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Biopeticidal Efficacy of *Datura inoxia* and *Dodonaeaviscosa* against *Callosobruchus maculatus* (Coleoptera: Bruchidae)

***Ritika Gangotia, Babu Saddam**

Forest Protection Division, HFRI, Shimla, Himachal Pradesh, India

Abstract

Callosobruchus maculatus (Fabricius) is a serious pest of stored grains, worldwide. In an attempt to find natural and cheaper methods of control of stored product pests some traditionally useful materials have been evaluated for their pesticidal properties. Biopesticidal efficacy of *Datura inoxia* (Miller) and *Dodonaea viscosa* Linnaeus (Jacquin) in acetone and methanol extracts have been tested on *C.maculatus* (Coleoptera: Bruchidae) fed on cowpea, *Vigna unguiculata* (W) seeds. All the concentrations viz. 5, 10 and 20% of the acetone and methanol extracts were found to be effective in controlling the pest *C. maculatus.* The extracts were effective in increasing mortality, decreasing the oviposition and F1 adult emergence of the insect pest. Thus, the botanicals acted as insect antifeedant and the order of toxicity of various treatments on cowpea weevil was: Acetone extract *D. inoxia*> Methanol extract of *D. inoxia*> Acetone extract of *D.viscosa*> Methanol extract of *D.viscosa*. 20% acetone extract of *D. inoxia* was most effective among all the four extracts. Hence it is recommended that the two plants may be exploited to control *C.maculatus* in particular and against other pests in general. However some more biochemical and biological parameters of both the plants and insect species may be taken under consideration for efficient and enlarged scale control of pest species.

Keywords: *C. maculatus*, Bruchidae Acetone, Methanol, Stored grain, Pest, *D.viscosa, D.inoxia*, Bioefficacy

