

Evaluation of Efficacy of Phytochemicals from Invasive Weeds Against *Dolichos* Bean Aphid, *Aphis craccivora* Koch

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ABSTRACT

There are several factors that influence crop yield. Insects and weeds are one of the causative factors in crop yield reduction. The *Aphis craccivora* Koch is the most devastating pest of the lablab bean, affecting the crop in a variety of ways and reducing crop production. Though chemical pesticides have a measurable effect on lablab bean aphid, their substantial impact on the ecosystem is notable. In this work, invasive weeds such as *Parthenium hysterophorus* L. and *Argemone mexicana* L. were tested for insecticidal activity against lablab bean aphid using the leaf dip and film smear methods in the laboratory. The bio-efficacy of aqueous extracts (20%) of both weeds was compared to the effectiveness of the chemical pesticide Rogor (Dimethoate 0.02%). The results showed that Rogor had the highest mortality, although *P. hysterophorus* outperformed *A. mexicana* in both bio-assays. The leaf dip approach showed more positive effects than film smear method. The current study implies that chemical pesticides can be substituted with bio-formulations obtained from these invasive weeds present in crop fields, which have potential to manage invasive weeds in an ecofriendly manner.

Key words: *Parthenium hysterophorus* L., *Argemone mexicana* L., Phyto-insecticides, Leaf dip method, Film smear method, Insecticidal activity.

INTRODUCTION

Lablab purpureus L. (Syn. *Dolichos lablab* L.), is grown as both pulse and vegetable crop grown in different parts of the country. It is a high grain – yielding, nitrogen fixing, dual purpose legume that improves soil fertility (Ngure et al. 2021) and well suited to most tropical environments as it is adaptable to a wide range of rainfall, temperature and altitude (Ravinaik et al. 2015). Despite its ability to adapt to stressful environments, biotic factors like insects have an impact on crop productivity. It is recorded 55 species of insects and a species of mite feeding on dolichos bean crop from seedling stage to the harvest of the crop (Govindan 1974). The primary limiting factor in *Dolichos lablab* L. is that it is heavily infested by aphid, which prevents a successful harvest under ideal climatic conditions (Mondal et al. 217). The dolichos bean aphid, *Aphis craccivora* Koch is the most serious pest, damaging the dolichos bean from seedling to maturity stages,

the highest population is seen at flowering to the pod formation stage (Golvankar et al. 2019). Both nymphs and adults suck the cell sap from leaves, petioles, tender stems, inflorescences and tender pods. The continuous feeding by the large population of aphids results in yellowing, curling and subsequent drying of tender pods (Patil et al. 2016). Due to severe infestation of *A. craccivora* resulting the significant yield loss (Mweke et al. 2020) from 20 to 40% yield loss of bean, *Lablab purpureus* L. (Hossain et al. 2021). Insecticides are considered essential for the management of different pests like aphids. Under this roof chemical pesticides have raised ecological problems and health issues of mankind. To avoid harmful effects of chemical pesticides, phyto-pesticide is the significant way to manage aphids. Invasive weeds in crop fields and allied areas are creating nuisance to growing crops and affecting yield drastically due to their strong competitive ability for survival and growth. Lablab bean is similar victim crop affected by weeds that causes 15-45%

of yield loss and reduce productivity (Doba et al. 2021, Khan et al. 2020). *Parthenium hysterophorus* L. and *Argemone mexicana* L. are two invasive weeds that were accidentally brought to India many decades ago and have detrimental effects on the agricultural environment. The current work is undertaken to evaluate the sustainable approach for incorporation of these invasive weeds to be used as phyto-insecticides against aphids.

MATERIALS AND METHODS

The research was carried out both in the field of Waghapur village (18°23'46.53" N and 74°08' 28.26" E), Taluka Purandhar, District Pune, and in the laboratory of MES Abasaheb Garware College. The bioassay experiment is carried out in the laboratory conditions. All the materials and methodologies for rearing of aphids, collection of weeds, bio assays tests performed by leaf dip method and film smear method of (Kranti et al. 2023) were used to evaluate the insecticidal activity of selected weeds against lablab bean aphid.

