Growth retarder effects of *Prosopis cineraria* extracts on pre-adult stages of adzuki bean weevil *Callosobruchus chinensis*

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ABSTRACT

A study was conducted to evaluate the possible effects of *Prosopis cineraria* botanical extracts on *Callosobruchus chinensis* development. To stop the test pest from invading green gram seeds, extracts from the bark, fruit, and leaves of the plant *P. cineraria* were investigated as remedial treatments. In this study, the term "rate of development" refers to the amount of time it takes for a pest insect to emerge as an adult. The effectiveness of the botanical preparations was assessed in terms of the adult insects' delayed emergence from the infected seeds. When compared to control groups, which had a mean rate of development of 26 days, the treatment with plant extracts dramatically accelerated *C. chinensis* pace of development. A 39.67-day maximum was recorded when using 10% bark aqueous extract. The rate of insect development was also slowed down by all 10% preparations, 5% aqueous leaf extract, 5% aqueous suspension, and 5% aqueous bark extract. Based on the promising study results, it was determined that this tree's leaf extract, which is widely accessible in the dry regions of the Indian subcontinent, might be utilized as a cheap, safe, and convenient grain protectant, particularly for domestic usage.

Key words Biopesticides, *Callosobruchus chinensis,* Growth retarder, *Prosopis cineraria,* Rate of development, Stored grain pests.

MS History: 09.06.2023(Received)-22.08.2023(Revised)- 25.08.2023 (Accepted)

Citation: Shailja Rawat. 2023. Growth retarder effects of *Prosopis cineraria* extracts on pre-adult stages of adzuki bean weevil *Callosobruchus chinensis*. *Journal of Biopesticides*, **16**(2):108-114. **DOI:10.57182/jbiopestic.16.2.108-114.**

INTRODUCTION

The strain of an ever-growing population has led to an ever-growing need for food and, consequently, agricultural products. Appropriate food conservation both during and after harvest is a critical component of food production, as it minimizes crop losses during storage. Numerous organisms are supported by the grains kept in storage. Almost all grains are vulnerable to pest attacks due to the ecological interactions between the grain, abiotic variables (such as temperature and humidity), and biotic factors (such as the presence of pests, parasites, etc.). Ineffective and improper storage methods make this issue worse. Pulses are severely harmed by the Adzuki bean weevil (*Callosobruchus* sp.; Coleoptera: Bruchidae). There are about 20 species in the genus *Callosobruchus*, which are native to Asia and Africa. According to Tuda *et al.* (2005), they are mostly found in tropical and subtropical areas of the world. *C. chinensis* is a well-known pest that severely damages greengram and pigeon pea crops (Mehta and Modgil, 1996).

Synthetic insecticides work well to contain this invasive species, but they also come with a host of drawbacks, including harm to the environment, recurrence of the pest, and loss of beneficial natural enemies. Concerns have also been raised about their residual toxicity and insect resistance following spraying (Brent and Hollomon, 1998). Pesticides derived from plants offer a more secure substitute, shielding the environment from pesticide contamination. Numerous botanical preparations have been shown to exhibit strong insecticidal, repellent, egg-laying inhibitory, toxicity, and anti-feedent properties at the egg, larva, and pupa stages of the life cycle (Kedia *et al.,* 2015). On the other hand, relatively little research has been done on a control strategy that highlights *C. chinensis* developmental retardation.

New methods are also being investigated, such as the use of diatomaceous earth (DE) (Gad *et al.*, 2021, 2022). Insecticidal efficacy of gas ozone during grain packaging on adults of *C. maculatus* and *C. chinensis* on cowpea seeds under storage circumstances was also studied by Gad et al. (2021) and they discovered that it was a safe and efficient substitute for chemical pesticides. Research is also being done on the effectiveness of modified atmospheres (MO), such as packaging containing carbon dioxide, in preventing Callosobruchus sp. infestations (Cheng *et al.*, 2013; Sagar and Pareek, 2020; Bourne-Murrieta *et al.,* 2021). Additionally, research is being done to determine whether agricultural waste might act as an insect repellent (Ashamo *et al.,* 2022). Cold plasma preservation of grain, the newest technology for stored grain preservation, is being tried and yields good results.