1. Introduction

Agriculture development has been influenced by increased demand for food due to increased population. Achieving this food sufficiency in a sustainable manner is a major challenge for the farmers, agro-industry, researchers and government. Post-harvest losses are often more significant than crop losses which occur in the field. In Africa, as much as 20-50% of the grain, maize and pulses are lost because of infestations from weevils, bruchids and other insects (FAO, 1985) [6]. As in field crops a wide range of insect pests attack on stored products and the commonest among them are beetles and moths (Ofori*etal*., 1997) [14]. Grain infestation by pests result in annual production losses and storage deterioration. The class insecta is the largest group in the animal kingdom with 30 orders and 8,00,000 known species worldwide. The order Coleoptera has the largest number of described species and the family Bruchidae is small but economically very important and almost 2000 species are known worldwide (Pajni and Tewari, 2002) [15]. Insects rarely become pest in the natural ecosystems but when the insect population becomes large enough to cause harm to people, crop, animals or any other possessions in simplified or managed ecosystem insects may be categorized as pest (Elizinga, 2004). Grain crops are commonly stored in small scale due to their valuable nutrient contents and relative ease in storage when they are dried after harvest (Duke, 1981) [4]. Stored product insects can infest grain round the year under favourable conditions. All storage pests undergo complete metamorphosis, that is they reproduce by laying eggs which hatch into immature forms and become adults after different larval and pupal instars. Several insects have short developmental periods from egg to imago and thus completes several generations in a year (Zakladnoi, 1987) [22]. *Vigna unguiculata* commonly called as cowpea is one of the most important legume widely cultivated in the tropics as food, feed and for soil fertility enrichment (Singh and Emden, 1979; Jackai and Daoust, 1986) [19, 8]. The major constraint to availability of this crop is insect pest. Up to 100% damage to cowpea grains in storage has been reported due to *Callosobruchus maculatus*, an agricultural insect pest of Africa and Asia but presently range throughout the tropical and subtropical world.*C. maculatus* is a field to store pest as its infestation starts in the field as the mature pods dry (Huignard *et al*., 1985) [7] when such seeds are harvested and stored the pest population increases rapidly, results in destruction within a short duration of 3-4 months (Rahman and Talukder, 2006) [17] Cowpea provides more than half of the plant protein consumed by many poor people in Africa, and is a source of income (Rachie, 1985) [16]. A major constraint to the sustainable production and postharvest preservation of cowpea in the tropics is infestation by the storage bruchid, *C. maculatus.* This pest can render unprotected grains unsuitable for food or seed within 2-4 months of storage (Seck *et al*., 1991) [18]. Since the earlier nineteenth century certain inorganic compounds has been used as poisons for the control of insects and other pests. Synthetic insecticides are expensive for subsistence farmers and may pose potential risks owing to the lack of adequate technical knowledge related to their safe use. However, their increasing use in recent years has created a range of ecological problems such as bio-magnification, resurgence and the development of insecticide tolerant strains of pest species. As such, farmers have reverted to the usage of natural products that include plant extracts, powders, ashes, cow dung and oils to control pests with varying level of effectiveness (Naumann and Isman, 1995) [13]. With the discovery of insecticidal properties of certain plants the insecticides of botanical origin came into prominence and are found comparatively safe. Plant based pesticides in grain protection has a long history (Chimbe and Galley, 1996) [2] which appears to be quite safe and promising and there are no. of bibliographic databases on the use of different botanicals or parts of plants (leaves, stem, twigs, roots and seeds) or their extracts or residues (ash, husk) by farmers against stored grain pests (Dales, 1996; Murugan *et al*., 1999) [3, 12]. in the long run they are environment friendly and less hazardous. Therefore, under present study the two plant species *Datura inoxia* and *Dodonaeaviscosa* have been explored for insecticidal properties to control stored grain bruchid, *C. maculatus*. The toxic effect of synthetic chemicals can be overcome, only by persistent search for new and safer pesticides accompanied by wide use of pest control method, which are eco- friendly and effective (Mohana *et al*., 2010) [11]. Accordingly, hundreds of secondary metabolites have been isolated and showed variable biological activities against various pests. These bioactivities included mainly, stomach poison, feeding deterrent, repellent or growth regulatory effects but so far, only a handful of botanical insecticides have been commercialized, despite rich plant resources. The present work is therefore being an attempt to explore the bio efficacy oftwo locally available plant species to manage the pet population growth of *C. maculatus* below economic injury level and to avoid the harmful effects of synthetic pesticides.

2. Materials and Methods

The infested seeds of *Vignaunguiculata* were collected from different areas of Himachal Pradesh (India). After adult emergence from infested sample, cultures were initiated and subletted in disposable petridishes (90×15mm) along with host seeds under controlled conditions of temperature and relative humidity in Biological oxygen demand incubator (DB-2025, Decibel) at 25°C and 70.6 relative humidity with three replica each. Adults thus emerged were identified as *Callosobruchus maculates* by running them in dichotomous key developed by Johnson (1990) [9] and Kingsolver (2004) [10]. Two plants viz. *Dodonaea viscosa* and *Datura inoxia* were collected and identified by running in taxonomic keys developed by Eichler (1883) [5] and plant taxonomists, Department of biosciences, H.P. University, Shimla (Himachal Pradesh). Before extraction different plant parts were washed and dried in shade at room temperature for 10-15 days on laboratory benches.

Acetone and methanol extracts were prepared according to the method of Talukder and Howse (1993) [20] with slight modifications. 500 grams of dry powder of respective plant was added in solvent as shaken for 30 minutes with magnetic grinder and the solution was left undisturbed for 24 hours then filtered through Whatman filter paper number 1. The solids left were dissolved in other 30ml of same solvent was again shaken for 15 minutes then was filtered again and the filtrate was then combined. This solution was then placed in a water bath at 55℃ till concentrate was formed by setting the temperature of water bath according to the boiling point of the respective solvent used. After complete evaporation of the solvent the crude extract of the plant material was stored in refrigerator in sealed glass jars. 20gm of crude extract was then used to make different concentrations for treatment against pest. Different concentrations of crude extract *i.e* 5%, 10% and 20% concentrate solution was then made. 1ml of solution of each of the above concentration was then applied to Whatman filter paper which after air drying was later placed in the petridish containing 50 seeds each. Concentrations used were determined after conducting preliminary experiments to standardize the doses and then used for assessing their insecticidal properties. 10 insects *i.e* 5 males and 5 females were placed in each of these petridishes. The experimental set up was completely randomized with 3 replicas. Acetone and methanol treated filter paper placed in petridishes were taken as control and both of them were not toxic to the insects. All the petridishes were observed for next 15 days. The number of dead insects were counted after every 24 hour and also upto 100% motality of insects. After application of plant crude extract the corrected percentage mortality was calculated by using Abott's formula (Abott, 1925) as follows.