The percent corrected mortality was calculated by using Abbott's formula (Abbott 1925). To calculate the lethal times, 50% (LT50), 90% (LT90) and 95% (LT95), serial time-mortality data from toxicity bioassays were analyzed by Probit analysis using SPSS software (SPSS, version 25). Mortality rates of *Aphis craccivora* Koch, treated with aqueous extracts of *P. hysterophorus* and *A. Mexicana* were compared by one-way analysis of variance (ANOVA).

RESULTS AND DISCUSSION

The study aimed to assess the insecticidal activity of both weeds against lablab bean aphids. The tests were carried out using the leaf dip method and the film smear method. Toxicity of *P. hysterophorus* and *A. mexicana* with comparison of Rogor and control for film smear method and leaf dip method is shown (Tables 1 and 2). Comparison of LT₅₀, LT₉₀ and LT₉₅ of aqueous extract of *P. hysterophorus* L. with *A. mexicana* L., Rogor and control by film smear method is given by calculating LT₅₀, LT₉₀ and LT₉₅ by probit analysis (Table 1). LT50 values of T4, T8 and T9 are 10.46, 9.72 and 10.42 hrs, respectively.

Considering the values of LT90 and LT95 for T4, T8 and T9 are 21.06, 19.23 and 21.11 hrs and 24.07, 21.93 and 24.13 hrs, respectively, T4 showed effective significance as compared to T8 and T9. Comparatively LT50, LT90 and LT95 values for Rogor are 6.87, 13.38 and 15.28 hrs. Comparatively LT₅₀, LT₉₀ and LT₉₅ values for Rogor are 6.87, 13.38 and 15.28 hrs. LT50 values of T4, T8 and T9 are 9.13, 11.76 and 11.43 hrs, respectively (Table 2).

The values of LT₉₀ and LT₉₅ for T4, T8 and T9 are 19.9, 25.63 and 22.76 hrs and 22.9, 29.53 and 26.00 hrs, respectively, T4 showed effective significance as compared to T8 and T9. In terms of Rogor, the LT₅₀, LT₉₀, and LT₉₅ values are 15.5, 14.93 and 18.03 hrs, respectively. The results of percent corrected mortality by film smear method and leaf dip method are shown in Figures 1 and 2. Results of film smear method showed highest affectivity by Rogor, followed by T4, T8 and T9. All three treatments showed similar results at 24 hrs, where in the leaf dip method T4, T9 and T8 showed effective results at 24 hrs against lablab bean aphids. The insecticidal toxicity of various plants against insects using leaf dip method and film smear method has shown significant results. The past studies have proved that these methods are reliable to examine toxicity effects. Ahmed et al. (2020) reported that the toxicity results of *A. argyi* against *B. brassicae* aphid showed an LC₅₀ of 3.91 mg mL⁻¹ followed by the toxicity of *C. colocynthis* and *C. indica*, exhibiting LC₅₀ values of 6.26 and 10.04 mg mL⁻¹, respectively which were obtained via a leaf dip method. While Alim et al. (2017) examined, the highest mortality (100%) of *Aleurodicus dispersus* Russell adults was recorded for neem (ethanol) extract (500 mg/L) at 18 hrs after the treatment.

The significant insecticidal activities of *A. mexicana* and *P. hysterophorus* have been reported against various agricultural pests. The larvicidal efficacy of *A. mexicana* leaf extract against *Spodoptera litura* fab revealed toxicity of LD₅₀ = 20.54 mg/ml in ethanol and LD₅₀ = 31.55 mg/ml in aqueous, respectively (Vetal and Pardeshi 2019). Patil and Zambare (2019) reported the effectiveness of *A. mexicana* seed extracts against *Tribolium castaneum* (sixth instar). Total mortality was seen with acetone extract at 1.6 ml/kg wheat, whereas 56.6±4.16% larvicidal effect was seen with ethanol

Table 1. Insecticidal toxicity of *P. hysterophorus* L. and *A. mexicana* L. on *A. craccivora* Koch by film smear method