All of these techniques work quite well, but they have the disadvantage of being expensive, difficult to prepare, and requiring special knowledge. The goal of this research was to create a pro-poor pest management instrument that is simple to make, using easily obtained materials, and is locally accessible. *Prosopis cinerearia* was the plant used for the investigation. This tree is frequently seen in dry areas of the Indian subcontinent. This is a valuable tree that provides gums and tannins in addition to food, fuel, fodder, and timber (Leaky and Last, 1980). It is a highly valuable commercial and medicinal tree that has been utilized for years immemorial as an antibacterial and anti-inflammatory substance. This plant contains alkaloids, flavonoids, phenolics, and tannins, all of which have been shown to be poisonous to microorganisms, worms, protozoans, mosquito larvae, and adult malarial parasites. For a very long time, it has been used to treat wounds, boils, pimples, and pain alleviation (Henciya *et al.*, 2017). Considering the lacuna this study was initiated to find out the impact of *Prosopis cinerearia* on *Callosobruchus chinensis* development.

MATERIALS AND METHODS

Thus, in the Laboratory of Entomology at Dungar College, Bikaner University, a study was designed to assess the effects of botanicals extracted from *P. cineraria* on the development of *C. chinensis* on stored green gram.

Culture of *C. chinensis*

By heating the cleansed green gram (*Vigna radiata*: Leguminosae) seeds for four hours at 60^{o}C, any potential infestation was eliminated. A solitary pair of *C. chinensis* taken from the departmental laboratory's stock culture, was raised on these grains and housed in glass jars covered with muslin cloth in a BOD incubator with a temperature of 28 ± 2^{0}c and a relative humidity of 70% for a period of seven days. The adults were then taken out of the jars and removed. The adults that emerged from these eggs were once again inoculated in pairs among several jars. As a result, a single line culture was produced.

Treatments methods

Three different types of extracts were made from the powdered bark, fruit, and leaf of *P. cineraria*: aqueous extracts, ether extracts, and aqueous suspensions. 1g of the ground plant material was placed in a filter paper thimble and boiled in 50 ml of DW until the volume was concentrated to 10 ml in order to create the aqueous extract. This was regarded as a concentration of 10%. In order to prepare concentrations of 10, 5, 2.5, and 1 percent, the serial dilution approach was used. One gram of ground plant material was placed in an extraction thimble and distilled with ether using a soxhlet extraction apparatus to create an ether extract preparation. A 10-milliliter extract was produced. This served as the stock solution for subsequent dilutions and was regarded as a 10% solution. A 10% aqueous suspension was made by pulverizing 10 g of plant material and mixing it with 50 g pulse; a 5% aqueous suspension was made by mixing 5 g of powder into a 50 g pulse, and so on.

Monitoring of the outcome

The rate of development was defined as the amount of time (measured in days) from the day the egg was laid until the adult escaped by cutting a hole in the seed.

Statistical analyses

SPSS software was used for the statistical analysis. An analysis of variance ANOVA was used to determine the significance of the results at the 5% level of significance.

Result

The term "rate of development" in this study refers to how long it took the pest insect to emerge as an adult. Figures 1-3 display the *C. chinensis* development rate under prepared treatments. In the control groups, a mean rate of development of 26 days was noted. Using 10% aqueous bark extracts, the bruchid's maximum development time was found to be 39.67 days. The pace of insect development is significantly slowed down by 10% formulations, 5% aqueous extract of leaves, 5% and 10% aqueous bark suspension, and 5% aqueous bark extract.

