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# TOXIC POTENTIALS OF SOME PLANT POWDERS ON SURVIVAL AND DEVELOPMENT OF *CALLOSOBUCHUS MACULATUS* (F.) AND *CALLOSOBUCHUS CHINENSIS* L.

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**Abstract:** Leaves of *Vitex negundo* L., *Annona squamosa* L., *Nicotiana tabacum* L., *Polygonum hydropiper* L. and leaf, bark and seed kernel of *Azadirachta indica* A. juss. were powdered and admixture at the rate of 1-, 2- and 3g per 50g cowpea seeds. *Callosobruchus maculatus* (F.) and *C. chinensis* L. adults of both sexes were released in the treated and control cowpea seeds. The mean numbers of eggs laid by both bruchids was significantly decreased in *A. indica* seed kernel treated cowpea seeds. The toxic effect of the plant parts were observed up to seven days. Between 26.66% ± 12.01 to 100% mortality rates were recorded for *C. maculatus* and 86.66% ± 6.66 to 100% for *C. chinensis* in all the trials. The mortality rates in the untreated control ranges between 10-26%. Very few adults were emerged at *A. indica* seed kernel treatments. The adult emergence was 5.33% ± 0.88, 4.33% ± 0.88 and 1.66% ± 0.88 for *C. maculatus;* and 5.33% ± 0.88, 3.66% ± 0.66 and 2.00% ± 0.57 for *C. chinensis* at the doses of 1 -, 2 and 3g per 50g cowpea seed respectively. No significant weight loss was obtained in tobacco leaf powder and *A. indica* seed kernel treated seeds for both bruchid species. Among the plant materials highest percentage of weight loss was found in *P. hydropiper* leaf powder followed by *A. indica* bark, *A. squamosa* leaf and *V. negundo* leaf powder.

**Key words:** *Azadirachta indica, Annona squamosa, Nicotiana tabacum, Polygonum hydropiper, Vitex negundo,* cowpea weevil, pulse beetle, *Vigna unguiculata,*

mvivsk: *Vitex negundo* L., *Annona squamosa* L., *Nicotiana tabacum* L., *Polygonum hydropiper* L.-Gi cvZvi ¸ov Ges *Azadirachta indica* A. juss.-Gi cvZv, evKj I ex‡Ri ¸ov †mvbvgM cwZ 50 Mv‡g 1-, 2- Ges 3 Mvg †gkvb nq| *Callosobruchus maculates* (F.) I *Callosobruchus chinensis* L. Dfq wj‡½i cYv½ †cvKv c‡qvMK Ges wbqšb †mvbvgM ex‡Ri g‡a¨ Qvov nq| *A. indica* - ex‡Ri ¸ov Øviv wgwkZ †mvbvgM ex‡R Dfq e"wK‡Wi Wx‡gi msL¨v ZvrchcYfv‡e Kg cvIqv hvq| c‡qvMKZ Dw™`¸‡jvi welwµqvi djvdj mvZw`b chš¨ chv‡e¶Y Kiv nq| mKj chv‡e¶‡Y *C. maculatus* - Gi †¶‡Î 26.66% ± 12.01 n‡Z 100% Ges *C. chinensis* - Gi †¶‡Î 86.66% ± 6.66 n‡Z 100% gZ¨i nvi †`Lv hvq| wbqwšZ †mvbvgM ex‡R gZ¨i nvi wQj 10 †_‡K 26%| *A. indica* - ex‡Ri ¸ov Øviv wgwkZ c‡qvM‡K Le Kg msL¨K †cvKv cYv½ `kv cvß nq| cwZ 50 Mvg †mvbvgM ex‡R 1-, 2- Ges 3 Mvg ex‡Ri ¸ov Øviv wgwkZ c‡qvM‡K cYv½ `kv cwßi nvi wQj *C. maculatus*-Gi †¶‡Î h_vµ‡g 5.33% ± 0.88, 4.33% ± 0.88 Ges 1.66% ± 0.88, Ges *C. chinensis* -Gi †¶‡Î h_vµ‡g 5.33% ± 0.88, 3.66% ± 0.66 Ges 2.00% ± 0.57| Dfq ewK‡W *N. tabacum*-Gi cvZv Ges *A. indica* -Gi ex‡Ri ¸ovq ‡mvbvgM ex‡Ri IRb nvm ZvrchcY ‡`Lv hvqwb| Dw™`¸wji g‡a¨ *P. hydropiper* -Gi cvZvi ¸ovq ‡mvbvgM ex‡Ri IRb nvm mev‡c¶v †ekx cvIqv hvq Ges Gici avivewnKfv‡e wbgµgbhvqx *A. indica* -Gi evKj, *A. squamosa* Ges *V. negundo* -Gi cvZvi ¸ovq Zv cvIqv hvq|