Correct % mortality = $1 - n \text{ in } T / n \text{ in } C \times 100$, where n = number of insects, C = control and T = treated

Standard Deviation, $\sigma = \sqrt{E\times 2/N}$

3. Observations

The experiment has been focused to explore the plant species for the control of pest species. The deleterious effects of certain purified phytochemicals on insects are manifested in several ways including toxicity, growth inhibition, feeding inhibition, oviposition deterrent, suppression of calling behaviour and reduction in fertility and fecundity. Plants have an almost limitless ability to synthesize aromatic substances mainly the secondary metabolites. Insecticides of plant origin have been exploited from time to time for management of insect pest and crop plants. In present study the effect of D*atura inoxia* and *Dodonaea viscose* extracts in acetone, methanol and water were studied. Different concentrations of the extracts (5, 10 and 20 %) have been evaluated to check:

- Mortality of *C. maculatus* under different concentration of plant extracts (Graph-1 to 6).
- Fecundity of *C. maculatus* under different treatments (Graph-7 & 8).
- Emergence of F1 population *of C. maculatus* under different concentrations (Graph 9 & 10).

In 20% leaf extract of *D.inoxia* acetone, methanol and aqua mortality was seen on 6^{th}, 7^{th} and 7^{th} day where mortality in control on 16^{th} day was 46.66±0.51. Average oviposition rate by female individuals was also found to be reduced in treated seeds. In *D.inoxia* acetone extract the oviposition was decreased from 63.2±0.51 in acetone control to 13.2±0.33 in 20% treated seeds. Similarly in methanol extract from 68.4± 0.89 in methanol control to 14.43 ± 0.63 in 20% treated seeds and in aqueous extract treated seeds it decreased from 71.8± 0.33 in aqua control to 14.33 ± 0.87 in 20% extract treated seeds. In case of *D.viscosa* leaf extract the complete mortality was seen on 11^{th}, 15^{th} and 12^{th} day in 20% acetone, methanol and aqua extract. The oviposition status decreased from 78.6±0.51 in acetone control to 33.4±0.51, similarly in methanol extract from 67.2±0.33 in methanol control to 27.8±0.66 and in aqueous treated seeds it decreased from 85±0.66 in control to 34±0.43 in 20% extract treated seeds respectively. Emergence of F1 adults decreased significantly in case of all the three extracts. The number of adult emerged in control was 31.63±0.31. In acetone extract of *D.inoxia* the emergence was reduced to 7.00±0.00, in methanol to 5.33±0.51. Similarly, in aqueous extract the emergence was reduced to 9.6±0.43 in 20% treated seeds respectively. Mean F1 adults also decreased significantly in case of all the three extracts of *D.viscosa* emergence in control was observed as 32.33±0.98 and 14.3±0.56 in 20% acetone extract treated seeds. In methanol F1 adult emergence was reduced to 21.26±0.88 in 20% treated seeds. Similarly, in aqueous extract the emergence was reduced to14.71±0.53 in 20% treated seeds respectively.