ANOVA analysis was used to compare all the data overall, and the results indicated that, in terms of the pace of development, plant parts, concentrations, treatments, and extracts all varied significantly amongst themselves at the 5% level of significance. The most successful plant part in slowing the insect's development rate was the leaf (34.03 days), which was followed by the bark (33.63 days). Insects treated with these two treatments took much longer to mature than those treated with fruit formulations (31.78 days). When compared to sets treated with ether extracts (32.06 days), sets treated with aqueous extracts and aqueous suspension could considerably lengthen the time it took the insect to emerge as an adult (33.89 and 33.50 days, respectively). The rate of development differed greatly amongst formulations with varying concentrations. A positive correlation was seen between the concentration and the pace of development, with values of 29.74 (1%), 32.33 (2.5%), 34.56 (5%) and 35.96 days (10%). This further demonstrates the effectiveness of botanicals in postponing the pest's developmental stage.

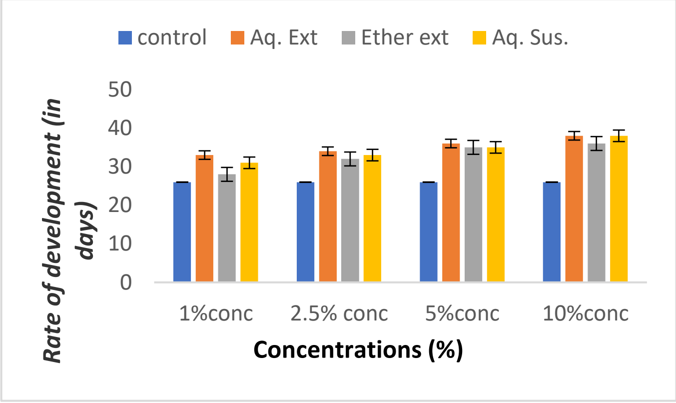

Fig.1. Rate of development (days) of *Callosobruchus chinensis* with different treatments made with *Prosopis cineraria* leaf.

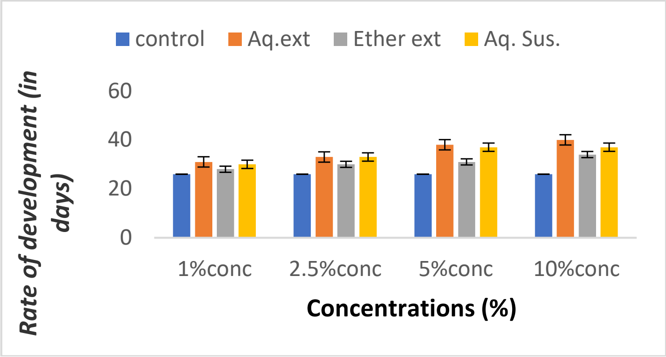

Fig. 2. Developmental period (days) of *Callosobruchus chinensis* with different treatments with *Prosopis cineraria* bark

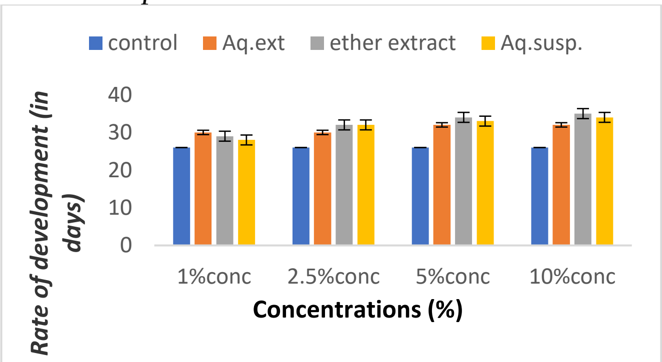

Fig. 3. Impact of *Prosopis cineraria* fruit (pod) on the development period (days) of *Callosobruchus chinensis*