## Introduction

*Callosobruchus maculatus* (Fab.) and *Callosobruchus chinensis* L. are very dangerous pest of the pulse crop throughout the world. *C. chinensis* is much more abundant and a destructive pest of chickpea (*Cicer arietinum* L.) and lentil (*Lens esculenta* Moech). It is cosmopolitan and a serious pest of green grams, peas, cowpeas and lentil and has also been reported attacking cotton seed, sorghum and maize (Ahmed et al. 2003). It has a short life cycle which is completes in 25–34 days during summer and 40-50 days in winter (Ghosh and Durbey 2003). The damage of *C. chinensis* is generally started in ripened pods in the field from where it is carried to storage godowns. Both grubs and adults are responsible for causing the damage. Gujar and Yadav (1978) reported 55-60% loss in seed weight and 45.50-66.30% loss in protein content due to its damage and pulse seeds become unfit for human consumption as well as planting. *C. maculatus* is also an important stored grain pest with a short life cycle that lasts for approximately 25-30 days and it develops rapidly and may cause the total loss of stored grain legumes within a few months of storage (Babu et al. 1999). The degree of damage varies with different kinds of legumes on the basis of exposure time, storage facilities and other factors associated with seeds. The rate of damage increased or decreased with the duration of storage under normal condition i.e., the longer the duration, the higher the damage (Gujar and Yadav, 1978). To combat the problem of protein deficiency prevalent in developing countries, apart from mass production, there is a need to reduce qualitative as well as quantitative losses of pulses during storage (Babu et al. 1999).

At present, pest control measures in storage rely on the use of synthetic insecticides and fumigants. Their indiscriminate use in the storage, however, has led to a

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number of problems including insect's resistance, toxic residues in food grains (Fishwick 1988), environmental pollution (WMO 1995) and increasing costs of application. Manmade chemicals have many harmful effects (Purohit and Vyas 2005). In view of these problems together with the upcoming WTO 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 infestations (Yusof and Ho 1992; Subramanyam and Hagstrum 1995).

There is no doubt that botanical insecticides are an interesting alternative to insect pest control, and on the other hand only a few of the more than 250,000 plant species on our planet have been properly evaluated for this purpose. Plant material based (botanicals) insecticides are target specific, non-toxic to human and beneficial organisms, less prone to insect resistance and resurgence, biodegradable and less expensive and are promising grain protectants. Plant materials constitute a rich source of bioactive chemicals (Wink 1993); hence they could lead to the development of new classes of safer insect control agents. Use of plant for infestation control in stored grains therefore seems to offer desirable solutions, especially in developing tropical countries where plants are found in abundance everywhere throughout the year.

In the present study a survey was carried out in farmer houses to establish which plants are/were most often used in traditional storage practice for the protection of stored cowpea. About five of the most frequently used plant species were selected in the present study. These plants were tested in the laboratory for their toxic effect against *C. maculatus* and *C. chinensis* to provide a suitable, effective method of protection of stored cowpeas. If these plants prove to be effective, their adoption as measures for crop protection by farmers would be easier as they were already used traditionally.

## Materials and Methods

The infested samples of cowpea, black gram, chickpea, and lentil with pulse beetles were collected from different locations and sources (godowns and general public stores) of Shaheb Bazar, Rajshahi, and Chapai Nawabganj. Mass cultures were maintained in earthen pot (4l) and sub-cultures in glass jars (1l) or beakers (500 ml) with the food medium. The botanicals used in this study were Neem (*Azadirachta indica* A. juss.), Nishinda (*Vitex negundo* L.), Custard apple (*Annona squamosa* L.), Tobacco (*Nicotiana tabacum* L.) and Bishkatali (*Polygonum hydropiper* L.). Leaves and other plant parts (bark and seed kernel) were collected from different localities of Rajshahi. The plant parts were air-dried at room temperature (25-30°C) until they become crisp dry. The plant parts were then finely powdered by a hand grinder followed by a mechanical grinder. All the plant materials were sieved repeatedly to obtain fine dust particles. The resulting dust particles were used as direct admixture to the cowpea seeds at different application rates.