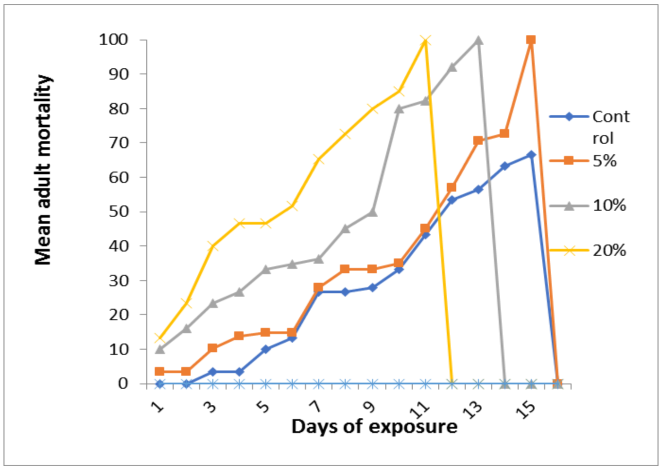

Fig 1: Graph showing mean adult mortality *of C. maculatus* in different doses of *D. viscosa* leaf methanol extract.

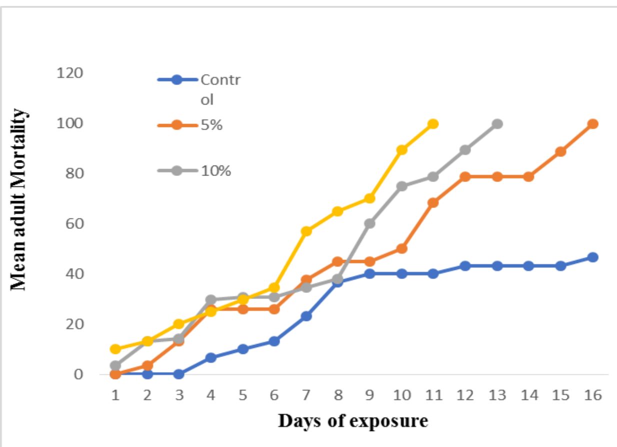

Fig 2: Graph showing mean adult mortality of *C. maculatus* under different doses of *D. viscosa* leaf extract in acetone.

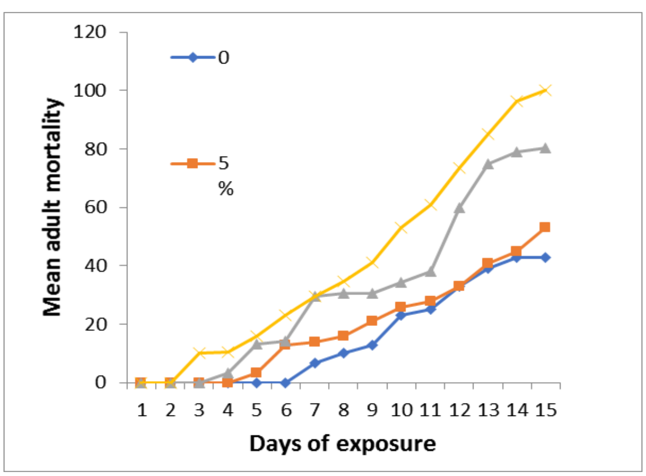

Fig 3: Graph showing mean adult mortality *of C.maculatus* in different doses of *D.viscosa* leaf aqueous extract.

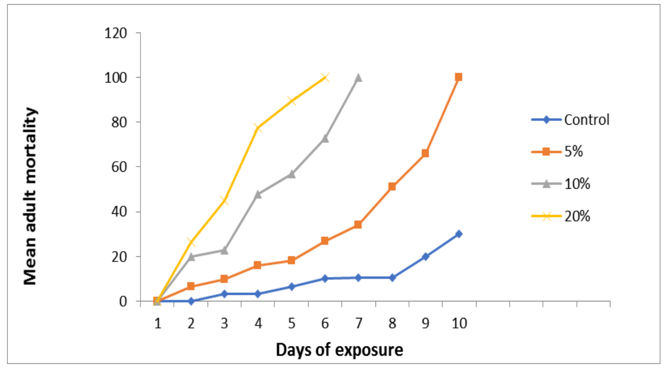

Fig 4: Graph showing mean adult of *C.maculatus*by different doses of *D.inoxia* leaf extract in methanol