DISCUSSION

The bruchid's rate of development varied according to the various treatments. It was found to be 26 days in control sets and up to 39 days in some treatments, indicating the impact of plant treatment on this particular life-cycle component. Ekeh *et al.* (2015) reported similar outcomes when employing biopesticides derived from *Aframomum melegueta, Capsicum nigrum, Zingiber officinale, Ocimum gratissimum, Azadiracta indica,* and *Allium sativa* against *C. maculates*. The researchers also examined the impact on the pest's life cycle and adult longevity. On *V. unguiculata*, treated with *A. sativum* the adult stage of *C. chinensis* appeared on day 40.00 ± 0.00. In 2015, Bhattacharya and Dhar also documented a slowdown in the pulse beetle's development rate when they applied two potent microbials, *Bacillus subtilis* [Bs (T8) and Bs (Pundibari-I)], together with three botanicals (neem oil, pongamia oil, and mustard oil) as seed protectors. Compared to a control group that lasted 32.57 days, Bs Pundibari-1 showed the longest developmental duration, measuring 37.44 days.

Ketoh *et al.* (2006) investigated the insecticidal effects of piperitone, the primary ingredient in *Cymbopogon schoenanthus*, and the plant's oil on *C. maculatus* at various stages of development. When it came to grubs, crude extract worked better, but piperitone worked better in preventing the development of recently laid eggs and early larval stages. Using an ANOVA to compare the effects of various plant components on the rate of development, it was discovered that the treatments of the leaves and bark had a considerably greater effect than those of the fruit (pod). The findings of Morallo Rejaesus *et al.* (1990), who saw *C. chinensis* development retardation when treated with *C. frutescens* fruit, corroborate these findings. The findings are consistent with the research of Juneja and Patel (1994), who found that when stored green grams were treated with mint leaves, orange peel, ground custard apple seeds, and black pepper, there was no population growth of *C. analis* up to four months. Pandey and Verma (1977) noted that moong seed could be effectively protected for at least 100 days when treated with powder of *Annona* spp.; Okonkwo and Okoye (1992) reported that the grains can be effectively protected from infestation for more than three months against *C. maculatus* with the leaves of *R. communis.*

The study conducted by Pandey *et al*. (1985) revealed that the *Coryra cephalonica* development duration varied from 45.33 to 48.08 days in the control group. However, when the species was treated with neem oil, cakes, leaves, flowers, powdered kernels, and babool gum, the development period increased to 65.08 days. Similar results were also reported by Schumutterer and Rembold (1980) and Mathur *et al.* (1989), who observed that *A. indica* seeds inhibited growth. The current study's development rate was also influenced by the various extracts, with aqueous suspension and aqueous extract exhibiting notable differences. These conclusions are consistent with the research conducted by Singhamony *et al.* (1986), which found that pepper acetone extracts might protect wheat.

The extract concentration in this investigation had a substantial impact on the rate of development; sets treated with a 10% formulation showed a particularly long development period. The effectiveness of various concentrations of Nimbicidine, a pesticide derived from neem, on *Tribolium castaneum* was examined by Das *et al.* (2006). They observed a significant decline in growth over an extended period of development. According to Khan and Borle (1985), the best substances for prolonging the growth of *C. chinensis* were clay and powdered *A. calamus* rhizome at concentrations of 0.1 to 0.5%. The efficacy of plant oils of Cedar wood, clove, neem, eucalyptus, sweet flag, and orange was investigated on *C. maculatus* by Swamy and Wesley (2022) through the use of wooden cube impregnation. They discovered notable insecticidal, oviposition-deterrent, and repellent properties. Idoko and Ileke (2020) examined the effectiveness of five botanicals on *C. maculatus*, namely the leaves of eucalyptus, Ficus, *Aframomum melegueta, Tetrapleura tetraptera*, and *Annona muricata*. With an LC_{50} value of 2.42 ml/kg and an LC_{95} value of 4.86 ml/kg, the essential oil of *A. melegueta* proved to be the most effective of these. At a dosage of 5 ml/kg, the cent percent mortality of *C. maculatus* was achieved 48 hours after administration. According to this study, several alkaloids that are present in plant extracts and have an impact on the grub's development inside the seed may exist. Prophylline, linoleic acid, maslinic acid, trihydoxycinnamic acid, 5,3',4'-trihydroxyflavanone, 3,4,5, 2-hydroxy ethyl ester, 5.5'-oxybis-1-3'benzendiol, 3-glucoside, and 7-glycoside 3-benzyl-2-hydoxy.urs-12-en-28-oic acid. were found in *P.cineraria fruit* to Liu et al. (2012). contain *P. cineraria* leaves were shown to contain cholesterol, stigmasterol, and campesterol by Malik and Kalidhar (2007). Alkaloids that impede plant development were isolated from *P. juliflora* leaves by Nakano *et al.* (2004). In order to reduce the amount of hazardous synthetic pesticides used in fruit post-harvest management, Solanki *et al.* (2018) have discovered a novel antifungal protein from *P. cineraria* seeds. Singh (2012) discovered that *P. juliflora* plant extracts had anti-mosquito, anti-fungal, anti-helminth, and antibacterial action. He attributed these properties to the plant's sterols, phenolics, tannins, flavonoids, alkaloids, and quinones

