pests have been recorded damaging this crop (Hassan *et al.,* 1998). According to Aslam and Suleman (1999) pulse beetle (*C. chinensis* L.) is a destructive pest of chickpea under storage.

Since use of insecticides is not advised on food grains directly, it has been practice in the past to use plant extract as grain protectants (Jilani *et al.*, 1988). Neem powder and its extract works as repellent and has been reported by several researchers against *C. chinensis* L. and others (Saeed, 2004; Reddy and Singh, 1998; Bhuiyah *et al.*, 2002). Tripathy *et al.* (2001) tested effect of plant powders and extracts against *C. chinensis* L. attacking black gram. Al-Lawati *et al.* (2002) tested the potential of eight plant extracts against oviposition, adult emergence and mortality of *C. chinensis*. Gautam *et al.* (2000) evaluated the effect of nine edible plant products *i.e.*, aonla, black pepper, bitter gourd, clove, cinnamon, fenugreek, ginger, red chilies and tumeric to control chickpea beetle attack to stored chickpea. Aslam *et al.* (2004) tested the bio-efficacy of ten plant materials including leaves of olive, tea, bhang, elephanta, neem, dharek and fruits of garlic, cloves, black pepper and red chilies in ground form against biology and life span of *C. chinensis* L.

In Pakistan, the production of chickpea, on the average, is 0.37 million tones per year. Chickpea occupies 75 % (1.75 million hectares) of the total area under cultivation for pulses in Pakistan (Ahmed *et al.*, 1993). Here chickpea is stored at godowns and warehouses in bulk which are readily attacked by various insect pests thereby becoming unfit for human consumption and looses its germination capacity as well. Chickpea beetle (*Callosobruchus* spp.) causes very heavy losses each year and affects economy of the country. Suitable control strategies are thus needed to be adopted against this pest. In view of above, present study evaluates the insecticidal, anti-feedent and anti-ovipositional potential of extracts from ten plant species against chickpea beetle, *C. chinensis* L. under laboratory conditions.

MATERIALS AND METHODS

Experiment was conducted in Stored Grain Research Laboratory of Entomology Department, Pir Mehr Ali Shah Arid Agriculture University Rawalpindi to check bio-potential of extracts educed

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from different plant materials to control stored chickpea beetle, *C. chinensis* Linnaeus (CCL) under laboratory conditions.

Plant materials used for taking extractions include leaves of olive (*Olea europea*), tea (*Thea chinensis*), bhang (*Canabis sativa*), elephanta (*Elephantia* sp.), neem (*Azadirachta indica*), dharek (*Jacaranda mimosifolia*) and fruits of garlic (*Allium sativum*), cloves (*Syzygium aromaticum*), black pepper (*Piper nigrum*) and red chillies (*Capsicum annum*). All plant materials were shade dried following Don-Pedro (1985) and Aslam *et al.* (2004) and their extracts were taken by decoction technique (Zia, 2004). For this, one gram of each dried plant material was individually boiled in 100 ml of water at 100^{o}C for 10 minutes. Kettle lid was kept covered to avoid evaporation. On collecting extracts, cotton swabs weighing 1g each were injected with 1ml of each extract separately by a sterile syringe. Cotton swabs were then given enough time to get dried so as to incise increasing moisture contents in jars which may enhance fungal growth.

Adults of CCL were fed by a single variety of gram *i.e.* CM-2000. The variety was obtained from pulse section of National Agriculture Research Centre, Islamabad and subjected to fumigation using Agtoxin, following Riaz *et al.* (2000) for two weeks so as to kill any pest already existing. A sample of 40g sieved grains of variety CM-2000 were placed into all the glass jars and cotton swabs injected with extracts of ten plant species were added in each glass jars respectively. Adults of CCL were collected from different godowns in Rawalpindi. Their pairing was done following Halstead (1963) and they were released in the jars so as to give them enough time for oviposition. In each glass jar 10 pairs of adult chickpea beetle were released. Glass jars were then placed in an incubator with a temperature of 30±2°C. Mouth of glass jars was covered with muslin cloth and secured by rim of lid so as to disallow escape of chickpea beetles as well as any other insect contamination. Experiment was laid down in completely randomized design (CRD) with eleven treatments (extracts of ten plant materials and a control treatment) with three replications. For determining effect of plant extracts on following six parameters data were recorded on weekly basis up to 100% mortality of F1 generation:

i) Mortality of old chickpea beetles: For this, days required for killing 100% of released pulse beetles were recorded.

ii) Damage to grains: The damage in terms of number of holes/grain was calculated by randomly selecting ten grains in each replication and counting their damaged holes. Average for total damaged holes was taken to determine injury level for each treatment.

iii) Effect on fecundity (Oviposition): For this, ten grains were randomly selected from each replication and eggs laid on these grains were counted. Average number of eggs per grain of each treatment served as the level of fecundity.

iv) Effect on hatching of eggs: All the newly emerged adults in each jar under each replication were counted and their average was taken.

v) Mortality of F-1 generation: For this, days required for killing 100% freshly emerged beetles of F1 generation were recorded.

vi) Percent weight loss observed in infested chickpea grains: At the end of experiment percent weight loss was calculated.