For toxicity tests seven sterilized petridishes (9-cm diamter) containing 50g of sterilized cowpeas were treated with 1g of plant powders separately. The 8$^{th}$ petridishes contained same amount of untreated cowpeas, serving as control. Each of petridishes from both groups was then infested with 10 newly emerged adult bruchids of both sexes. Each treatment and control was replicated three times. Temperature and relative humidity ranges between 25-30°C and 60-70% respectively. In the same environment and condition, the same procedure was repeated using the same quantity (50g) of grains treated with 2g and 3g of the dust in the second and third trials. Observations were made on adult's fecundity, mortality, adult emergence of weevils and the weight loss after the emergence of adult. Eggs laid on 20 seeds randomly selected from each petridishes were counted on 5$^{th}$, 6$^{th}$ and 8$^{th}$ day post infestation in trials 1, 2, and 3, respectively. Those seeds were then returned into the same petridishes and observations were made on the emergence of adult weevils. The data obtained was subjected to analysis of variance.

## Results and Discussion

*Effect on oviposition*: The results after the all three trials had shown it clearly that the tested plant materials affected the oviposition of *C. maculatus* and *C. chinensis*. The number of eggs laid per 100 seeds of both bruchid species was much reduced in treated samples in comparison with untreated control (Table 1). Among plant powders, *A. indica* seed kernel was very effective and the mean numbers of eggs laid per 100 seeds in the doses 1-, 2- and 3g per 50g (w/w) was 8.33 ± 1.66, 8.33 ± 3.33 and 3.33 ± 1.66 respectively for *C. maculatus.* For *C. chinensis* the oviposition in the same treatment was 8.33 ± 1.16, 10.00 ± 2.88 and 3.33 ± 1.66 in the above mentioned doges respectively. DMRT value shows that *A. indica* seed kernel treatment means significantly differ with other treatments and control in most of the cases. *N. tabacum* and *V. negundo* leaf powder also reduce the oviposition at 3g (6.66 ±3.33) and 1g (15.00 ± 2.88) treatments respectively for *C. maculatus*. In case of *C. chinensis* the above mentioned plant powders reduce the oviposition at 2g (23.33 ±

3.33) and 3g (25.00 ± 2.88) treatments respectively. *P. hydropiper* leaf offered the least ovicidal effect with highest mean fecundity in both the species though it significantly differ from control in 1- and 2g doses in *C. maculatus* and 3g dose in *C. chinensis.*

*Effect on adult mortality*: The toxic effect of the plant parts were observed up to 7 days. Between 26.66% ± 12.01 to 100% mortality rates were recorded for *C. maculatus* and 86.66% ± 6.66 to 100% for *C. chinensis* in all the trials (Table 2). The mortality rates in the untreated control ranges between 10-26%. In *A. indica* seed kernel treated cowpea seeds 100% mortality was observed in all doses for both the species. *C. chinensis* was more susceptible and 100% mortality was recorded in *V. negundo* leaf powder in all doses and 1- and 3g per 50g cowpea seeds for *A. indica* bark powder and *A. squamosa* leaf powder respectively. In all cases for both species treatment of the plant parts significantly increased the mortality of the bruchids with respect of the untreated control.

*Effect on adult emergence*: Very few adults were emerged at *A. indica* seed kernel treated cowpea seeds. The adult emergence was 5.33% ± 0.88, 4.33% ± 0.88 and 1.66% ± 0.88 for *C. maculatus;* and 5.33% ± 0.88, 3.66% ± 0.66 and 2.00% ± 0.57 for *C. chinensis* in 1-, 2 and 3g per 50g cowpea seed doses respectively. *N. tabacum* leaf powder at the same doses offered adult emergence as 6.33% ± 1.20, 6.00% ± 2.08 and 1.00% ± 0.57 for *C. maculatus* and 43.33% ± 6.83, 21.33% ± 4.09 and 7.66% ± 1.20 for *C. chinensis* in the same doses respectively. Few adults were emerged in *A. indica* bark and leaf treated samples in comparison with *V. negundo*, *A. squamosa,* and *P. hydropiper* leaf powder (Table 3). Here also all control values significantly differ with the treated ones.