Tr. No.	Treatments	Dosage	LT-50	LT-90	LT-95
T1	Aqueous extract <i>P. hysterophorus</i>	5%	20.77 ^{ab}	35.25 ^b	52.56 ^b
T2		10%	19.92 ^{ab}	35.38 ^b	39.77 ^{ab}
T3		15%	16.1 ^{ab}	30.33 ^{ab}	34.36 ^{ab}
T4		20%	10.46 ^{ab}	21.06 ^{ab}	24.07 ^a
T5	Aqueous extract <i>A. mexicana</i>	5%	22.7 ^b	39.68 ^c	44.5 ^c
T6		10%	18.47 ^{ab}	34.02 ^{bc}	38.43 ^{bc}
T7		15%	14.39 ^{ab}	28.2 ^{abc}	32.11 ^{abc}
T8		20%	9.72 ^{ab}	19.23 ^{ab}	21.93 ^{ab}
T9	Aqueous extract <i>P. hysterophorus</i> + Aqueous extract <i>A. mexicana</i>	20%	10.42 ^{ab}	21.11 ^{ab}	24.13 ^{ab}
T10	Rogor (Dimethoate)	0.02	6.87 ^a	13.38 ^a	15.28 ^a
T11	Control	-	21.93 ^b	26.4 ^{abc}	27.67 ^{abc}

Table 2. Insecticidal toxicity of *P. hysterophorus* L. and *A. mexicana* L. on *A. craccivora* Koch by leaf dip method

Tr. No.	Treatments	Dosage	LT50	LT90	LT95
T1	Aqueous extract <i>P. hysterophorus</i>	5%	25.26 ^a	41.03 ^c	45.46 ^c
T2		10%	24.3 ^a	39.76 ^c	44.16 ^c
T3		15%	17.56 ^a	31.26 ^{bc}	35.13 ^{bc}
T4		20%	9.13 ^a	19.9 ^{ab}	22.9 ^{ab}
T5	Aqueous extract <i>A. mexicana</i>	5%	28.8 ^a	46.26 ^c	51.30 ^d
T6		10%	21.36 ^a	35.36 ^{bc}	39.33 ^{cd}
T7		15%	17.7 ^a	31.43 ^{bc}	35.33 ^{bcd}
T8		20%	11.76 ^a	25.63 ^{ab}	29.53 ^{abc}
T9	Aqueous extract <i>P. hysterophorus</i> + Aqueous extract <i>A. Mexicana</i>	20%	11.43 ^a	22.76 ^{ab}	26.00 ^{abc}
T10	Rogor (Dimethoate)	0.02	15.5 ^a	14.93 ^a	18.03 ^{ab}
T11	Control	-	9.93 ^a	11.86 ^a	12.43 ^a

extract at 20.1 ± 1.73 ml/kg wheat. In a field experiment, the mustard aphid, *Lipaphis erysimi* (Kaltenbach), was controlled by spraying *Brassica juncea* with aqueous extracts made from shade-dried *Parthenium* leaves. After applying the extract for three days, population of *L. erysimi*, was drastically reduce to 29% of the initial infestation, probably due to as a result of the action of phenolic acids (Wiesner et al. 2007). Chickpea seeds treated with powder of leaf and stem of *Parthenium* showed toxicity to *Callosobruchus chinensis* with significant percent inhibition in adult emergence with 83.33 and 52.78, respectively (Tesfu and Emanu 2013).

Other than any other pests the reported application of these invasive weeds as an insecticide against aphids has been found to have a considerable impact. Santos et al. (2015) studied that ethanol extract of *A. mexicana* showed effectivity against *A. craccivora*. Ali and Rizvi (2009) evaluated the bio effectiveness of *A. mexicana* against the mustard aphid, *Lipaphis erysimi* (Kalt), and found the maximum population decrease.