Data recorded for all of the above parameters were subjected to statistical analysis as CRD by using computer software SPSS program version: 11 and Minitab program with descriptive statistics and analysis of variance (Steel and Torrie, 1980). Where significant F ratio was obtained, Duncan's Multiple Range tests (DMRT) were applied to the means. Based on grouping of DMRT, treatments were assigned different levels of efficacy against CCL.

Chemical analysis of all plant extracts (for crude protein and ash contents) and chickpea variety (for crude protein, fats, ash and moisture contents) were also carried out following AOAC (2007) to authenticate obtained results.

In addition, physical characteristics of chickpea variety were also studied by keeping in view the work by Nwanze *et al.* (1975) which states that bruchids can detect microscopic differences in seed coat texture which may be partially responsible for their choice of varieties. Physical characteristics of chickpea variety (CM–2000) including seed texture, shape, color and its coat thickness were found to be rough, rounded, brownish and thick respectively. Variety CM-2000 was chosen due to

its susceptible genotype.

RESULTS AND DISCUSSION

Table I shows chemical composition of plant extract. Chickpea variety CM 2000 showed 19.25% protein, 3.58% fat, 3.76% ash and 11.45% moisture content.

Table I.- Chemical composition of plant extracts

Treatments	Ash %	Protein %
Olive	4.80%	11.37%
Red chilies	1.80%	11.70%
Dharek	5.10%	21.00%
Bhang	6.00%	19.25%
Neem	6.20%	11.37%
Elephanta	3.10%	21.87%
Cloves	3.50%	6.12%
Black pepper	4.00%	12.20%
Garlic	0.90%	3.30%
Tea	5.90%	24.50%

Table II shows the effect of extracts of different plants on mortality of old beetles, grain damage, fecundity, hatching and mortality of newly emerged adults of chickpea beetle. On comparison with control, black pepper (*Piper nigrum*) was found to be highly effective, followed by cloves (*Syzygium aromaticum*). Bhang (*Canabis sativa*), neem (*Azadirachta indica*) and garlic (*Allium sativum*) were partially effective. Olive (*Olea europea*) and dharek (*Jacaranda mimosifolia*) were little effective. Whereas red chillies (*Capsicum annum*), elephanta (*Elephantia* spp.) and tea (*Thea chinensis*) were observed to be ineffective. However maximum days to mortality were recorded in control treatment.

All treatments caused significant decrease in number of holes made per grain by the beetle compared to control. Yet black pepper (*Piper nigrum*) caused highly significant decrease in number of holes per grain (Table II).

The beetles treated with plant extracts laid significantly fewer number of eggs when compared with the control beetles. However, comparatively fewer eggs were laid in the presence of black pepper (*Piper nigrum*), bhang (*Canabis sativa*), red chillies (*Capsicum annum*), tea (*Thea chinensis*) and olive (*Olea europea*) as shown in Table II.

Like wise the number of adult hatched from eggs during F-1 generation decreased significantly in the presence of plant extracts compared to normal hatching in control. However black pepper *(Piper nigrum)* was once again found to be highly effective. Cloves (*Syzygium aromaticum*), garlic (*Allium sativum*), neem (*Azadirachta indica*), tea (*Thea chinensis*), red chillies (*Capsicum annum*) and bhang (*Canabis sativa*) also had similar effect. All these treatments were also thus classified to be effective. Dharek (*Jacaranda mimosifolia*), elephanta (*Elephantia* spp.) and olive (*Olea europea*) were however not much different from control treatment (Table II).

Considering hundred percent mortality of freshly emerged chickpea beetles of F1 generation, black pepper *(Piper nigrum)* again proved to be highly effective with significant difference from control treatment. Bhang (*Canabis sativa*), dharek (*Jacaranda mimosifolia*), olive (*Olea europea*), elephanta (*Elephantia* sp.), red chillies (*Capsicum annum*) and tea (*Thea chinensis*) gave results with significant difference to that of control treatment but there was no significant difference found between themselves (Table II).

Minimum weight loss was recorded in chickpeas treated with extracts of black pepper (*Piper nigrum*). Cloves (*Syzygium aromaticum*), garlic (*Allium sativum*) and neem (*Azadirachta indica*) gave results that were significantly different from control but statistically they were nearly the same as of black pepper. Bhang (*Canabis sativa*) gave results that were almost similar to control treatment and showed non-significant difference to it. Percent weight loss observed is shown in Figure 1.

Results divulged black pepper to be the best anticipating treatment in controlling CCL due to its high insecticidal, anti-feedent and anti-ovipositional potential. Aslam *et al.* (2004) studied the effect of ten plant materials in dried ground form against chickpea beetle. Results revealed black pepper as a prominent growth inhibitor against CCL. followed by cloves. Abbas (2005) tested efficacy of some plant oils and extracts against CCL. during storage. Among these black pepper and red chilies produced promising results in controlling chickpea beetle attack.

