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Review Article

Plant botanicals as controlling agents against pests *Sitophilus oryzae* and *Callosobruchus chinensis:* A review

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Abstract: Agriculture is adversely affected by numerous insects and pests, nematodes, and invasive weeds. It reduces the yield and produces low-quality grains by 5% of world food production. Stored grain pests are the primary cause of decreased quality, seed viability, grain weight, and commercial value. Chemical pesticides and insecticides proved to be effective and cheaper. The use of chemical pesticides and insecticides harms the environment by affecting soil fertility, developing resistance in pests through genetic variations, and increasing toxic residues. Botanical insecticides cost-effective, biodegradable, and eco-friendly. Botanical insecticides can never entirely replace synthetic pesticide production, but they may solve problems associated with the application of synthetic pesticides. This review summarises the use of plant botanicals as controlling agents against pests *Sitophilus oryzae* and *Callosobruchus chinensis*.

Keywords: Botanical pesticides; *Callosobruchus chinensis*; Invasive weeds; *Sitophilus oryzae.*

Introduction

Invasive weeds are unwanted plants, non-natives due to their occurrence from different geographical regions (IPM, 2014). Invasive species have their successful establishment due to faster reproduction rate, dispersal mechanisms, potency to establish a larger population in a short period with adaptive nature resulting in resource depletion (Dhole, 2013; Ghayal, 2011; Maharajan, 2007). Weeds are considered severe pests in ecosystem or agriculture by competing with soil nutrients, space, water or moisture, sunlight, and their adverse effect on adjacent flora and fauna. Secondary metabolites from plants termed as allelochemicals or eco chemicals are non-nutritive substances used by plants for defense against herbivore, predation, repellence as a mode of communication. Agriculture is adversely affected by numerous pests, pathogens, nematodes, and invasive weeds leading to reduced yield and low-quality grains by 5%of world food production (Aneja, 2016). Pests are the primary cause of decreased quality, seed viability, and grain weight leading to low commercial value (Kazmi, 2017).

Coleoptera belongs to class Insecta mainly affects stored grain pests from a different group of families such as *Sitophilus oryzae* (Curculionidae), *Callosobruchus chinensis* (Bruchidae), *Tribolium castaneum* (Tenebrionidae), *Trogoderma granarium* (Dermestidae). In which *Sitophilus oryzae*, commonly known as rice weevil most damaging and widespread cereal pest found in areas of tropical warm climatic zones, mainly infesting cereals crops like wheat, rice, maize, barley and sorghum (Kazmi, 2017). *Callosobruchus chinensis* is a common species of beetle found in the bean weevil subfamily and is known to be a pest to many stored legumes of chickpea, mung bean and garden pea (Thein, 2013). Many management methods, such as spraying and fumigation, are toxic to pests by penetrating the insect body via cuticle or respi-

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ratory system. Binding of plant derivatives with some solid or liquid carriers such as lacquer, Sodium sulphate, or paraffin as pest control measures suggested by Harding, 1985 (Soon II Kim, 2001).

Botanical Insecticides:

Vrikshyavurveda, an ancient traditional method, emphasized the use of *Azadiracta indica* or Neem as an effective botanical pesticide and insecticide (Das, 2015; Dutta, 2015; Rahman, 2006; Regnault-Roger, 2008). Other medicinal plant sources such as *Eucalyptus, Murayya koenegii*, garlic, turmeric, tulsi, cinnamon, and mustard oil were used as insecticides in Indian and Chinese literature. The use of chemical pesticides and insecticides with organochlorines, organophosphates, carbamates, and synthetic pyrethroids proved to be effective and cheaper in early history than Botanical Insecticide (BI). The use of chemical pesticides and insecticides has seriously caused a negative impact on the environment by affecting soil fertility, developing resistance in pests through genetic variations, and increasing toxic residues (Dutta, 2015). Considering the deleterious effects due to the continuous use of chemical pesticides, research has focused on formulations and standardization of botanical insectcides after a few decades. Botanical pesticides are eco-friendly formulations derived from naturally occurring substances such as microbes (viruses, bacteria, fungi), plants and animals (Aneja, 2016).

As per US-EPA, botanical pesticides have been classified based on active ingredients derived source (Mazid, 2011).