Methanol extract of *A. mexicana* revealed 5% repellency against *A. gossypii* Glover adults (Ali et al. 2017). On either side, the lifespan and productivity of adult *Lipaphis erysimi* Kalt were significantly

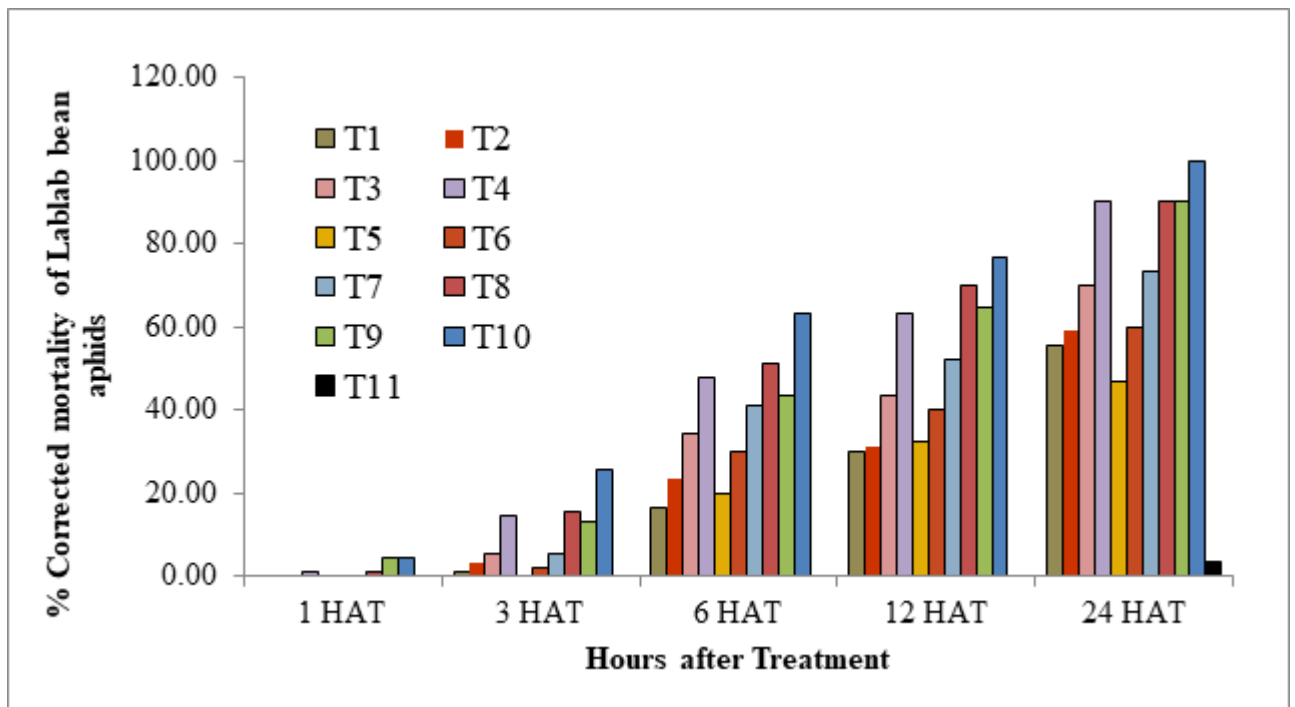


Figure 1. Graph representing the percent corrected mortality by aques extracts of *P. hysterophorus* L. and *A. mexicana* L as compared to Rogor and control by film smear method. Treatment T1 to T11 are as per the list in Table 1