Declarations

Funding- No funding has been received by the author for carrying out the present research work.

Conflict of interest- The present study involves no conflict of interest in any form, financial or otherwise.

Availability of data- Applicable on request

Code Availability- Not Applicable

Authors' contribution- This study was done entirely by one author, which is Dr Shailja Rawat.

Ethics Approval- Not Applicable

Consent to participate- Not Applicable

Consent for publication- Not Applicable

REFERENCES

Ashamo, M.O., Ileke K.D. and Onasile,A.I. 2022. Bulletin of the National Research Centre. 46,108.https://doi.org/10.1186/s42269-022-00795-z

Bhattacharya, S. and Dhar, T. 2015. Studies on the bio-efficacy of some biopesticides on the biology of pulse beetle, *Callosobruchus chinensis. International Journal of Agriculture*, *Environment* and *Bioresearch* **1**(1): 59-64.

Bourne-Murrieta, L.R.,Iturralde-García, R.D., Wong-Corral, F.J., Castañé, C. and Riudavets, J. 2021. Effect of packaging chickpeas with CO2 modified atmospheres on mortality of *Callosobruchus chinensis* (Coleoptera: Chrysomelidae). *Journal of Stored Products Research*.**94**:101894 .https://doi.org/10.1016/j.jspr.2021.101894

Brent KJ, Hollomon DW. 1998. *Fungicide resistance: the assessment of risk. Monograph no. 2. FRAC.* Brussels: global crop protection federation.

Cheng,W., Lei,J., Ahn,J., Wang,Y., Lei,C. and Zhu-Salzman, K., 2013. CO2 enhances effects of hypoxia on mortality, development, and gene expression in cowpea bruchid, *Callosobruchus maculatus*. *Journal of Insect Physiology.* **59**(11): 1160-1168.https://doi.org/10.1016/j.jinsphys.2013.08.009

Das, D.R., Selina P. and Faruki, S.I. 2006. Efficacy of commercial neem-based insecticide, Nimbicidine against eggs of the red flour beetle *Tribolium castaneum* (Herbst). *University Journal of Zoology, Rajshahi University.* **25**:51 – 55. https://doi.org/10.3329/ujzru.v25i0.327

Ekeh, F. N., Odo, G.E., Nkru, E. Agwu, E.J., Ikegbunam, C., Ada, S.H. 2015. "Effects of biopesticides on developmental stages and longevity of *Callosobruchus maculatus* in some leguminous grains. *Journal of Parasitology and Vector Biology*. **7**(1): 9-21. http://10.5897/JPVB2014.016

Gad, H.A., Abo Laban, G.F, Metwaly, K.H., Al-Anany, F.A. and Abdelgaleil, S.A.M. 2021. Efficacy of ozone for *Callosobruchus maculatus* and *Callosobruchus chinensis* control in cowpea seeds and its impact on seed quality, *Journal of Stored Products Research.* **92** : 101786 https://doi.org/10.1016/j.jspr.2021.101786