Table II.- Days to 100% mortality of old chickpea beetles, *Callosobruchus chinensis* L. treated with extracts of different plant species.

Treatments	Mortality of old chickpea beetles	Damage to grains	Effect on hatching of eggs	Effect on fecundity (Oviposition)	Mortality of F-1 generation
Olive	30.33 ± 2.33 cd	0.73± 0.13ab	1.26± 0.56ab	6.04 ± 5.95 ab	28.00 ± 4.04 b
Red chilies	35.00 ± 0 de	0.66 ± 0.37 ab	1.26± 0.56 ab	2.95 ± 0.42 a	25.66 ± 4.66 b
Dharek	30.33 ± 2.33 cd	0.53 ± 0.24 ab	1.00 ± 0.50 a	4.19 ± 3.83 ab	30.33 ± 2.33 b
Bhang	28.00 ± 0 c	0.53 ± 0.24 ab	1.06 ± 0.66 ab	2.95 ± 0.42 a	23.33 ± 2.33 b
Neem	28.00 ± 0 c	0.46 ± 0.17 ab	0.53 ± 0.33 a	1.90 ± 1.54 a	11.6 ± 4.66 a
Elephanta	35.00 ± 0 de	0.73 ± 0.24 ab	0.73 ± 0.13 a	4.52 ± 3.03 ab	28.0 ± 4.04 b
Cloves	18.66 ± 2.33 b	0.20 ± 0.11 ab	0.26 ± 0.06 a	0.95±0.47 a	7.00 ±4.04 a
Black pepper	14.00 ± 0 a	0.06 ± 0.06 a	0.13 ± 0.06 a	0.23 ± 0.23 a	2.33 ± 2.33 a
Garlic	28.00 ± 0 c	0.53 ± 0.24 ab	0.46 ± 0.13 a	1.52 ±0.74 a	11.66 ±4.66 a
Tea	37.33 ±2.33 e	0.80 ± 0.11 b	1.26 ± 0.37 ab	2.61 ± 1.19 a	25.66 ± 2.33 b
Control	39.66 ±2.33 e	1.53 ± 0.06 c	2.600 ± 0.94 b	10.00 ±1.15 b	46.66 ±2.33 c

The values are Mean±SD. Means followed by same letters are not significantly different from each other at alpha = 0.05.

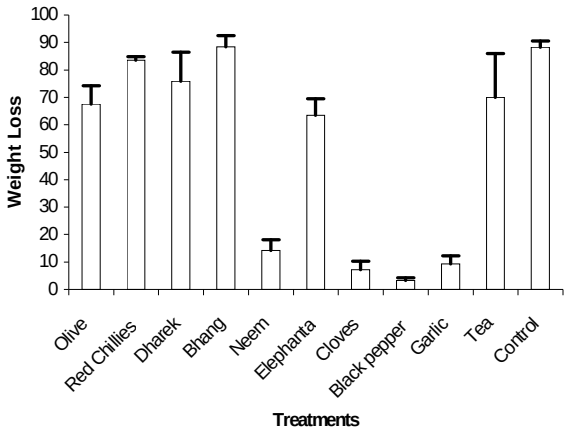

Fig. 1. Percentage of weight loss in chickpea under different treatments.

To authenticate results of current study**,** correlation between chemical composition of plant extracts and all parameters of experiment was made at alpha 0.01 and alpha 0.05 (Table III). The coefficient of correlation between percent ash and protein contents in plant extracts and mortality of old chickpea beetles, damage to grains, effect on fecundity (oviposition), effect on hatching of eggs, mortality F-1 generation and percent weight loss in infested chickpea grains was found positive, stating plant extracts with least ash and protein contents as more effective against chickpea beetle (CCL).

Table III.- Correlation between chemical composition of plant extracts and all parameters of experiment.

Parameters	Ash %	Protein %
1. Days to mortality of old chickpea beetles	r = 0.038 NS p= 0.917	r = 0.530 NS p= 0.115
2. Number of damaged holes	r = 0.058 NS p= 0.874	r = 0.481 NS p= 0.159
3. Number of eggs	r = 0.249 NS p= 0.487	r = 0.531 NS p= 0.114
4. Fresh adult emerged (F1 Generation)	r = 0.178 NS p= 0.622	r = 0.434 NS p= 0.210
5. Days to mortality of fresh adult emerged (F1 Generation)	r = 0.183 NS p= 0.612	r = 0.661* p= 0.037
6. % Weight loss	r = 0.249 NS p= 0.488	r = 0.688 NS p= 0.028

*Correlation is significant at 0.05 level
NS = Correlation is non significant

CONCLUSIONS

The results in compilation demonstrate black pepper *(Piper nigrum)* as a promising treatment in controlling attack of chickpea beetle. Preferred and recommended method of application is extracted form which ultimately reduces direct contact and mixing of this bio pesticide with whole grains under storage, as normally observed in case of dried

ground form application methodologies.

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