*Effect on weight loss of the grain*: Table 4 shows the average percentage of weight loss of cowpea seeds at the end of each trial after the emergence of adult. No significant weight loss was obtained in tobacco leaf powder and *A. indica* seed kernel treated seeds for both *C. maculatus* and *C. chinensis* infestation. In tobacco leaf powder no weight loss was recorded for 1g and 3g treatment in *C. maculatus,* and in 2g treatment the weight loss was only 0.03% ± 0.02. For *C. chinensis* the weight loss of tobacco leaf powder treated grain was recorded as 2.61% ± 0.69, 2.56% ± 0.49 and 2.94% ± 0.58 at 1-, 2- and 3g per 50g seed treatments respectively. The control batch always possess higher weight loss of grain with respect to treated seeds. Among the plant materials highest percentage of weight loss was found in *P. hydropiper* leaf followed by *A. indica* bark, *A. squamosa* leaf and *V. negundo* leaf powder.

Admixing powders of *A. indica*, *A. squamosa* and *V. negundo* to at 1-5g per 50g cowpea seeds gave promising levels of bruchid control in terms of reductions in the number of eggs laid. It is not known whether reduced oviposition was the result of an inhibition of egg laying or was the consequence of reduced longevity. However, since females deposit most of their eggs in the first 3 days of adult life (Nwanze *et al.* 1975; Wasserman 1985), any reduction in adult life-span which the plant powders may have caused would be expected to have contributed little to the reduced oviposition. Many of the plants which farmers use as protectants have a strong smell which, it is believed, repels or kills insect. Previous workers reported that plant powders reduce oviposition by bruchids under laboratory conditions. The plants involved include: *A. indica* kernel powder (Sowunmi and Akinnusi 1983) and *Tridax procumbens* (L.) with C. *maculatus* (Bhaduri et al. 1985), and *A. squamosa* seed powder with *C. chinensis* (Ali *et al.* 1981).

The use of *A. indica* seed kernel in the control of *C. maculatus* was studied by Sowunmi and Akinnusi (1983) and indicated that 0.5% admixture treatment was effective for up to four months after which considerable grain damage was encountered. *A. indica* seed kernel applied to pea seeds reduced damage by *C. chinensis* over a three month storage period by reducing $F_1$ adult emergence (Kumari et al. 1990). Pandey and Singh (1995) found that seeds of black gram could be effectively protected from damage by *C. chinensis*, by mixing the seed with dried powder of *A. indica* leaves at a rate of 100-400 mg/50 gm seed. Rajapakse et al. (1998) observed that *A. indica* gave significant reduction of oviposition and adult emergence of *C. maculatus*.

The oviposition deterrence and ovicidal properties of *N. tabacum* leaf powder was tested in the laboratory by Ofuya (1990). The leaf powder of *A. indica*, *V. negundo* and *P. hydropiper* and their combinations were tested against *C. chinensis* on *Lens esculenta* seeds by Rouf et al. (1996) who reported that *P. hydropiper* leaf powder at 4g/50g lentil seeds was most effective in reducing oviposiotion and adult emergence of *C. chinensis. V. negundo* three percent admixed with black gram reduced damage by natural infestations of *C. chinensis* significantly during a nine month storage period (Prakash and Jagadiswari 1989). Miah et al. (1992) noted that the oviposition, adult emergence and damage by *C. chinensis* were significantly reduced on *L. sativus* and cowpea seeds treated with *V. negundo* leaf powder. Lakshami and Venugopal (2000) tested six plant products viz., *V. negundo, A. squamosa* (leaf and seed). *Annona calamus*, *Curcuma longa* L., *A. indica* seed kernel dusts for their effectiveness against *C. maculatus* in green gram seeds and noted that the mean number of laid eggs was less in *A. squamosa* (seeds) both at 1% (80.25 nos) and 3% (3.50 nos) levels followed by *A. calamus* (72.59 and 4.67 nos) at these concentrations. The number of adult emerged was also less in *A. squamosa* seed (4.26 nos) followed by *A. calamus* (41.25 nos) at 1% level. Singh (2003) studied the effect of *A. indica* leaf powder on infestation of pulse beetle in stored grain and proved to be effective at the rate of 0.5 to 0.2 mg/100g of grains and provided good results in respect of toxic effect, safety and economy.