1) Plant Incorporated Protectants (PIP) as BT-protein
2) Microbial as bacteria, fungi, viruses
3) Plant (Botanicals) as *Azadiricta indica* or Neem, Ipomoea, Triphala, *Pinus kesia*, Limonene, Linalool, Rotenone Pyrethrum and Pyrethrins, Sabadilla, Ryania plant botanicals used as biopesticides, which are specific on target organisms as aphids, fleas, beetles, thrips. (Mazid, 2011). Pyrethrins are secondary metabolite compounds derived from Chrysanthemum flowers are potential insecticide to date, less toxic to mammals, and rapidly degrading. Abamectin is a macrocyclic lactone produced by *Streptomyces avermitilis* active against few pests but developed resistance in Tetranycid mites (Chandeler, 2011). Nicotine and Rotenone are highly toxic even to humans with comparable potential or strength to that of synthetic chemical insecticide. Thus, incorrect concentrations such as BI can disrupt pest control in a natural (eco-friendly) way.
4) Biochemical pesticides include insect sex-pheromones.

Few pesticides incorporated under the Insecticide Act, 1968 are commercialized and widely used are

- Biofungicide: *Trichoderma*
- Bioherbicide: *Phytophora*
- Bioinsecticide: *Bacillus thuringiesis* (BT)
- PIP: BT gene, Protease inhibitor, Lectines, Chitinase.

As per revised data available amongst various plant and animal sources, there are 835 active substances which contribute their application worldwide are 680 synthetic pesticides (82%), 69 Insect pheromones (8%), 61 Plant extracts (7%) and 25 Microbial (3%) (Redbond, 2003) National Farmers Policy, 2007 has strongly recommended the exploration of biopesticides to control pests in an eco-friendly manner (Aneja, 2016).

Advantages of using biopesticides:

- Available natural source.
- Selective or producing little or no toxic residue hence less harmful to the environment as decomposing quickly,

- Target organism-specific.
- Cost production lower than chemical pesticide.
- Proven component property under Integrated Pest Management program.

Selection criteria of Botanical Pesticide

- The plant should be perennial
- Wide distribution and huge biomass i.e, readily available
- Plants with some different uses.
- The plants used should not otherwise have a high economic value.
- The active ingredients preferably should be effective at low concentrations.

Experimental Layout

Plant insecticides are used worldwide based on various extracts, especially from families as Rutaceae, Lamiaceae, Meliaceae, Asteraceae, Annonaceae, Malvaceae, Piperaceae, Verbenaceae, and Labiatae (Dimetry, 2014; Yankanchi, 2010). Standardisation of deriving partial pure compound by various methods such as maceration of fresh leaves compared with dried and powdered sample extraction, either with aqueous-based or polar- non-polar solvents (Das, 2015: Upasani, 2003) Extraction methods are Soxhlet extraction, followed with filtration through Whatman filter paper No. 1 and then subjected to the rotary evaporator for further evaporation of the excess solvent and dark green residue obtained, which is further stored at 4^{o}C till further analysis (Ali, 2012, Upasani, 2003: Yankanchi, 2010) Desired concentrations are made by the addition of alcohol or acetone or suitable solvent previously used during extraction of plant extracts. Further experimental observations are carried out by standard Impregnated filter paper dip method by inserting filter paper in prepared concentrations for maximum 2 mins, then the solvent is air-dried, and filter papers are placed in petri-dish. Adult 5-10 individual pairs are released in plates and observations are noted after 24, 48, 72, 96 hours up to 21 days of exposure as per parameters as contact toxicity and mortality under study (Ali, 2012; Rahman, 2006; Soon II Kim, 2001; Thein, 2013). Ovipositional or egg-laying parameters are studied similarly as contact toxicity and grains or seeds are treated with different solvent concentrations, the solvent is allowed to air dry, and then grains are placed in the desired chamber. Data is recorded after 7th day of oviposition of eggs. Eggs are counted, and grain infestation is observed (Acero, 2014; Hashim, 2017; Hossain, 2010; Rahman, 2006; Upasani, 2003). Few parameters such as toxicity were studied on pests by applying a solution of different concentrations to thorax (dorsal surface) by micro-capillary tube. 50 Insect pests were chilled for 10 mins before applying solutions (Rahman, 2006; Roy, 2014; Thein, 2013). Insecticidal activities of specific essential oils were conducted by the Fumigation action method. Extract concentrations applied to filter paper were placed at the bottom of a polythene cup and weevils were placed in another cup embedded in 1st cup covered with mesh cloth. Mortality was noted after 1,2,3,4 days of exposure (Soon II Kim, 2001). Permethrin, the synthetic chemical pesticide used as a positive control against treatment (Kazmi, 2017). Collective data from 3/4 replicas were subjected to further analytical tests.

