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Plant Weeds *Parthenium hysterophorus* and *Ageratina adenophora* for Fall Armyworm Control

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ABSTRACT

The locally available plant weeds *Parthenium hysterophorus* and *Ageratina adenophora* were used for the sustainable agricultural practices of insect control; for polyphagus cash crop pest *Spodoptera frugiperda* (Family: Noctuidae) in laboratory conditions. In present investigation Antifeedant, Larvicidal and deformed growth at different concentrations of methanolic crude plant extracts were studied. The LC50 value for methanolic extract of *P. hysterophorus* and *A. adenophora* for 72 hours of exposure against fifth instar larvae were 5.92% & 7.82% and LC90 values were 8.14% & 8.96% respectively. Antifeedant activity of *P. hysterophorus* was more than *A. adenophora* against Fall Armyworm. Both plants extract exposure showed deformities in larval, pupal and adult stage of the Fall Armyworm. *P. hysterophorus* and *A. adenophora* both have potential Antifeedant, Larvicidal and growth inhibiting activity against *Spodoptera frugiperda*.

KEYWORDS

Parthenium hysterophorus, Ageratina adenophora, Spodoptera frugiperda, Morphological deformities.

INTRODUCTION

The present scenario of global warming gives rise to the climate change; which resulted in life cycle disruption of many beneficial as well as pest insects to boost this problem some insects changed their life according to climate changes. Earlier the fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae), was a destructive pest of corn and a rice only. These two strains were identified for their control management a corn-associated strain feeds primarily on corn, and a rice-associated strain which feeds primarily on forage grasses and rice; present days this worm turns towards cotton to attain basic needs of life. The determination of which strain feeds on cotton has not been fully characterized until now (Dejane et al., 2012). This polyphagous insect is commonly distributed in the tropical and subtropical regions of world (Andrews, 1988), made damage to cash crop, cotton during harvesting time. The chemical control methods usually employed to control this insect has favored the selection of populations resistant to many organo-phoshate and pyrethroid insecticides (Yu, 2006; Yu and McCord, 2007; Virla et al., 2008) which resulted in search for new pesticide molecules for *S. frugiperda*.

Now a day researchers turned toward the botanicals as the chemical pesticides resulted in evoluation of the pesticide resistance in several pests. More than 2000 species of plants are known to possess some insecticidal activity. Due to these reasons number of researches are orienting towards the evaluation of toxicity of secondary metabolite of plants; like phenols, alkaloids, glucosinolates, cyanogenic glycosides and saponins (Tagliari et al., 2004). Various studies of different plant species extract are performed on different insect pests still their applications are not known to the farmers (Ulrichs et al., 2008).

In the present study an attempt has been made to discover the new plant derived toxicants for the Fall armyworm which generally causes damage to the plant during harvesting or at full mature stage of the cotton plant in late Fall and autumn. As this pest outbreak is seen on the mature plants; farmers could not use chemical pesticides in the farms as it get absorbed on the cotton threads and such cotton has less market value to prevent this contamination of cotton products there is an urgent need to use botanicals, as these are non toxic to other organisms.

MATERIALS AND METHODS

Locally available weed plants *Parthenium hysterophorus* and *Ageratina adenophora* belonging to family *Asteraceae* were used for the present investigation. Plants were collected, washed under tap water, dried, grinded in mixie and subjected to the Soxhlet apparatus for extraction using methanol as a solvent. *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae), eggs were collected from agricultural field and sterilized with 0.02% sodium hypochloride solution, dried and allowed to hatch; after hatching feed on fresh cotton leaves in a lab condition at room temperature (27 ± 2°C) with 14-10 hours light: dark photoperiod and 75 ± 5% relative humidity; fifth instar larvae were used for the further toxicity studies.

Antifeedant activity:

Antifeedant bioassay was carried out using leaf disc no choice method. The crude extracts were dissolved in methanol and fresh cotton leaf discs of 4-cm diameter were punched using cork borer and dipped in 2, 4, 6, 8 and 10% concentrations. The leaf discs treated with methanol were used as control. In each petridish (1.5cm x 9cm) wet filter paper was placed below leaf to avoid early drying of the leaf and single fifth instar larva was introduced on each leaf. Progressive consumption of leaf area by the larva after 24 hours was recorded in control and treated discs using the leaf area meter. Leaf area eaten by the larva in plant extract treatment was corrected from the control and the percentage antifeedant activity was calculated according the formula given by Baskar et al., (2011).

$$\text{Antifeedant activity} = \frac{\text{Leaf area consumed in control} - \text{Leaf area consumed in treatment}}{\text{Leaf area consumed in control}} \times 100$$

Larvicidal activity:

Different concentrations of crude extracts were used by leaf dip method and exposed to the larvae. After 24 hours of treatment, the larvae were continuously maintained on the non-treated fresh cotton leaves and mortality was recorded after 72 hours of treatment. Five replicates (12 larvae per replicate) were maintained in laboratory and Per cent mortality was calculated (Abbott, 1925).

$$\text{Abbott's corrected mortality} = \frac{\%\text{mortality in treatment} - \%\text{mortality in control}}{100 - \%\ \text{Mortality in control}}$$

LC_{50} and LC_{90} were determined according to Probit analysis method of Finney (1971).

