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Abul Faiz
Department of Zoology, Barama College, Barama, Assam, India

Corresponding Author:
Abul Faiz
Department of Zoology, Barama College, Barama, Assam, India

Leaf extracts as anti-feedant in management of *Riptortus linearis* in black gram

Abul Faiz

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Abstract
Black gram (*Vigna mungo* L.), a plant in the leguminosae family, is harmed by various insect pests, and farmers depend on chemical pesticides to control it, putting the sustainable food system at risk. So, this study aimed to discover the insecticidal properties of plant leaf extracts as part of a project to use locally available bio-resources as bio-pesticides. In an experiment from August to November of 2018, according to traditional knowledge, aqueous leaf extract of *Ipomea fistulosa*, *Annona reticulata*, and *Polygonum hydropiper* plants was prepared and tested for pesticide (anti-feeding) activity against an insect pest *Riptortus linearis*. Pests were observed after 48 hours of treatment for residual toxicity and repellency accordingly. The data from the field demonstrated that *Annona reticulata* had a 66.70% decline, *Ipomoea fistulosa* by 65.74% and *Polygonum hydropiper* was found to be 65.56% effective against *Aphis craccivora* after 48 hours of treatment. The data collected were analysed in Excel. 2010 and found the differences in the decrease as significant. All of the findings suggest that *Annona reticulate*, *Ipomea fistulosa* and *Polygonum hydropiper* have effective pest control over the selected pests. The utilisation of these bio-products could be advantageous for sustainable agriculture due to various benefits such as low toxicity, improved crop quality and reduced pesticide use.

Keywords: Black gram, chemical pesticide, leaf extract, sustainable pest management

Introduction
Black gram (*Vigna mungo* L.) is locally available and belongs to the family *leguminosae* and sub family *papilionaceae* (Verdcourt, B. 1970) [31]. India is the largest producer (25% of global production), consumer (27% of world consumption) and importer (14%) of pulses in the world (FAO, 2018) [16]. According to the estimate of the Agriculture Department of Assam, the production of pulses in Assam was around 80000 MT (Agri Vision 2025) which can meet a little over 20% requirement of the state. Production of black gram is reduced due to the damage caused by insect pest (Chhabra and Kooner, 1985; Chandra and Rajak, 2004; Lal and Sachan, 1987) [8, 7, 26]. It is important to manage the damage causing organisms for better production. Sustainable farmers and ranchers are known for their deep respect for the natural world. They use less fossil fuel, produce fewer greenhouse gases, and often depend on human labour rather than chemicals and energy-intensive technology. Sustainable farms encourage biodiversity, conserve scarce water resources, and build healthy soil through techniques like composting and planting cover crops. Management practices, or ignorance of them, play a crucial role in the amount and impact of the pollutants. Management techniques range from animal management and housing to the spread of pesticides and fertilizers in global agricultural practices, which can have major environmental impacts. Bad management practices include poorly managed animal feeding operations, overgrazing, ploughing, fertilizer, and improper, excessive, or badly timed use of pesticides. Chemical pesticides have negative effects on living beings (Das, 1986; Dubey, *et al*. 2011; Khater, 2011) [10, 14, 25]. Search for alternatives of chemical pesticide by developing biotic stress tolerant varieties or by using bio-pesticides (Botanical/plant origin pesticides, microbial, parasites and predators) in the form of BIPM is the need of the day (Prakash *et al*., 2016) [29]. BIPM (Bio-intensive Pest Management) is the recent trend in Indian farming which is more eco-friendly and more economical and attracting the farmers for higher income to their produce including one or more components of bio-pesticides (Prakash and Rao, 2016) [29] and very important for a sustainable environment. Some of the rural folks have developed the knowledge system of

utilization of the plant resources to manage the insect pests of their essential commodities and crops (Barman *et al*., 2014; Deka *et al*., 2006) [4, 5]. It will be an alternative to chemical pesticide and build farmers' knowledge and skills in making best use of local resources. The findings of the available literature indicate that there is a considerable lack of research on local knowledge of ecosystem services, particularly those that may not be immediately beneficial to farmers and land managers but are crucial to the long-term viability of agro-ecosystems. Works related to the insect pest management in black gram by insecticide of plant origin is not satisfactory comparing to the economic importance and demand of the crop. Efficacy of the leaf extract of the three plants namely *Annona reticulata*, *Ipomea fistulosa* and *Polygonum hydropiper* against the selected insect pest on black gram *viz*. *Riptortus linearis* was not undertaken in any previous field study but used against storage pests. So this study was an attempt to evaluate the efficacy of these three indigenous plant leaf extract in bio-intensive management of insect pests on black gram. It will be an eye opener to the policy makers and environmentalists integrating socio-economics in agronomic research. Social issues like rural development, ethics, and health and food quality are also associated with this study.