The findings of the present study confirms the toxic effects of some of the leaf powders on oviposition and adult emergence of *C. maculatus* and *C. chinensis.* Varying activity by different powders indicate that the pest controlling factors are not uniformly present in every aromatic plant. The reduction in adult emergence could either be due to egg mortality or larval mortality or even reduction in the hatching of the eggs. It has been reported that the larvae which hatch from the eggs of *Callosobruchus* species must penetrate the seeds to survive (FAO 1999). The larvae are unable to do so unless the eggs are firmly attached to the seed surface. In the present study the eggs were found to be loosely attached to the chick pea seed surface in the treated seeds. The leaf powders might thus have inhibited the larval penetration into the seed and thus showed maximum feeding deterrence. The bitter taste, pungent smell and semiochemical nature of the plant powders causing quick mortality within five days would not allow the formation of resistant races of the insect which is quite prevalent with most of the synthetic pesticides (Shukla *et al.* 2007).

**Table 1.** Effect of the plant materials used on the oviposition (eggs laid/100 seeds) of *Callosobruchus maculatus* and *C. chinensis*

| Treatment | *C. maculatus* | | | *C. chinensis* | | |
|---|---|---|---|---|---|---|
| | 1g | 2g | 3g | 1g | 2g | 3g |
| *A. indica* leaf | 13.33$^{de}$ ± 1.66 | 20.00$^{bc}$ ± 5.77 | 21.66$^{cd}$ ± 1.66 | 38.33$^{ab}$ ± 8.81 | 36.66$^{ab}$ ± 4.40 | 21.66$^{d}$ ± 3.33 |
| *A. indica* bark | 20.00$^{cd}$ ± 5.00 | 15.00$^{cd}$ ± 2.88 | 20.00$^{cd}$ ± 5.77 | 28.33$^{bc}$ ± 4.40 | 50.00$^{a}$ ± 13.22 | 33.33$^{bcd}$ ± 8.81 |
| *A. indica* seed | 8.33$^{e}$ ± 1.66 | 8.33$^{d}$ ± 3.33 | 3.33$^{d}$ ± 1.66 | 8.33$^{c}$ ± 1.16 | 10.00$^{c}$ ± 2.88 | 3.33$^{e}$ ± 1.66 |
| *V. negundo* leaf | 15.00$^{de}$ ± 2.88 | 25.00$^{bc}$ ± 10.40 | 25.00$^{bc}$ ± 5.77 | 45.00$^{ab}$± 2.88 | 36.66$^{ab}$ ± 4.40 | 25.00$^{bcd}$ ± 2.88 |
| *A. squamosa* leaf | 28.33$^{bc}$ ± 1.66 | 23.33$^{bc}$ ± 4.40 | 8.30$^{cd}$ ± 4.409 | 38.33$^{ab}$± 7.26 | 43.33$^{ab}$ ± 7.26 | 41.66$^{ab}$ ± 4.40 |
| *N. tabacum* leaf | 16.66$^{de}$ ± 1.66 | 33.33$^{b}$ ± 6.009 | 6.66$^{cd}$ ± 3.33 | 30.00$^{b}$± 7.63 | 23.33$^{bc}$ ± 3.33 | 23.33$^{cd}$ ± 4.40 |
| *P. hydropiper* leaf | 33.33$^{b}$ ± 4.40 | 28.33$^{bc}$ ± 4.409 | 43.30$^{ab}$ ± 10.92 | 45.00$^{ab}$± 8.66 | 45.00$^{ab}$ ± 10.40 | 38.33$^{bc}$ ± 4.40 |
| Control | 48.33$^{a}$ ± 4.40 | 51.66$^{a}$ ± 1.66 | 53.33$^{a}$ ± 8.81 | 58.33$^{a}$± 8.81 | 50.00$^{a}$ ± 10.40 | 56.66$^{a}$ ± 9.27 |
| F value (LSD) | 16.43$^{*}$(9.67) | 5.71$^{*}$ (16.38) | 8.44$^{*}$ (18.35) | 4.69$^{*}$ (20.45) | 3.08$^{*}$ (23.76) | 8.30$^{*}$ (16.57) |