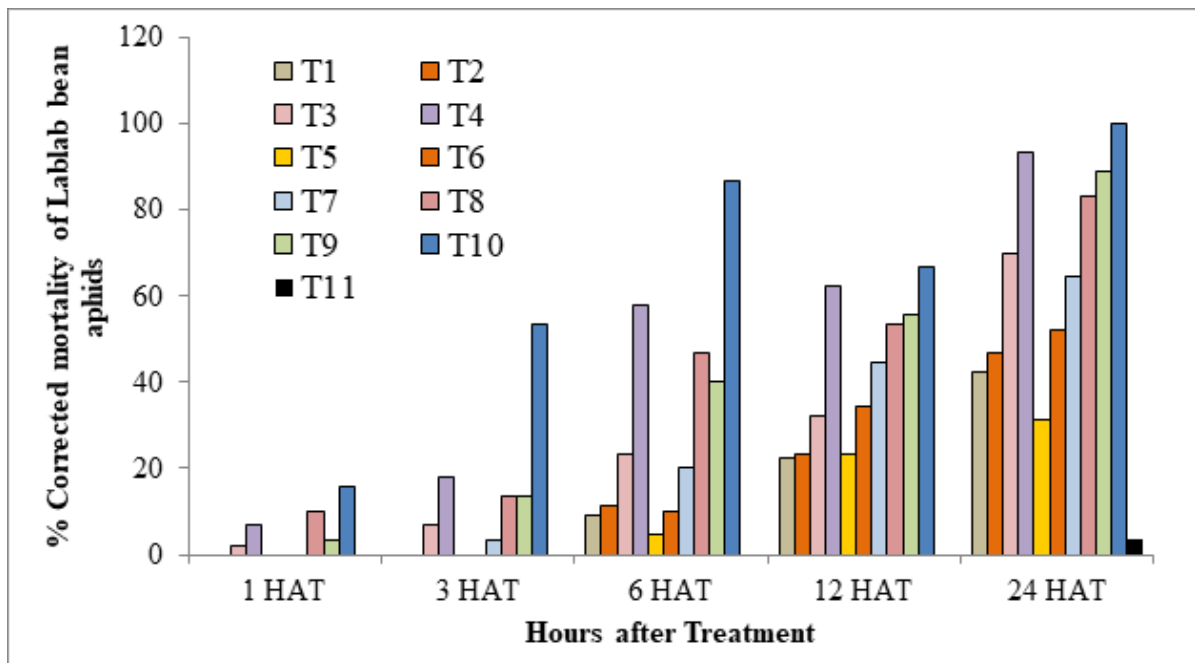


Figure 2. Graph representing the percent corrected mortality by aques extracts of *P. hysterophorus* L. and *A. mexicana* L as compared to Rogor and control by leaf dip method. Treatment T1 to T11 are as per the list in Table 1

reduced by a petroleum ether extract of *P. hysterophorus* leaves (Sohal et al. 2002). Similarly, its leaves extract shown effective lethality against *L. erysimi* (Chandel et al. 2012). The extract of *P. hysterophorus* on mustard greatly decreased the population of mustard aphids *L. erysimi* (Bhattacharyya et al. 2007). None the less, Parthenin showed more effective toxicity against *A. craccivora* (Eswara Reddy et al. 2018). A recent research (Baig et al. 2022) found that a congress weed leaf extract significantly reduced aphids on potato leaves. The current investigation and literature review discovered that various forms of whole weed and various extracts of *P. hysterophorus* and *A. mexicana* exhibit substantial insecticidal activity against agricultural insects including aphids.

CONCLUSION

Chemical pesticides are mostly efficient against aphids while having a negative impact on the accompanying ecology. As a result, bio-formulation is an effective method for mitigating the environmental effects of chemical pesticides. The current study was designed to assess the efficacy of formulations derived from invasive plants against lablab bean aphid. *A. mexicana* and *P. hysterophorus* have shown that a wide range of phytochemicals are effective in a variety of bioactivities. *P. hysterophorus* demonstrated significantly better results than *A. mexicana* in terms of toxicity against aphids and overall efficiency of pesticide prepared from aqueous extract of the weeds. A mixture of both of these weeds proved effective equivalent to *P. hysterophorus*. The study's findings imply that an insecticide derived from *A. mexicana* and *P. hysterophorus* can be used on lablab bean aphids to achieve results comparable to commercial pesticides while causing no harm to the environment. Additional study is needed to assess the bio-efficacy of invasive weeds against the desired pests in order to produce bio insecticides. Environmental hazards can be avoided, and invasive weeds can be managed by employing them as insecticides.