Materials and Methods

The location of our experimental site was in Assam (26.3303^0 N, 91.5148^0 E) in Kamrup (Rural) district and performed during August to November in 2018. Leaf extract was prepared according to Indian Traditional Knowledge System. It was sprayed on the field and the data were collected and analysed. At last the data were validated by statistical test-ANOVA. The application of plant leaf extracts was used to investigate the bio-intensive management of pest problems. *Annona reticulata* (Custard apple, sitaphal), *Ipomea fistulosa* (Naffatia, amarlota), and *Polygonum hydropiper* (Bihlongoni) were chosen for extract preparation. The plant *Annona reticulata*, Family-Annonaceae is a semi-deciduous tree growing up to 10 meters tall. *Ipomea fistulosa*, commonly known as "morning glory" or "besharm," is a plant of the Convulvulaceae family while *Polygonum hydropiper*, commonly known as "patharua bihlongoni," is a plant of the Polygonaceae family. With the help of relevant and standard literature, all of the plant species were recognised. The leaf extracts were tested for their efficiency to know the residual toxicity and repellency on *Riptortus linearis (Hemiptera: Coreidae)*. *Riptortus linearis* (pod-sucking pests) attack the black gram crop particularly in post flowering stages and can cause a decrease in yield. The nymphs and adults damage the pods by sucking, seeds become deformed which ultimately causes yield loss. *Riptortus pedestris* is reported by different authors from different parts of India but *Riptortus linearis* is also prevalent and reported from Assam (Faiz and Ahmed, 2020) [15]. Comparative efficacy of the extracts was also studied in terms of mortality or rate of reduction of the insect pests.

The evaluation of the efficacy of the leaf extract was conducted on a 400 square metre field. It was divided into six 66 square metre plots, each of which was subdivided into four 16.5 square metre blocks. The experimental design followed here was a random block design consisting of six replications and four treatments, one of which was the control. Fresh leaves (1 kg) from each of the three plants were picked and surface dried in sunshade. These were processed in mixture grinder to make powder and then it was soaked in 5 litres of water and left to decay at room temperature for 72 hours. Through muslin cloth this mixture was filtered and kept as stock solution (Centre for Indian Knowledge system, 2011) [6]. A sprayer was used to saturate the plots in each replication with crude extracts (20% concentration), ensuring consistent coverage of the region. After 35 days from seed sowing, the field spray was carried out in the 39th standard week of the year 2018.

Residual toxicity test: Hameed *et al*. (2013) [20] followed a method to determine the residual mortality of the insect pests and in this investigation his method was followed. Data were collected from 5 plants from each block by visual counting including the control in 24 hours before treatment and again 48 hours after treatment. The following formula was followed to determine the percentage residual mortality.

$$\text{Mortality \%} = \frac{(\text{population in control} - \text{population in treated plots}) \times 100\%}{\text{population in control}}$$

The experiment's findings were classified as "Good" which implies a statistically significant reduction in insect numbers, i.e. 75 percent mortality compared to untreated plots, "Fair" means 50-74 percent, and "Bad" means below 50 percent mortality compared to untreated plots.

Repellency test: The repulsion effect of the plant extracts was determined following the procedure of Ahad and his associates (2012). Data collection was done by following the same procedure. The repulsion in percentage was determined by the following formula.

Repulsion in percentage= $(N_c\text{-}50) \times 2$

Here N_c is the number of insects found in control plot in percentage. If the value of repulsion becomes positive then considered the extract having repellent action and in case of negative value then extracts were considered having attraction.

Statistical Analysis: All the data obtained were analyzed statistically to validate the result of the experiments. The mean reduction of the insect pests was calculated by following the method of Fowler *et al*. (1998) [17]. The mean values of all the observed data were calculated and analysis of variance was carried out by the F- test and the data obtained for residual mortality were analyzed in the software package developed in Excel. 2010 by Professor Dr. D. S. Dhakre, Department of EES, Visva- Bharati University to find out the significant differences in the reduction under the effect of different treatments to justify the findings.