Gad, H.A., Al-Anany, M.S., Atta, A.A.M., Abdelgaleil, S.A.M., 2021.Efficacy of lowdose combinations of diatomaceous earth, spinosad and *Trichoderma harzianum* for the control of *Callosobruchus maculatus* and *Callosobruchus chinensis* on stored cowpea seeds, *Journal of Stored Products Research*. 91. https://doi.org/10.1016/j.jspr.2021.101778

Gad,H.A., Al-Anany,M.S., Atta, A.A.M. and Abdelgaleil, S.A.M. 2022.Effectiveness of diatomaceous earth combined with chlorfluazuron and hexaflumuron in the control of *Callosobruchus maculatus* and *C. chinensis* on stored cowpea seeds. *Journal of Stored Products Research.* 97. https://doi.org/10.1016/j.jspr.2022.101985.

Henciya,S., Seturaman,P., James, A.R., Tsai, Y., Nikam,R., Wu,Y., Dahms, H. and Chang, F.,R. 2017. Biopharmaceutical potentials of *Prosopis* spp. (Mimosaceae, Leguminosa), *Journal of Food and Drug Analysis*. **25**(1) : 187-196. https://doi.org/10.1016/j.jfda.2016.11.001

Idoko, J.E. and Ileke, K.D. 2020. Comparative evaluation of insecticidal properties of essential oils of some selected botanicals as bio-pesticides against Cowpea bruchid, *Callosobruchus maculatus* (Fabricius) of stored cowpea. *Bulletin of Natural Research Centre*. **44**(119):1–7. https://doi.org/10.1186/s42269-020-00380-2

Juneja, R.P. and Patel, J.R. 1994. Botanical materials as protectants of green gram, *Vigna radiata* (L.) Wilczek against pulse beetle *Callosobruchus analis* (Fab.). *Gujrat Agriculture University Research Journal.* **20**(1):84-87.

Kedia, A., Prakash, B., Mishra, P. K., Singh, P. and Dubey, N. K.2015. Botanicals as ecofriendly biorational alternatives of synthetic pesticides against *Callosobruchus* spp. (Coleoptera: Bruchidae)-a review. *Journal of Food Science and Technology*, **52**(3): 1239–1257. https://doi.org/10.1007/s13197-013-1167-8

Ketoh, Guillaume, K., Koumaglo, Honore K., Geitho Isabelle A. and Huignard, J. 2006. Comparative effect of *Cymbopogon schoenanthus*essential oils and piperitone on *Callosobruchus maculatus* development. *Fitoterapia,* **77**(7-8):506 – 510.

Khan,M.I. and Borle, M.N. 1985. Efficacy of some safer grain protectants against the pulse beetle *Callosobruchus chinensis* L. infesting stored Bengal gram (*Cicer arietinum* L.). *Panjabrao Krishi Visyapeeyh Research Journal*. **9**(1): 53-55.

Leakey, R.R.B. and Last, F.T. 1980. “Biology and potential of Prosopis species in arid environments, with particular reference to *P. cineraria*.” *Journal of Arid Environments*. **3**(1):9-24.https://doi.org/10.1016/S0140-1963(18)31672-0

Liu, Y., Singh, D. and Nair, M. G., 2012. Pods of Khejri (*Prosopis cineraria*) consumed as a vegetable showed functional food properties. *Journal of Functional Foods*, **4**(1): 116-121. https://doi.org/10.1016/j.jff.2011.08.006.

Malik, A. and Kalidhar, S. B. 2007. Phytochemical examination of *Prosopis cineraria* L.(druce) leaves. *Indian Journal of Pharmaceutical Sciences.* **69** (4): 576-578. https://doi.org//10.4103/0250/474X.36950.

Mathur, N.M., Sharma, M.M. and Srivastava, R.P. 1989. Effectiveness of neem kernel powder against lesser grain borer, *Rhyzopertha dominica* Fab. and rice weevil, *Sitophilus oryzae* Linn. *Ind. Journal of Applied Entomology*. **3**:59 – 60.

