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LC_{50} AND RELATIVE TOXICITY OF PLANT EXTRACTS AGAINST COWPEA APHID *APHIS CRACCIVORA* KOCH

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ABSTRACT

A laboratory bioassay was carried out to determine the LC_{50} and relative toxicity of three botanicals (leaf extracts) along with a check imidacloprid 17.8 SL and control on the cowpea aphid *Aphis craccivora* Koch. Extract of *Polygonum hydropiper* showed the maximum efficacy (LC_{50} 0.341%) followed by *Murraya koenigii* (0.707%) and *Pongamia pinnata* (3.357%) after 72 hr exposure. Considering the relative toxicity of imidacloprid as unit value, *P. hydropiper, M. koenigii* and *P. pinnata* were 0.090, 0.043 and 0.009x less toxic, respectively.

Keywords: *Aphis craccivora*, *Polygonum hydropiper, Murraya koenigii, Pongamia pinnata,* toxicity, leaf extracts, imidacloprid, LC_{50}

Aphis craccivora Koch (Homoptera: Aphididae), commonly known as the bean aphid, is one of the most destructive aphid pests. Besides direct damage by sucking and directly by sooty mould, *A. craccivora* transmits several non-persistent plant viruses including broad bean mosaic, ground nut rosette, Iranian strain viruses, etc., in many places in the world (Kaiser, 1979; Thottappilly and Rossel, 1985). Botanical insecticides are naturally occurring chemicals extracted from plants and are biodegradable. These are relatively harmless to non-target organisms but are not long lasting as those of synthetic pesticides (Isman, 2008). Also, the possibility of insect developing resistance to botanical insecticide is less. Brief descriptions on the anti-insect properties of such plants are given below:

Polygonum hydropiper L. (water pepper)- polygoidal, a compound isolated from this plant has strong antifeedant activity against African army worms, *Spodoptera exempta* (Kubo et al. 1976) and aphids (Asakawa, 1988). *Murraya koenigii* L. (curry leaf)- repellent and antifeedant activity against insects (Singh et al. 2014). *Pongamia pinnata* L (Karanj)- karanjin, pongamol and pinnatin extracted from this plant are toxic to the head louse, *Pediculus humanus capitis* (Shirwaiker et al., 2003). The present study evaluates the extracts of these on the cowpea aphid *Aphis craccivora*.

MATERIALS AND METHODS

The study was carried out in the laboratory at Department of Entomology, Assam Agricultural University, Jorhat during 2017-2018. *P. hydropiper*, *P. pinnata* and *M. koenigii* were selected based on the literature survey and as these are available indigenously. The plant parts (leaves) were collected from the nearby vicinity of Assam Agricultural University, Jorhat campus. The leaves were dried under shade and ground to fine powder. The powdered materials were sieved through 60 mesh sieve and extraction was done in soxhlet apparatus with methanol as the solvent. The treatments were compared with a check- imidacloprid 17.8 SL, and an untreated control (methanol).

For the determination of LC_{50} values several concentrations of botanicals were prepared by serial dilution method. These were applied in the form of dry film, deposited on the inner surface of the petriplate. Thin and uniform film of treatments was prepared by taking 1 ml of insecticide solution in a petriplate and rotated till dryness. Toxicity of these films was determined against fourth instar nymph of *A. craccivora*. Twenty aphids were released into each petriplate, which served as one replication. Three replications of each concentration of the insecticide were maintained. Simultaneously one control (only dry film of methanol) set was also run. The plates were kept in an incubator at 28±2°C for six hr. Then the aphids were transferred to glass jars (20 x10 cm dia) containing flowers and pods of cowpea. The mouth of each jar was kept closed with a piece of muslin cloth held in position with the help of rubber bands. These jars were kept in incubator at 28±2°C and after 24, 48 and 72 hr mortality counts were made.

Percent aphid mortality in each treatment was worked out. The observed mortality was corrected if there were mortality in control by using Abbott's formula (1925). The dosages mortality data so obtained were subjected to Probit analysis Finney (1952) to find out LC_{50} values. The relative toxicity of different insecticides was calculated by taking LC_{50} value of imidacloprid as unit.