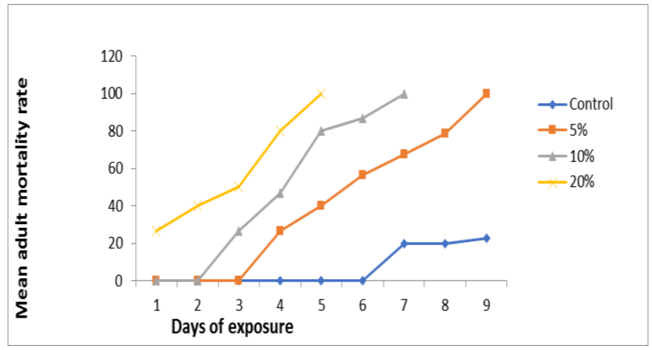

Fig 5: Graph showing mean adult mortality of *C. maculatus* under different doses of *D. inoxia* leaf extract in acetone.

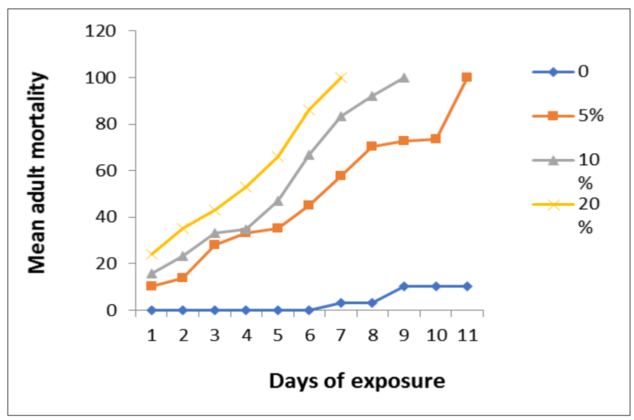

Fig 6: Graph showing mean adult of *C. maculatus* by different doses of *D. inoxia* leaf extract in distilled water.

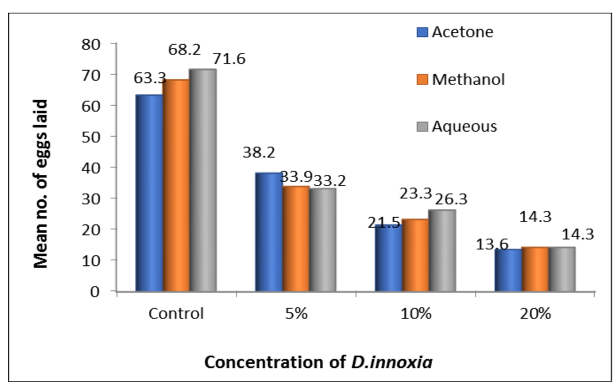

Fig 7: Histogram showing oviposition status of female *C. maculatus* under different treatment of *D. inoxia* leaf extract.

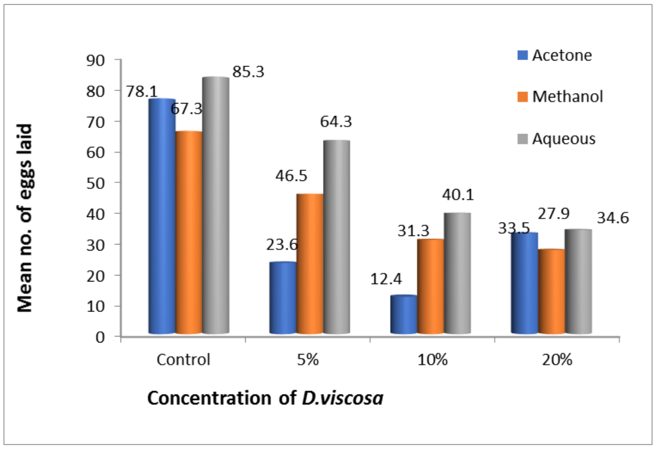

Fig 8: Histogram showing oviposition status of female of *C.maculatus* under different treatments of *D.viscosa* leaf extract.