Means having similar digits are insignificant; *P<0.01

**Table 2.** Effect of the plant materials used on the mortality of adult *Callosobruchus maculatus* and *C. chinensis*

| Treatment | *C. maculatus* | | | *C. chinensis* | | |
|---|---|---|---|---|---|---|
| | 1g | 2g | 3g | 1g | 2g | 3g |
| *A. indica* leaf | 76.66$^{ab}$±6.66 | 76.66$^{a}$±3.33 | 96.66$^{ab}$±3.33 | 96.66$^{a}$±3.33 | 100.00 | 100.00$^{a}$ |
| *A. indica* bark | 70.00$^{ab}$±15.27 | 80.00$^{ab}$±0.00 | 86.66$^{abc}$±8.81 | 100.00$^{a}$ | 93.33±6.66 | 100.00$^{a}$ |
| *A. indica* seed | 100.00$^{a}$ | 100.00$^{a}$ | 100.00$^{a}$ | 100.00$^{a}$ | 100.00$^{a}$ | 100.00$^{a}$ |
| *V. negundo* leaf | 73.33$^{ab}$±3.33 | 80.00$^{ab}$±10.00 | 80.00$^{abc}$±0.00 | 100.00$^{a}$ | 100.00$^{a}$ | 100.00$^{a}$ |
| *A. squamosa* laef | 96.66$^{a}$±3.33 | 70.00$^{b}$±10.00 | 66.66$^{c}$±8.81 | 100.00$^{a}$ | 93.33±6.66 | 100.00$^{a}$ |
| *N. tabacum* laef | 26.66±12.01 | 66.66$^{b}$±17.63 | 70.00$^{c}$±5.77 | 90.00$^{a}$±5.77 | 93.33±3.33 | 96.66$^{a}$±3.33 |
| *P. hydropiper* leaf | 43.33$^{b}$±20.27 | 56.66$^{b}$±3.33 | 76.66$^{bc}$±13.33 | 93.33$^{a}$±3.33 | 86.66±6.66 | 86.66$^{a}$±8.81 |
| Control | 10.00$^{c}$±4.00 | 26.66$^{c}$±6.66 | 20.00$^{d}$±0.00 | 20.00$^{b}$±5.77 | 26.66±6.66 | 26.66$^{b}$±14.52 |
| F value (LSD) | 8.79$^{*}$(32.76) | 6.34$^{*}$ (25.47) | 13.23$^{*}$ (20.60) | 68.21$^{*}$ (9.99) | 25.81$^{*}$ (14.57) | 17.34$^{*}$ (18.36) |

Means having similar digits are insignificant; *P<0.01

**Table 3.** Effect of the plant materials on the total number of *Callosobruchus maculatus* and *C. chinensis* adults emerged.

| Treatment | *C. maculatus* | | | *C. chinensis* | | |
|---|---|---|---|---|---|---|
| | 1g | 2g | 3g | 1g | 2g | 3g |
| *A. indica* leaf | $12.00^{cd}$ ± 3.05 | $14.00^{c}$ ± 5.03 | $16.66^{c}$ ± 0.33 | $73.66^{bc}$ ± 3.84 | $56.33^{b}$ ± 8.83 | $94.66^{a}$ ± 12.44 |
| *A. indica* bark | $17.00^{cd}$± 7.02 | $15.66^{c}$ ± 0.88 | $12.66^{c}$ ± 5.23 | $69.33^{bc}$ ± 5.04 | $42.66^{bc}$ ± 3.75 | $54.33^{b}$ ± 16.34 |
| *A. indica* seed | $5.33^{d}$ ± 0.88 | $4.33^{c}$ ± 0.88 | $1.66^{c}$ ± 0.88 | $5.33^{e}$ ± 0.88 | $3.66^{d}$ ± 0.66 | $2.00^{c}$ ± 0.57 |
| *V. negundo* leaf | $41.33^{bc}$ ± 6.06 | $50.33^{b}$ ± 19.27 | $46.66^{b}$ ± 4.91 | $89.00^{b}$ ± 4.58 | $38.00^{bc}$± 3.21 | $23.00^{c}$ ± 3.21 |
| *A. squamosa* laef | $93.00^{a}$ ± 17.06 | $50.00^{b}$ ± 16.50 | $3.33^{c}$ ± 0.88 | $55.33^{cd}$ ± 3.28 | $43.33^{bc}$± 5.23 | $22.33^{c}$ ± 1.85 |
| *N. tabacum* leaf | $6.33^{d}$ ± 1.20 | $6.00^{c}$ ± 2.08 | $1.00^{c}$ ± 0.57 | $43.33^{d}$ ± 6.83 | $21.33^{cd}$ ± 4.09 | $7.66^{c}$ ± 1.20 |
| *P. hydropiper* leaf | $74.66^{ab}$ ± 25.21 | $49.33^{b}$ ± 13.59 | $47.00^{b}$ ± 14.22 | $110.66^{a}$ ± 16.69 | $62.33^{b}$ ± 7.88 | $52.33^{b}$ ± 3.28 |
| Control | $82.00^{a}$ ± 8.08 | $99.33^{a}$ ± 11.78 | $97.66^{a}$ ± 6.69 | $78.66^{b}$ ± 3.71 | $117.66^{a}$±18.18 | $93.66^{a}$ ± 4.66 |
| F value (LSD) | $9.86^{*}$(34.98) | $8.45^{*}$ (33.49) | $30.24^{*}$ (18.38) | $19.75^{*}$ (21.43) | $16.84^{*}$ (24.63) | $22.38^{*}$ (22.98) |