RESULTS AND DISCUSSION

The data on mortality of *A. craccivora* revealed that *P. hydropiper* extract @ 5.00% caused highest mortality of 66.31, 73.50 and 81.10% after 24, 48 and 72 hr whereas 10.00% *P. pinnata* extract caused mortality (65.65%) at 24 hr, 71.45% at 48 hr and 77.71% at 72 hr. For *M. koenigii* leaf extract, mortality recorded was as 64.38, 7.05 and 79.18% after 24, 48 and 72 hr at 5.00 %, respectively. Imidacloprid caused highest mortality in comparison to the botanicals with 73.14, 81.10 and 90.00% after 24, 48 and 72 hr, respectively at 0.08 per cent. The mortality was increased steadily with increase in concentration as well as exposure period in all the botanical extracts **(Table 1).** The regression equation, LC_{50} values, relative toxicity, fiducial limit and the order of toxicity using plant extracts and imidacloprid

Table 1. Mortality of *Aphis craccivora* due to botanical extracts and imidacloprid

Treatment	Concentration (%)	Post-treatment mortality (%) 24hr	48hr	72hr
P. hydropiper	5.00	66.31 (54.51)	73.50 (59.01)	81.10 (64.23)
	3.00	58.64 (49.97)	65.37 (53.95)	72.82 (58.57)
	2.00	53.45 (46.97)	60.61 (51.12)	68.14 (55.63)
	1.00	47.41 (43.51)	54.16 (47.38)	59.34 (50.38)
	0.50	42.48 (40.67)	49.93 (44.95)	55.77 (48.31)
	0.25	32.51 (34.76)	41.97 (40.37)	47.47 (43.54)
	0.10	27.82 (31.83)	32.67 (34.86)	36.10 (36.92)
S.Ed(±)		4.10	4.77	4.24
CD (p=0.05)		8.70	10.11	9.00
P. pinnata	10.00	65.65 (54.12)	71.45 (57.70)	77.71 (61.82)
	9.00	59.72 (50.60)	66.86 (54.85)	71.35 (57.63)
	8.00	53.36 (46.92)	60.71 (51.18)	65.20 (53.84)
	7.00	48.37 (44.06)	54.08 (47.34)	59.13 (50.26)
	5.00	41.52 (40.11)	47.99 (43.84)	52.84 (46.62)
	2.50	34.74 (36.11)	40.96 (39.79)	45.43 (42.37)
	1.50	27.91 (31.89)	31.46 (34.11)	36.10 (36.92)
S.Ed (±)		3.93	4.26	5.21
CD (p=0.05)		8.33	9.03	11.05
M. koenigii	5.00	64.38 (53.35)	72.05 (58.08)	79.18 (62.85)
	4.00	58.57 (49.93)	64.12 (53.20)	71.35 (57.63)
	3.00	50.41 (45.23)	56.24 (48.58)	63.91 (53.07)
	2.00	45.45 (42.38)	50.94 (45.53)	57.20 (49.13)
	1.00	40.51 (39.52)	47.95 (43.82)	53.63 (47.08)
	0.50	35.44 (36.53)	40.84 (39.72)	46.43 (42.95)
	0.25	28.88 (32.50)	33.60 (35.42)	39.30 (38.82)
S.Ed(±)		4.14	4.41	4.74
CD(p=0.05)		8.79	9.36	10.05
Imidacloprid	0.08	73.14 (58.75)	81.10 (64.23)	90.00(71.56)
	0.07	65.83 (54.19)	72.93 (58.64)	81.10 (64.23)
	0.06	57.49 (49.28)	64.12 (53.20)	71.35(57.63)
	0.05	50.35 (45.20)	57.25 (49.16)	63.91(53.07)
	0.04	42.27 (40.55)	48.93 (44.38)	54.71(47.70)
	0.03	35.51 (36.57)	41.93 (40.35)	47.47(43.54)
	0.02	27.89(31.87)	34.78(35.95)	39.30(38.82)
	Control	1.66 (7.40)	3.33 (10.51)	5.00 (12.92)
S.Ed(±)		4.16	3.62	3.68
CD (p=0.05)		8.83	7.67	7.81

after 24, 48 and 72 hr are calculated. These reveal that *P. hydropiper* showed lowest LC_{50} value (0.341%) followed by *M. koenigii* (0.707%) and *P. pinnata* (3.357%) after 72 hr exposure period (Table 2).