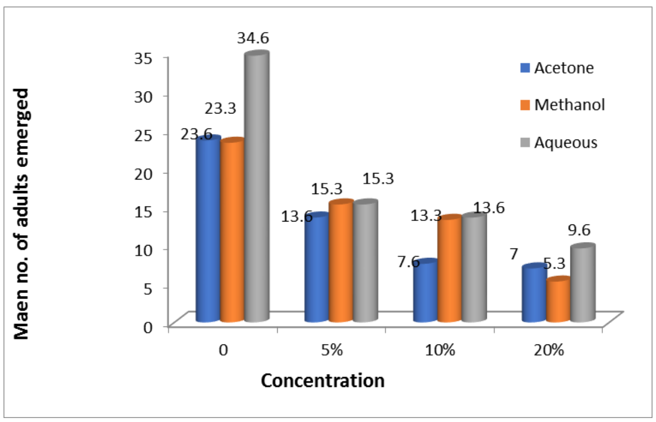

Fig 9: Histogram showing F1 adult emergence in *D.inoxia*leaf extract treated seeds

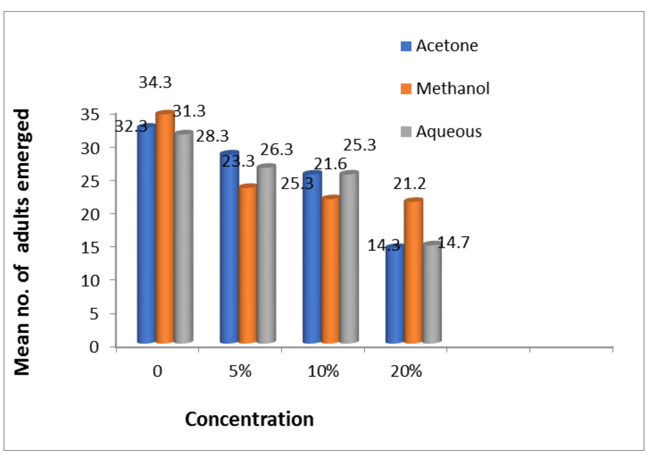

Fig 10: Histogram showing F1 adult emergence in *D. viscosa*leaf extract treated seeds.

4. Results and Conclusion

Regarding mortality of adult pest all the four extracts were found effective in causing insect pest mortality, reducing the fecundity of insects and egg laying was decreased with increased concentrations of the extracts. Emergence of *C. maculatus* F1 adults also decreased significantly in acetone and methanol extract of both the plants. On the basis of present investigation, it has been observed that all the concentrations viz. 5, 10 and 20% of the acetone and methanol extracts were effective in controlling the pest *C. maculatus*. *D. inoxia* extract was however found to be more effective than *D.viscosa* extract. Complete mortality was seen in acetone leaf extract on 6th day when mortality in control was zero, oviposition was highly reduced from 63.21±0.33 to 13.2±0.33 and the F1 adult emergence also decreased from 31.63±0.33 in control to 7.00±0.33 in 20% *D.inoxia* acetone leaf extract respectively. The use of botanicals should be encouraged in small farm storage, as the cost of these botanicals are low and easily available when compared with the losses incurred in untreated seeds. Additionally, more seeds would be available for use as food and for sale by the farmer as grain infestation would be reduced. Consumers would also get more value for their money, as well as enjoy cowpea seeds that are free from beetle infestation throughout the year. Thus, the present investigations indicate that botanical derivatives might be useful as insect control agents for commercial use. To minimize the severe damage caused by insect pests, the traditional use of plant products, proved to be highly effective against stored product insects. Application of plant products to grain seeds for storage is an inexpensive and effective technique, and its easy adaptability will give additional advantages leading to acceptances of this technology by farmers. A study to improve the effectiveness of botanical derivatives as insecticides will benefit agricultural sectors of developing countries, as these substance are not only of low cost, but also have less environmental impact in term of insecticidal hazard.

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