Modgil, R. and Mehta, U. 1996. Effect of *Callosobruchus chinensis* (L.) (Coleoptera: Bruchidae) on carbohydrate content of chickpea, green gram and pigeon pea. *Mol Nutr Food Research*. **40**(1):41–43.

Morallo Rejesus, B. and Rejesus B. Morallo 1986. Botanical insecticides against the diamondback moth. *Diamondback Moth Management. Proc. First Int. Workshop,* Tainan, Taiwan, **PP**. 241-255.

Nakano,H.,Nakajima, E., Hiradate, S., Fujii, Y., Yamada, K., Shigemori, H. and Hasegawa, K. 2004. Growth inhibitory alkaloids from mesquite (*Prosopis juliflora* (Sw.) DC.) leaves. *Phytochemistry*.**65**(5):587-591. https://doi.org/10.1016/j.phytochem.2004.01.006.

Okonkwo, E.U. and Okoye, W.I. 1992. The control of *Callosobruchus maculatus* (F.) in stored cowpea with dried ground *Ricinus communis* (L.) leaves in Nigeria. *Tropical Pest Management*, **38** (3): 237-238. https://doi.org/10.1080/09670879209371698

Pandey, G.P. and Verma, B.K. 1977. Annona (Custard apple) seed powder as a protectant of Mung, against pulse beetle, *Callosobruchus maculatus* Fab. *Indian Journal of Agriculture Sciences*. **51** (12):910 – 912.

Pandey, N.D., Pal Krishna, Pandey Sanjeev, Tripathi, R.A. and Singh, V.P. 1985. Use of Neem, *Azadirachta indica* (A. Juss.) as seed protectant against rice moth, *Corcyra cephalonica* Stain. I. Effect on the development and damage. *Bull. Grain Technology*. **23**(2):147-153.

Sagar, N.A. and Pareek, S. 2020. Chapter 19 - Safe Storage and Preservation Techniques in Commercialized Agriculture, Editor(s): Chukwuebuka Egbuna, Barbara Sawicka, Natural Remedies for Pest, Disease and Weed Control, Academic Press, 221-234.

Schmutterer, H. and Rembold, H. 1980. Effect of some pure fractions from seeds of *Azadirachta indica* on feeding activity and metamorphosis of *Epilachna varivestis* (Coleoptera: Coccinellidae). *Z. ang. Entomology*. **89** (2):179 – 180.

Singh, S. 2012. Phytochemical analysis of different parts of *Prosopis juliflora. International Journal of Pharmaceutical Research*, **4**(3): 59-61.

Singhmony, S., Anees, I., Chandrakala, T. and Osmani, Z. 1986. Efficacy of certain indigenous plant products as grain protectant against *Sitophilus oryzae* (L.) and *Rhizopertha dominica* (F.). *Journal of Stored Products Research.* **22** (1) : 21-23.

Solanki, D.S., Kumar, S., Parihar, K., Tak, A., Gehlot, P., Pathak, R. and Singh, S.K. 2018. Characterization of a novel seed protein of *Prosopis cineraria* showing antifungal activity. *International Journal of Biological Macromolecules*. **116**: 16-22. https://doi.org/10.1016/j.ijbiomac.2018.05.018

Swamy, S.V.S.G. and Wesley, B.J. 2022. Bioefficacy of plant oils applied through wooden cube impregnation against pulse beetle, *Callosobruchus maculatus* (F.) in green gram. *Journal of Environmental Biology*. **43**: 239-244.http://doi.org/10.22438//jeb/43/2/MRN-1841

Tuda, M., Chou, L-Y., Niyomdham, C., Buranapanichpan, S. and Tateishi, Y. 2005. Ecological factors associated with pest status in *Callosobruchus* (Coleoptera: Bruchidae): high host specificity of non-pests to Cajaninae (Fabaceae). *Journal of Stored Product Research*. **41**:31–45.

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