The comparison of relative toxicity revealed that *P. hydropiper* was 0.038, 0.062 and 0.090 times less toxic than imidacloprid when exposed for a period of 24, 48 and 72 hr, respectively. *P. pinnata* was 0.007, 0.008 and 0.009 times less toxic than imidacloprid after 24, 48 and 72 hours exposure period whereas *M. koenigii* was 0.021, 0.029 and 0.043 times less toxic than imidacloprid when exposed for a period of 24, 48 and 72 hours, respectively. The order of toxicity with respect to LC_{50} was imidacloprid>*P. hydropiper* >*M. koenigii* >*P. pinnata* for the exposure period of 24, 48 and 72 hours, respectively (Table 2).

From the above results it was found that the aphid mortality was highest in *Polygonum hydropiper* treatment with lowest LC_{50} value and highest relative toxicity for all the exposure period. *P. hydropiper* was reported to be effective against *Callosobruchus chinensis* (Bhuyan et al. 2004), *Sitophilus oryzae* (Hasan et al. 2008), *Aleurodicus disperses* (Alim et al. 2017) and *Tribolium castaneum* (Kundu et al. 2007).

From the above work it was confirmed that *M. koenigii* is also effective for the management of aphid. This may also be in conformity with the results of Namrata et al. (1997) who reported the higher fumigant and contact toxicity effects of *M. koenigii* leaf volatiles against *C. chinensis* with the LC_{50} value of 4.672 mg/L. Singh et al. (2015) reported that ethanolic extract of *M. koenigii* has highest acaricidal property followed by chloroform and acetone extract against *Rhipicephalus microplus*. According to Senrung et al. (2014) hexane extract of *M. koenigii* @ 5% was very effective as an antifeedant as well as oviposition deterrent against *Spodoptera litura*.

From our study it was found that *P. pinnata* is

Table 2. Estimated LC_{50} value, regression equation, heterogenety ($\chi 2$), fiducial limit and order of relative toxicity for three botanicals and imidacloprid

Treatment	Regression Equation	Heterogenety χ^2	LC_{50} (%)	Fiducial limit	Relative Toxicity	Order of Toxicity
			24 hr			
P. hydropiper	Y=0.036+ 0.565 X	18.931	1.158	0.927 1.470	0.038	I
P. pinnata	Y=0.841+ 1.079 X	28.250	6.011	5.165 7.103	0.007	III
M. koenigii	Y=0.209+ 0.648 X	24.042	2.100	1.727 2.614	0.021	II
Imidacloprid	Y=2.641+ 1.964 X	24.944	0.045	0.048 0.054	1.000	-
			48 hr			
P. hydropiper	Y=0.141+ 0.591 X	31.525	0.576	0.411 0.774	0.062	I
P. pinnata	Y=0.726+ 1.141 X	27.889	4.328	3.686 4.994	0.008	III
M. koenigii	Y=0.055+ 0.671 X	29.878	1.209	0.917 1.554	0.029	II
Imidacloprid	Y=2.892+ 2.010 X	28.020	0.036	0.033 0.040	1.000	-
			72 hr			
P. hydropiper	Y=0.314+ 0.672 X	24.037	0.341	0.265 0.423	0.090	I
P. pinnata	Y=0.615+ 1.169 X	43.068	3.357	2.625 4.037	0.009	III
M. koenigii	Y=0.109+ 0.722 X	34.925	0.707	0.491 0.930	0.043	II
Imidacloprid	Y=3.485+ 2.306 X	39.458	0.031	0.027 0.034	1.000	-

relatively less effective as compared to *P. hydropiper* and *M. koenigii* with LC_{50} value 3.357 after 72 hours of treatment but it can effectively used for aphid management. Tran et al. (2016) provided evidence that pongam leaf extracts have a toxic effect against the turnip aphid *Lipaphis pseudobrassicae* causing high level of the mortality with the LC_{50} values 0.585%, 0.151% and 0.113% at 24, 48 and 72 hours, respectively. Kulat et al. (1997) have also indicated that pongam leaf extract was highly toxic to *Aphis gossypii*. Similarly anti-lice activity of methanol leaf extracts of *P. pinnata* was reported by Samuel et al. (2009) against *Pediculus humanus capitis* with values ranging between 32.6 and 82.9%.

Thus, these three leaf extracts are one of the promising tools to combat insect pests that are often difficult to control solely with synthetic pesticides. Apart from acute lethal toxicity of these leaf extracts on insects, they also possess some nonlethal, negative effects (antifeedant, repellent, oviposition deterrent, etc.) against insects. Although such effects were not examined in our study, we provided evidence that even at low concentrations these leaf extracts caused significant reduction of vitality and fertility of the cowpea aphid, *Aphis craccivora* Koch and further research can be carried out to determine those non lethal effects against insects.