Experimental studies are being conducted on few standard parameters: Mortality, Fecundity, Oviposition or number of eggs laid, Toxicity, Repellent or attractant, Adult emergence, Weight loss *i.e*, grain damage after post-harvest in stored grains. Analytical methods for separation of active compounds, the functional group are assessed by Chromatography, GC-MS, FTIR, H'NMR studies. FTIR studies are used to analyze functional groups present in phytochemicals (Kazmi, 2017; Roy,2014; Upsani, 2003). Data collected were subjected to Probit analysis, Abbott's formula (1925), GLM (General Linear Model) for mortality and repellence. Analysis and calculation of Fecundity, adult emergence, oviposition and seed damage % are done using one-way ANNOVA (Ali, 2012; Rahman, 2006; Roy, 2014; Yankanchi, 2010). Non-parametric tests as Chi-square test and students t-tests were also referred (Yankanchi, 2010)

Diterpenoids or several neoclerodane diterpenoid isolated from genus *Clerodendrum* have shown an inhibitory effect on reducing pupal weight and adult emergence in a common housefly a dipteran pest and some lepidopteran (Yankanchi, 2010). Due to the presence of scopolamine alkaloid in *Datura alba,* has been used against agricultural pests, like Cabbage butterfly, Rice eating caterpillar, aphids and grasshoppers. It is highly recommended for pest control programs of *Prostephanus truncatus* (large grain borer), *Trogoderma granarium, Tribolium castaneum* and *Sitophilus oryzae* (Ali, 2012). *Eucalyptus globosus* plant leaf extracts proved to be effective over *Citrus limon* at 15% concentration against *Tribolium castaneum* (grain flour beetle) (Khan, 2013). The study was mainly focused on the evaluation of natural plant extracts as toxicants against stored grain pests. Aqueous extracts of *Alternanthera pungens* showed the highest insecticidal effect or mortality rate (100%) against *Tribolium castaneum,* similar to the results of aqueous and methanol extracts of *Ricinus communis* against *Callosobruchus chinensis* (Kazmi, 2017; Upasani, 2003). The possible explanation is the presence of phytochemicals present in plants such as alkaloids, saponins, glycosides, and quercetin a significant compound in *Ricinus,* which proved to be a potential source of biopesticide.

Similar to agricultural pests, disease causing vectors such as *Aedes*, *Culex* mosquitoes have developed physiological resistance against Permethrin or carbosulfan pesticides. Research work is in progress to develop eco- friendly bio-insecticides. Study of plant extracts of *Comsos bipinnatus, Foeniculum vulgare* and *Tagetes minuta* revealed ethanolic and n-hexane extracts showed good larvicidal and suicidal activities against *Culex* mosquito larvae, over aqueous extracts (Modise, 2016).

Despite all bioassays and studied parameters investigations need to be improved on the mode of action of allelochemicals or pure compound from the medicinal plant on non-target organisms, different extraction methods, plant origin, lethal and sub-lethal effects and appropriate formulations for stored grains and enclosed spaces (Acero, 2014; Ahad, 2015; Ali, 2012; Das, 2015; Hashim, 2017; Rahman, 2006; Roy, 2014; Soon II, 2001; Thein, 2013; Yankanchi, 2010). Disadvantages though few but research needs to be focused on the isolation of pure compounds on a larger scale, improvisation on increasing stability and shelf life of active compound will directly relate to effectiveness for a more extended period and in smaller quantities. There are few limitations in terms of applicability since certain alternative and useful sources are from invasive weeds, proving toxic to humans and domestic animals. Therefore, safety issues need to be considered before commercialization of grain protectants (Ali, 2012).

Conclusion

The need of the future is to develop an eco-friendly approach to combat insect pests that should be able to regulate pest populations by exploring naturally occurring botanicals including extracts of plants, insecticidal plants and plant essential oils which may serve as useful repellents, antifeedants, insecticides, fungicides, weedicides, nematicides, molluscicides, etc. (Dimetry, 2014). BI can never entirely replace synthetic pesticide production but they may seek problems associated with the application of synthetic pesticides (Pavela, 2014). We have summarized the BI's advantages and disadvantages, including major factors that point on limitations to their practical use.