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REFERENCES

- Abbott, W.S. 1925. A method of computing the effectiveness of an insecticide. *Journal of Economic Entomology*, 18, 265-267.
- Ahmed, M., Peiwen, Q., Gu, Z., Liu, Y., Sikandar, A., Hussain, D., Javeed, A., Shafi, J., Iqbal, M.F., An, R., Guo, H., Du, Y., Wang, W., Zhang, Y. and Ji, M. 2020. Insecticidal activity and biochemical composition of *Citrullus colocynthis*, *Cannabis indica* and *Artemisia argyi* extracts against cabbage aphid (*Brevicoryne brassicae* L.). *Scientific Reports*, 10(1), 522. <https://doi.org/10.1038/s41598-019-57092-5>
- Ali, A., and Rizvi., P.Q. 2009. Efficacy of some plant leaf extracts against mustard aphid, *Lipaphis erysimi* on Indian mustard, *Brassica juncea*. *Plant Protection Research*, 50(2), 130-132. Ali, H., Sabiha, S., Islam, S., Rekha, S.B., Nesa, M. and Islam, N. 2017. Repellent activity of *Argemone mexicana* L. extracts against *Aphis gossypii* Glover and *Tribolium castaneum* (Hbst.) adults. *Journal of Pharmacognosy and Phytochemistry*, 6(1), 466-469. <https://www.phytojournal.com/archives/2017.v6.i1.1113/repellent-activity-of-argemone-mexicana-l-extracts-against-aphis-gossypii-glover-and-tribolium-castaneum-hbst-adults>.
- Alim, Md. A., Song, J., Lim, U.T., Choi, J.J., and Hossain, Md. A. 2017. Bioassay of plant extracts against *Aleurodicus dispersus* (Hemiptera: Aleyrodidae). *Florida Entomologist*, 100(2), 350-357. <https://doi.org/10.1653/024.100.0234>
- Baig, B., Yousaf, S. and Iqbal, J. 2022. Characterization and quantification of active compounds in *Parthenium hysterophorus* for development of a bio-herbicide to reduce reliance on synthetic herbicides. *Journal of Hunan University (Natural Sciences)*, 49(10), 1691-1704.
- Bhattacharyya, A., Adhikary, S., Roy, S. and Goswami, A. 2007. Insecticidal efficacy of *Parthenium hysterophorus* on *Lipaphis erysimi* Kalt - A field study. *Journal of Ecotoxicology & Environmental Monitoring*, 17(2), 113-118.
- Chandel, B.S., Singh, V. and Trevedi, S.S. 2012. Aphidicidal potential of *Azadirachta indica*, *Adhatoda vasica*, *Vitex negundo*, *Parthenium hysterophorus* and *Lantana camara* against mustard aphid, *Lipaphis erysimi* Kaltenbach