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REFERENCES

Abbot W S. 1925. A method of computing the effectiveness of an insecticide. Journal of Economic Entomology 18: 265-267.

Alim M, Song J, Lim U T, Choi J J, Hossain M A. 2017. Bioassay of plant extracts against *Aleurodicus dispersus* (Hemiptera: Aleyrodidae). Florida Entomologist 100(2): 350-357.

Asakawa Y, Dawson G W, Griffis D C. 1988. Activity of drimane antifeedants and related compounds against aphids and comparative biological effects and chemical reactivity of (-) - and (+) -polygodial. Journal of Chemical Ecology 14(10):1845-1855.

Bhuyan A S, Siddhabhatti P M, Wadaskar R M, Khan M I. 2004. Seasonal incidence and control of pod borer complex in pigeonpea. Pestology XXVIII (9): 99-104.

Finney D J. 1952. Probit analysis, third edition. Cambridge University Press, Cambridge, United Kingdom.

Hasan M F, Das R, Hossain M S, Rahman M S, Rahman M. 2008. The effect of *Polygonum hydropiper* L. stems extract on the mortality and repellency of *Sitophilus oryzae* L. Bangladesh Journal of Environmental Science 15: 37-39.

Kaiser W J. 1979. Natural infection of cowpea and moong bean by alfalfa mosaic virus in Iran. Plant Disease Report 63: 414-418.

Kubo I, Lee YW, Pettei M, Pilkiewicz F, Nakanishi K. 1976. Potent army worm antifeedants from the east African *Warburgia* plants. Journal of the Chemical Society, Chemical Communications 24: 1013-1014.

Kulat S S, Nimbalkar S A, Hiwase B J. 1997. Relative efficacy of some plant extracts against *Aphis gossypii* (Glover) and *Amrasca devastans* (Distant) on Okra. PKV Res J 21: 146-148

Kundu B R, Ara R, Begum M M, Sarker Z I. 2007. Effect of Bishkatali, *Polygonum hydropiper* L. plant extracts against the red flour beetle, *Tribolium castaneum* Herbst. University Journal of Zoology, Rajshahi University 26: 93-97

Isman M B. 2008. Pest Management Science 64: 8-11

Namrata P, Yadav T D, Jha A N, Vasudevan P. 1997. Contact and fumigant action of volatile essential oil of *Murraya koenigii* against *Callosobruchus chinensis*. Indian Journal of Entomology 59: 198-202.

Samuel A J S J, Radhamani S, Gopinath R, Kalusalingam A, Gnana KAV, Husain H A. 2009. In vitro screening of anti–lice activity of *Pongamia pinnata* leaves. Korean Journal of Parasitology 47: 377-380.

Senrung A, Singh J, Sharma S, Bhutia T N, Singh A K. 2014. Effect of *Murraya koenigii* extracts on feeding and ovipositional response of *Spodoptera litura* (Fab.) (Lepidoptera : Noctuidae). Journal of Entomology and Zoology Studies, 2(3): 27-31.

Shirwaikar A, Malini S, Kumari SC. 2003. Protective effect of *Pongamia pinnata* flowers against cisplastin and gentamicin induced nephrotoxicity in rats. Indian Journal of Experimental Biology, 1: 58-62.

Singh N K, Jyoti V B, Singh H, Prerna M, Daundkar P S, Sharma S K, Dumka V K. 2015. In vitro acaricidal activity of *Murraya koenigii* (L.) Spreng (Rutaceae) extracts against synthetic pyrethroid-resistant *Rhipicephalus* (*Boophilus*) *microplus*. Parasitology Research 114: 1531-1539

Singh S, Omre P K B, Madan S. 2014. Curry leaves (*Murraya koenigii* Linn Sprengal) - A MIRCALE PLANT. Indian Journal of Science and Research 4 (1): 46-52.

Thottappilly G, Rossel H W. 1985. Worldwide occurrence and distribution of virus diseases. In: Sing S.R. and Rachie, K.O. (eds). Cowpea research production and utilization. Wiley, New York, pp.155-171.

Tran D H, Khac P L, Ueno T. 2016. Control efficacy of pongam (*Pongamia pinnata* L.) leaf extract against the turnip aphid *Lipaphis pseudobrassicae* (Davis) (Hemiptera : Aphididae). Journal Faculty of Agriculture, Kyushu University 61 (1), 141–145.

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