Table 1: Information of botanical control agents against pests *Sitophilus oryzae* and *Callosobruchus chinensis*

Botanical name	Active ingredient	Parameters studied	Result	Reference
Datura alba (Solanaceae)	Tropane alkaloid as scopolamine	Contact toxicity, Transgenerational effect	Datura leaf extract (DLE) highest conc. of 2.5% showed significant mortality.	Ali Abid (2012)
Ricinus communis (Euphorbiaceae)	Flavonoids as quercetin and kaempferol	Insecticidal Ovicidal and Oviposition deterrent	Different concentrations of purified flavonoids showed mortality 100% with methanol, whereas with water of 73% and lowest with Petroleum ether of 46%.	Upasani (2003)
Lantana camara (Verbenaceae)	Flavonoids and triterpenoids main phytochemicals	Mortality	Dry leaf powder of Lantana 2% (w/w) proved to be effective against Maize's stored grains.	Koona and Njoya, (2004)
Chromoalena odorata (Asteraceae)	Flavonoids - quercetin, sinensetin, sakuranetin, padmatin, kaempferol, salvagenin	Repellence or Eradicant, Mortality	5th treatment of experimental design revealed 40% mortality.	Acero (2014)
Xanthium strumarium (Asteraceae)	Aromatic esters and long-chain ketone	Contact toxicity, Repellence, Fecundity, Adult Emergence	Formulations of Aqueous extracts were significant at 4% conc, in 4 days.	Roy (2014)

Parthenium hysterophorus (Asteraceae)	Parthenin and other toxin as sesquiterpene lactones, other phenolic acids.	Mortality and Adult emergence of F1 progeny.	(83.3%) Inhibition of adult emergence was reported significant over stem powder (52.78%). Mortality was recorded after 24h treatment.	Tesfu, (2013)
Parthenium hysterophorus (Asteraceae)	Parthenin and other toxin as sesquiterpene lactones, other phenolic acids.	*Work done on *Aedes aegypti*	Impact reported on *Aedes aegypti* mosquito	Kumar, (2011)
Vitex negundo (Lamiaceae); *Acacia arabica*, (Mimosaceae); *Carthmamus tinctorius*, (Asteraceae); *Ipomoea sepiaria* (Convolvulaceae)	Flavonoids, lignans, terpenoids and steroids.	Infestation Direct toxicity Surface protectant	Preparations of plant powder, dust, and seed oil were found useful in various combinations.	Rahman, and Talukedar, (2006)
Blumea lacera, (Asteraceae); *Mimosa pudica*, (Fabaceae); *Argemone mexicana*, (Papaveraceae); *Leucas aspera*, (Lamiaceae); *Polgonum hydropiper* (Polygonaceae)	Tannins, saponins, sterols, Flavonoids, Sesquiterpenes and sesquiterpenoids, as well as phenyl-propanoids.	Mortality, Fecundity, Adult emergence and Toxicity	Toxicity, LC50 & LC95 were observed at 4% conc. *Blumea lacera* is suggested as valuable botanical pesticide.	Ahad, (2015)

Clerodendrum inerme, (Verbenaceae); *Withania somnifera,* (Solanaceae) *Gliricidia sepia,* (Leguminosaceae) *Cassia tora,* (Fabaceae) *Eupatorium odoratum* (Asteraceae)	Diterpenoids found in *Clerodendrum inerme* Flavonoids contents in *Eupatorium* are quercetin, sinensetin sakuranetin, padmatin, kaempferol, Salvagenin,	Mortality, Progeny production	Amongst 2.5% and 5% conc., mortality was based on dose-dependent.	Yankanchi , (2010)
Adiantum incisum (Pteridaceae) ; *Alternanthera pungens* (Amranthaceae); *Trichodesma indicum* (Boraginaceae)	Saponins, Alkaloids, Tannins, Flavonoids	Insecticidal assay as Mortality test	Methanolic extract of *Adiantum incisum* (100%) were effective over aq. extract of *Trichodesma indicum* (25%) in mortality count. Hexane extracts of all extracts proved to be effective.	Kazmi, (2017)
Azadiricta indica (Meliaceae)	Azadiractin	Toxicity,	86% mortality at 3% with Neem extract	Das (2015)
Swietenia mahagoni (Meliaceae)		Repellence	86% mortality at 3% with Neem extract	Das (2015)
Murrayya koenegii, (Rutaceae); *Piper betel,* (Piperaceae); *Cymbopogon citrates* (Poaceae); *Cosmos caudatus* (Asteraceae)	Alphapinene, β- myrcene. Methyl eugenol Citral, citronella	Free choice chamber bioassay, No choice oviposition al test	Several effects were observed in experimental results with 1% (w/ w) of fresh leaves and 1gm of dried powder.	Hashim (2017)

References

1. Acero, L H. Dried Siam Weed (*Chromolaena odorota*) as Rice Weevils' (*Sitophilus oryza)* Eradicant. *International Journal of Chemical Engineering and Applications* 5.5 (2014): 363-366.