- (Hemiptera:Aphididae). Journal of Applied and Natural Science, 4(2), 181-186 . <https://doi.org/10.31018/jans.v4i2.245>
- Doba, S.D., Choudhary, R., Baldaneeya, N.S., Suthar, K.J. and Maheriya, V.D. 2021. Influence of different weed management practices on weed flora, growth, yield and economics of Indian bean (*Lablab purpureus* L.) under south Gujarat condition. International Journal of Chemical Studies, 9(2), 831-834. <https://doi.org/10.22271/chemi.2021.v9.i2i.11924>
- Eswara Reddy, S., Dolma, S., Verma, P. and Singh, B. 2018. Insecticidal activities of *Parthenium hysterophorus* L. extract and parthenin against diamondback moth, *Plutella xylostella* (L.) and aphid, *Aphis craccivora* Koch. Toxin Reviews, 37(2), 161-165. <https://doi.org/10.1080/15569543.2017.1339281>
- Golvankar, G.M., Narangalkar, A.L., Desai, V.S., Salvi, B.R. and Dhekale, J.S. 2019. Efficacy of different insecticides against lablab bean aphid, *Aphis craccivora* Koch. Journal of Entomology and Zoology Studies, 7(6), 1152-1158. <https://www.entomoljournal.com/archives/2019/vol7issue6/PartT/7-3-273-128.pdf>
- Govindan, R. 1974. Resistance to pests of field bean, *L. purpureus* with special reference to the biology and ecology of the pod borer *A. atkinsoni*. M.Sc. (Agri) thesis submitted to the University of Agricultural Sciences, Bangalore. 34 pages.
- Hossain, M.A., Yasmin, M.S., Bachchu, M.A. and Alim, M.A. 2021. Potency of three botanical oils against the *Aphis craccivora* koch (homoptera: aphididae) nymphs under laboratory conditions. SAARC Journal of Agriculture, 19(1), 139-154. <https://doi.org/10.3329/sja.v19i1.54785>
- Khan, A., Choudhury, M., Talucder, M., Hossain, M., Ali, S. and Akter, T. 2020. Constraints and solutions of country bean (*Lablab purpureus* L.) production: A review. Acta Entomology and Zoology, 1(2), 37-45. <https://doi.org/10.33545/27080013.2020.v1.i2a.17>
- Kranti, W., Nivedita, G., Mahesh, S. and Jadhav, R. 2023. Efficiency of phytochemicals obtained from selected invasive weeds against mustard aphid (*Lipaphis erysimi*) Kalt. Research Journal of Agricultural Science, 14(1), 242-246.
- Mondal, H., Roy, S., Hijam, L., Chakraborty, M., Dutta, P. and Hath, T. 2017. Differential aphid colony establishment in *Dolichos lablab* varieties correlated with some plant specific factors that impact on aphid fecundity. American Journal of Plant Sciences, 8, 754-769.
- Mweke, A., Akutse, K., Ulrichs, C., Fiaboe, K., Maniania, N. and Ekesi, S. 2020. Integrated management of *Aphis craccivora* in cowpea using intercropping and entomopathogenic fungi under field conditions. Journal of Fungi, 6(60), 1-16. <https://doi.org/10.3390/jof6020060>
- Ngure, D., Kinyua, M. and Kiplagat, O. 2021. Morphological and microsatellite characterization of improved *Lablab purpureus* genotypes. Journal of Plant Breeding and Crop Science, 13(2), 23-34. <http://41.89.164.27:8080/xmlui/handle/123456789/1631>
- Patil D. R. and Zambare S.P. 2019. Insecticidal activity of seeds extracts of *Argemone mexicana* against *Tribolium castaneum* (Herbst, 1797) (Coleoptera: Tenebrionidae). International Journal of Life Sciences, Special issue A13, 102-105.
- Patil, V.R., Pandav, S.M. and Phalke, S.H. 2016. Efficacy of different insecticides against *Dolichos* bean aphid, *Aphis craccivora* Koch. Advances in Life Sciences, 5(19), 8354-8356. <https://doi.org/10.15740/HAS/TAJH/10.1/49-52>
- Ravinaik, K., Hanchnamani, C., Patil, M. and Imamsaheb, S. 2015. Evaluation of dolichos genotypes (*Dolichos lablab* L.) under north eastern dry zone of Karnataka. The Asian Journal of Horticulture, 10(1), 49-52.
- Santos, C. and Silva, A.P. 2015. Extracts weed plant against bedbug *Aphis craccivora* koch 1854, the bean *Vigna unguiculata* (L.) walp. Ibero-American Journal of Environmental Sciences, 6(2), 69-75.
- Sohal, S.K., Rup, P.J., Kaur, H., Kumari, N. and Kaur, J. 2002. Evaluation of the pesticidal potential of the congress grass, *Parthenium hysterophorus* Linn. on the mustard aphid, *Lipaphis erysimi* (Kalt.). Journal of Environmental Biology, 23, 15-18.
- Tesfu, F. and Eman, G. 2013. Evaluation of *Parthenium hysterophorus* L. powder against *Callosobruchus chinensis* L. (Coleoptera: Bruchidae) on chickpea under laboratory conditions. African Journal of Agricultural Research, 8(44), 5405-5410.
- Vetal, D.S. and Pardeshi, A.B. 2019. Larvicidal potential of *Argemone mexicana* L. plant extracts against *Spodoptera litura* fab. The Pharma Innovation Journal. 8(6), 698-702.
- Wiesner, M., Roth, I., Bliedernicht, A., Buettner, C., Tessema, T., Goswami, A., Mewis, I. and Ulrichs, C. 2007. Insecticidal Effects of *Parthenium hysterophorus* Extracts Rich in Terpenoids and Phenolic Acids. In: Utilisation of diversity in land use systems: Sustainable and organic approaches to meet human needs. Witzhausen.

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