Results

Residual toxicity on *Riptortus linearis*: The data available from the experiment showed that, in *A. reticulata*, the average percentage reduction of the bug was 66.70 percent, 65.74 percent in *I. fistulosa*, and 65.56 percent in *P. hydropiper*. The population of *Riptortus linearis* varied between 8 to 16/five plants 24 hours before the spray of extract, according to the available data and after treatment, all of the extracts showed a considerable decline in the number of insects. After 48 hours, treatments were found

efficient in lowering the pest number which was better than the control with no treatment. In different treatments, the mean decline in *Riptortus linearis* ranged from 50.00 to 77.78 percent. *Annona reticulata* caused the greatest population loss (66.70 percent), closely followed by *Ipomea fistulosa* (65.74 percent) and *P. hydropiper (*65.56%). All the extracts have a fair control of the target pest. After 48 hours, the effectiveness of these treatments was determined to be in the following order: T_2> T_3>T_4>T_1 (Table 1).

The findings were evaluated using ANOVA, and the F-value was determined to be significant enough to prove the efficiency of the extracts. It indicates that means of *Riptortus linearis* population reduction after 48 hours of treatment with each extract were significantly different from one another (Table 2).

Repellency of the extracts: The percentage of repulsion was calculated from the observed data for the insect pest and found to be positive. *Riptortus linearis* had the lowest, with a score of 88.34. Plant extracts with a positive rating exhibit strong repellency against the insect pest studied (Table 3).

Discussion

The mean percentage reduction of *Riptortus linearis* was found as 66.70% in *Annona reticulata*. The result of Rosaiah (2001) [30] who reported that the efficacy of *A. reticulata* against the aphid of bhendi was remarkable is reflected in our findings too, though the insect is different. Experimental result agree with Chitra *et al*. (1997) [9] who reported that ether extract of *A. reticulata* leaf extracts gave 88.81 to 90.06 percent reduction in aphid population in cotton plant. The mean percentage reduction of *Riptortus linearis* was found as 65.74% in *Ipomea fistulosa* and 65.56% in *Polygonum hydropiper*. The efficacy of the leaf extract of *P. hydropiper* in insecticidal activities was supported by several workers (Ayaz, M. *et al*., 2016) [3]. The result agree with the findings of Kalita and Bhola (2018) [22] when they investigated the anti-feedant effect of some plant extracts including *Polygonum hydropiper* on *Tribolium castaneum* (Herbst) and found the plant extracts effective. Our result is also in agreement with Kalita and Hazarika (2020) [23] from Jorhat Agriculture University, Assam who reported the efficacy of *Polygonum hydrpiper* for management of *Sitophilus oryzae* (L.) and *Callosobruchus chinensis* L. Mohapatra *et al*. (2021) [27] also reported the efficacy of *Polygonum hydropiper* against Aphid in cowpea up to 77.48% when they were studying the efficacy of some indigenous products against cowpea aphid. The findings of the present investigation is also in agreement with Karkar, Korat and Dabhi (2014) who reported that botanicals i.e. neem seed kernel extract @ 5%, neem oil @0.3%, leaf extracts of neem, jatropha, naffatia (*Ipomea fistulosa*), custard apple (*A. reticulata*) and arduso were found to be more or less equally effective against insect pests Aphid, leaf hopper and whitefly infesting brinjal but seed kernel extract was most effective. Degri *et al*. (2012) [11] from Nigeria tested the efficacy of balanites (*Balanites aegyptiaca* Del), *Momordica balsamina*; bitter leaf (*Vernonia amygdalina* L) and a standard synthetic insecticide cypermethrin 10% EC against *Maruca vitrata* F; *Clavigralla tomentosicollis* Stal; *Anoplonemis curvipes* L; *Riptortus dentipes* F; *Mirperus jaculus* L and *Nezara viridula* L.and reported the declining infestation of cowpea. Degri *et al*. (2013) [12] investigated the control of pod-sucking bug *Riptortus dentipes* of Cowpea with aqueous plant extracts of neem seed oil (NSO), bitter melon (*Momordica balsamina*) and garlic (*Allium* sp) in the Nigerian savanna zone. Neem seed oil and garlic extracts significantly reduced the population of *Riptortus dentipes* on cowpea pods than bitter melon during the two wet seasons. Haryanta *et al*. (2020) [21] investigated the repelence of Bintaro Plant Extract (*Cerbera manghas*) against pod-sucking insects (*Riptortus linearis*) and reported the effect on mortality and development of *Riptortus linearis.* Thus the findings of present investigation are in accordance with some of the previous findings of several workers. The bio-efficacy of the plant leaf extracts have been confirmed from the study and may be exploited these types of extracts as eco-friendly bio-intensive integrated pest management measure against the insect pests of black gram.