2. Ahad, A, Kamrun Nahar, Ruhul Amin, Sang Jae Suh, and Yong Jung Kwon. Biological Activities of Five Weed Extracts against *Callosobruchus chinensis* L. (Coleoptera: Bruchidae). *Korean Journal of Applied Entomology* 54.2 **(**2015): 83-89.

3. Ali, A, Farooq Ahmad, Antonio Biondi, Yusha Wang, Nicholas Desneux. Potential for using *Datura alba* leaf extracts against two major stored grain pests, the khapra beetle *Trogoderma granarium* and the rice weevil *Sitophillus oryzae*, *Journal of Pest Science* 85 (2012): 359–366.

4. Aneja, K, S. A. Khan, Aneja Ashish. Biopesticides an eco-friendly pest management approach in agriculture: status and prospects. *Kavaka* 47 (2016): 145 – 154.

5. Chandler, David, Alastair. S. Bailey, G Mark Tatchell, Gill Davidson, Justin Greaves, Wyn P Grant. The development, regulation and use of biopesticides for integrated pest management, *Philosophical Transactions of Royal Society* B. 366 (2011): 1987–1998.

6. Cheng, Fang and Zhihui Cheng. Research Progress on the use of Plant Allelopathy in Agriculture and the Physiological and Ecological Mechanisms of Allelopathy, *Frontiers in Plant Science* 6.1020. (2015): 1-16.

7. Das, Shimul, Md. Zahir Rayhan, Md. Mustafa Kamal, Ritura Sarkar j, Ripon Kumar Gharami, Sanjoy Kumar Adhikary. Assessment of Toxic and Repellent Effect of Natural Bio Pesticides on Rice Weevil (*Sitophilus Oryzae* L). IOSR *Journal of Agriculture and Veterinary Science* 8.7 *(*2015): 16-23

8. Dole, J A. Lone, K. D. Dhole, G. A. Bodke, S. S. Allelopathic effects of aqueous and ethanolic extracts of some common weeds on seed health of *Triticum aestivum* L. (Wheat), *International Journal of Current Microiology and Applied Sciences* 2.6 (2013) : 254-260

9. Dimetry, Nadia Z. Different Plant Families as Bioresource for Pesticide: Advances in Plant Biopesticides. (2014) Springer India. pp 401.

10. Dutta, Srijita. Biopesticides: An Ecofriendly Approach for Pest Control, *World Journal. of Pharmacy and Pharmaceutical Science* 4. 06 (2015): 250-265

11. Ghayal, Nivedita and Kondiram Dhumal. Morphophysiological Investigations in Some Dominant Alien Invasive Weeds, Plants and Environment (2011). IntechOpen.

12. Hashim, Nur Aida, Nurul Nadia Shamsuddin, Khadijah Saad, Vu Thanh Tu Anh**.** Effects of Several Plant Leaves on Rice Weevil, *Sitophilus oryzae (*Coleoptera: Curculionidae) Productivity and Stored Rice Qualities. *Asian Journal of Agriculture and Food Sciences* 05. 03 (2017)

13. Hossain, M A and M A Haque. Efficacy of some indigenous plant extracts as grain protectant against pulse beetle, *Callosobruchus chinensis* L. *Journal of Agroforestry and Environment.* 4.1 (2010) : 197-202.

14. Kazmi, Zehra and Naila Safdar, Yasmin Azra. Assessment of *Adiantum incisum, Alternanthera pungens* and *Trichodesma indicum* as Bioinsecticides against Stored Grain Pests. *Proceedings of the Pakistan Academy of Sciences: Life and Environmental Sciences.* 54.2 (2017): 103–109

15. Khan, Fahwad Zafar Ahmad, Muhammad Sagheer, Mansoor-ul-Hasan, Shafqat Saeed, Kazam Ali, HafizaTahira Gul, Syed Arslan Bukhari, Syed Amir Manzoor. Toxicological and repellent potential of some plant extracts against stored product insect pest, *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae). *International Journal of Biosciences* 3.9 *(*2013): *280-286.*

16. Seerjana, Maharjan, Bharat Babu Shrestha, Prmod Kumar Jha. Allelopathic effects of aqueous extracts of leaves of *Parthenium hysterophorus* L. on seed germination and seedling growth of some cultivated and wild herbaceous species. *Scientific World* 5.5 (2007) : 33-39.