Means having similar digits are insignificant; *P<0.01

**Table 4.** Effect of plant materials on weight loss of grain after the emergence of adult *Callosobruchus maculatus* and *C. chinensis*

| Treatment | *C. maculatus* | | | *C. chinensis* | | |
|---|---|---|---|---|---|---|
| | 1g | 2g | 3g | 1g | 2g | 3g |
| *A. indica* leaf | $6.53^{ab}$±0.67 | $3.73^{bc}$±0.14 | $5.48^{a}$±1.30 | 4.36±0.76 | $4.86^{ab}$±0.62 | $4.21^{bc}$±1.57 |
| *A. indica* bark | $0.46^{c}$±0.24 | $3.26^{c}$±0.69 | $1.84^{a}$±1.09 | 9.2±0.65 | $6.00^{ab}$±1.35 | $6.68^{a}$±1.11 |
| *A. indica* seed | No loss | $0.04^{d}$±0.02 | No loss | 1.95±0.07 | $0.72^{d}$±0.64 | $0.04^{d}$±0.02 |
| *V. negundo* leaf | $4.90^{b}$±1.87 | $7.01^{ab}$±1.83 | $4.85^{a}$±1.50 | 7.86±1.34 | $8.42^{a}$±0.33 | $4.89^{bc}$±1.32 |
| *A. squamosa* laef | $5.09^{ab}$±1.80 | $4.56^{abc}$±1.98 | $0.84^{b}$±0.43 | 7.52±0.43 | $4.39^{bc}$±0.47 | $2.68^{cd}$±0.50 |
| *N. tabacum* leaf | No loss | $0.03^{d}$±0.02 | No loss | 2.61±0.69 | $2.56^{cd}$±0.49 | $2.94^{cd}$±0.58 |
| *P. hydropiper* leaf | $8.54^{a}$±1.08 | $7.13^{ab}$±7.15 | $4.08^{ab}$±2.36 | 9.78±1.27 | $6.90^{ab}$±0.93 | $6.75^{ab}$±1.28 |
| Control | $7.21^{ab}$±1.63 | $7.26^{a}$±1.37 | $4.79^{a}$±1.48 | 9.34±1.33 | $4.64^{b}$±0.39 | $8.75^{a}$±0.62 |
| F value (LSD) | $8.62^{*}$ (3.53) | $6.39^{*}$ (3.51) | $3.25^{*}$ (3.83) | $11.49^{*}$ (2.78) | $10.92^{*}$ (2.18) | $7.57^{*}$ (3.01) |

Means having similar digits are insignificant; *P<0.01

## Conclusion

The plant products that are traditionally used and produced by the farmers in developing countries appear to be quite safe and promising. Using plants with insecticidal properties is therefore an attractive alternative to the more expensive synthetic pesticides. The findings of the present study indicate the repellent and deterrent effects of some of the leaf powders on oviposition and adult emergence of *C. maculatus* and *C. chinensis*. The reduction in adult emergence could either be due to egg mortality or larval mortality or even reduction in the hatching of the eggs. Since plants contain very different compounds simultaneously, they exert not only repellent but also antifeedant, morphogenetic and toxic effects on insects. Tropical farmers are receptive to methods of stored produce protection that lie within their technical and financial means. Local plants such as *A. indica*, *A. squamosa*, *N. tabacum* and *V. negundo* potentially offer a cheap and easy control method for farmers. More development research is necessary on the feasibility of introducing plant powders at the farm level.

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