This study is demonstrating that black gram pests can be handled with leaf extracts from non-crop plant species endemic to the area. Even though the results appear to be adequate, some limitations were unavoidable. The method of leaf extract preparation was aimed towards farmers in rural areas who were less educated. Preparing an aqueous extract in cold water will be the most convenient way for them. However, not all leaf components may be water soluble. The experiments were done only in the field for a brief time of a year, because the crop in the study location is only cultivated during the Kharif season, which runs from July to August. The pest control trials were carried out with only one spray of the extract, with data collected after 48 hours of treatment. If more than one spray was used and more data was collected, the findings would have been more generalised.

Table 1: Residual mortality of *Riptortus linearis* on different treatments

Treatment	Replication	Before 24 hrs.	After 48 hrs	Reduction %
T_1 Controlled	1	16	14	--
	2	9	10	--
	3	12	9	--
	4	11	12	--
	5	10	7	--
	6	10	12	--
	Mean	11.33	10.67	--
T_2 *Annona reticulata*	1	13	5	61.54
	2	9	2	77.78
	3	11	4	63.64
	4	8	4	50.00
	5	9	2	77.78
	6	10	3	70.00
	Mean	10	3.33	66.70

T_3 *Ipomea fistulosa*	1	17	5	70.59
	2	10	5	50.00
	3	11	3	72.73
	4	15	5	66.67
	5	9	3	6667
	6	11	4	63.64
	Mean	12.17	4.17	65.74
T_4 *Polygonum hydropiper*	1	10	3	70.00
	2	11	4	63.64
	3	9	2	77.78
	4	8	4	50.00
	5	12	4	66.67
	6	8	3	62.5
	Mean	9.67	3.33	65.56

T_1: Treatment 1- Controlled T_2: Treatment 2- Extract of *Annona reticulata* T_3: Treatment 3- Extract of *Ipomea fistulosa*
T_4: Treatment 4- Extract of *Polygonum hydropiper* Hrs: Hours %: Percentage

Table 2: Randomized Block Design ANOVA test for efficacy of plant extract on *Riptortus linearis*

Efficacy of plant extract on *Riptortus linearis*								
No. of Replications				6				
No. of treatments				4				
Treatments	**Replication**						**Sum**	**Mean**
	1	**2**	**3**	**4**	**5**	**6**		
T_1	14	10	9	12	7	12	64.00	10.67
T_2	5	2	4	4	2	3	20.00	3.33
T_3	5	5	3	5	3	4	25.00	4.17
T_4	3	4	2	4	4	3	20.00	3.33
Result								
Source	**DF**	**SS**	**MS**	**F- value**	**p-value**			
Treatments	3	226.79	75.60	44.54	0.0000	** 1%		
Replications	5	21.38	4.28	2.52	0.0758	NS		
Error	15	25.46	1.70					
Total	23	273.63						
	Grand total		129.00	Root MSE	1.30			
	SE(m)		0.53	Grand Mean	5.38			
	SE(d)		0.75	Coefficient Variation	24.24%			
	Critical Difference		1.56	R Sqaure	0.91			

ANOVA: Analysis of Variance DF: Degrees of Freedom SS: Sum of Squares MS: Mean of Squares
SE(m): Standard Error of Mean SE(d): Standard Error of Deviation MSE: Mean Square of Error

Table 3: Repellency test

Name of the pest	**Mean No. of insects in control half**			**Repulsion in percentage (PR %)**	**Result of Repellency**
	Before 24 hours	**After 48 hours**	**Percentage of insects in the control half**		
Riptortus linearis	11.33	10.67	94.17	88.34	+

Conclusion

In this research work, bio-intensive management of insect pests was achieved using the services of botanical insecticides in the form of plant leaf extracts of locally available native plant species. The plant leaf extract if properly applied can be utilized for the management of the insect pests in Integrated Pest Management measures for more economical and eco-friendly approach. All the three plants extract *Annona reticulata*, *Ipomea fistulosa* and *Polygonum hydropiper* showed better efficacy in terms of residual mortality and repellency. Aqueous extracts of the plants reduced the population of these insect pests to an appreciable extent and can offer reasonable protection as anti-feedant to the black gram crop in the absence of superior alternatives.

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