17. Mazid, Salma, Jogen Ch Kalita, Ratul Ch Rajkhowa. A review on the use of biopesticides in insect pest management. *International. Journal of Science and Advanced. Technology* 1.7. (2011) : 169-178.

18. Modise, Serero Abiot and Anofi Omotayo Tom Ashafa. Larvicidal, pupicidal and insecticidal activities of *Cosmos bipinnatus, Foeniculum vulg-*

are and *Tagetes minuta* against *Culex quinquefasciatus* mosquitoes. *Tropical Journal of Pharmaceutical Research.* 15.5 (2016): 965-972.

19. Paul, Koona and Jean Njoya. Effectiveness of soybean oil and powder from leaves of *Lantana camara* Linn. (Verbenaceae) as protectants of stored maize against infestation by *Sitophilus zeamais* Motsch. (Coleoptera: Curculionidae). *Pakistan Journal of Biological Sciences* 7.12 (2004): 2125-2129.
20. Rahman, SS, Mizanur Rahman, Mohammad. Mizanur Rahman Khan, Shamem Ara Begum, Balaram Roy and SM Fakruddin Shahed. Ethanolic extract of melgota (*Macaranga postulata*) for repellency, insecticidal activity against rice weevil (*Sitophilus oryzae*). *Africa Journal of Biotechnology.* 6. 4 (2006): 379-383
21. Rahman, A and F A Talukder. Bio efficacy of some plant derivatives protects grain against pulse beetle, *Callosobruchus maculatus, Journal of Insect Science.* 6:03 (2006):
22. Redbond, Martin. Biocontrol 2003. Pesticide Outlook. 4 (2003): 168–170
23. Regnault-Roger, Catherine, and Bernard J R Philogene. Past and Current Prospects for the Use of Botanicals and Plant Allelochemicals in Integrated Pest management. *Pharmaceutical Biology.* 46:1-2 (2008): 41-52
24. Roman, Pavela, Limitation of Plant Biopesticides. *Advances in Plant Biopesticides* (2014)
25. Roy, Balaram, Mh. Ruhul Amin, Shah Jalal, Yong Jung Kwon, Sang Jae Suh. Evaluation of common cocklebur *Xanthium strumarium* leaf extract as post- harvest grain protectant of black gram against pulse beetle *Callosobruchus chinensis* (Coleoptera: Bruchidae) and isolation of crude compound. *Entomological Research,* 44 (2014): 254–261
26. Soon-Il Kim, Jung-Yeon Roh, Do-Hyoung Kim, Han-Seung Lee, Young-Joon Ahn. Insecticidal activities of aromatic plant extracts and essential oils against *Sitophilus oryzae* and *Callosobruchus chinensis. Journal of Stored Products Research 39* (2001): 293–303.
27. Tesfu, F and G Emana. Evaluation of *Parthenium hysterophorus* L. powder against *Callosobruchus chinensis* L. (Coleoptera: Bruchidae) on chickpea under laboratory conditions. *African Journal of Agricultural Research.* 8. 44 (2013): 5405-5410.
28. Thein, Win Myint, Pio A Javier and Flor A Ceballo. Insecticidal Activity of Crude Plant Extracts Against *Sitophilus* spp. (Coleoptera: Curculionidae) and *Callosobruchus chinensis* (L.) (Coleoptera: Bruchidae). *The Philippine Agricultural Scientist.* 96. 2 (2013)
29. Upasani, S M, Hemalata M Kotkar, Prashant S Mendki, Vijay L Maheshwari. Partial characterization and insecticidal properties of *Ricinus communis* L foliage flavonoids. *Pest Management Science.* 59 (2003) : 1349–1354,
30. Yankanchi, SR and AH Gadache. Grain protectant efficacy of certain plant extracts against rice weevil, *Sitophilus oryzae* L. (Coleoptera: Curculionidae). *Journal of Biopesticides.* 3.2 (2010): 511 – 513.

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