Morphological Deformities:

Larvae feed on cotton leaf dip in different concentration of crude extract and separate after 24 hours of exposure and maintained on fresh cotton leaves in separate petridish and deformities in the larval, pupal and adult stage were observed morphologically under dissecting and compound microscope.

Statistical analysis: The results of Antifeedant activity presented with ± SD; LC_{50} and LC_{90} values were calculated using probit analysis (Finney, 1971) and Chi square test.

RESULTS AND DISCUSSION:

Atifeedant activity of *P. hysterophorus* and *A. adenophora* leaf extract to Fall armyworm after 24 hours of exposure showed no significant difference; Highest concentration show high antifeedant percentage (Table 1).

These results were similar to Baskar et al., (2011) where they studied antifeedant activity of different plant extracts against *Spodoptera litura* in laboratory condition. The results obtained were also in accordance with Vasakorn et al., (2012) where

Table 1: Antifeedant activity of *Parthenium hysterophorus* and *Ageratina adenophora* against *Spodoptera frugiperda*.

Sr. No.	Concentration %	*Parthenium hysterophorus*	*Ageratina adenophora*
1	2%	12.11% ± 0.25	7.14% ± 0.53
2	4%	19.47 % ± 0.34	14.29% ± 0.46
3	6%	34.18% ± 0.27	26.15% ± 0.21
4	8%	50.74% ± 0.61	42.39% ± 0.43
5	10%	69.92% ± 0.47	63.47% ± 0.71

(n=12 replicates; ± SD and P ≤ 0.05)

Table 2: LC_{50} and LC_{90} values of *Parthenium hysterophorus* and *Ageratina adenophora* against *Spodoptera frugiperda* for 72 hours.

Sr. No.	Extracts	LC_{50}	95% confidence limit		LC_{90}	95% confidence limit	
			Lower	Upper		Lower	Upper
1	*Parthenium hysterophorus*	5.92	4.12	7.42	8.14	7.13	10.14
2	*Ageratina adenophora*	7.82	5.69	9.18	8.96	8.09	12.98

Table 3: Deformities observed in different concentration of *Parthenium hysterophorus* and *Ageratina adenophora* crude extracts against *Spodoptera frugiperda.*

Sr. No.	Concentration %	*Parthenium hysterophorus*			*Ageratina adenophora*		
		Larva	Pupa	Adult	Larva	Pupa	Adult
1	2%	N	N	Af	N	N	N
2	4%	La	Pd	Af	N	Pd	Af
3	6%	La, Lb	Pd, Pe	Af, Ag	La, Lb	Pd, Pe	Af
4	8%	La, Lb, Lc	Pd, Pe, Dead	Ag, Dead	Lb, Lc,	Pe	Af, Ag, Dead
5	10%	Dead	Dead	Dead	Lc	Pe, Dead	Dead

Note: N- Normal; La- Larva with abdominal distension; Lb- Larva with point of necrosis in integument; Lc- Larva with incomplete molting; Pd- Pupa with globular evagination in integument; Pe- Pupa failed to sclerotize; Af- Adult emerged with rolled wings; Ag- Adult failed emerge from pupa.

Antifeedant activity of *Jatropha gossypifolia* and *Melia azedarach* senescent leaf extracts on third instar larvae of *Spodoptera frugiperda* was observed in laboratory. Similarly Defag´o et al., (2006) recorded antifeedant activity of different plant parts of *Melia azedarach* on *Xanthogaleruca luteola*. Similarly Pavela (2010) and Zapata et al., (2009) shown the deterrent effect reduces the consumption of food using botanicals.

LC_{50} and LC_{90} values calculated for both plant weed plant extracts against Fall armyworm were least for *P. hysterophorus* as compared to *A. adenophora* (Table 2).

Methanolic extracts derived from copaiba leaves and fruit peels were toxic to second instar of *S. frugiperda* showed increased mortality (Dejane 2012); Similarly, the extract from senescent *Melia azedarach* leaves was much more effective in controlling *A. aegypti* than the

extract of fruits (Coria et al., 2008). Similarly Increase values of LC_{90} were observed by, Breuer et al., (2003) up to 2500 mg/L azadirachtin, 2500 mg/L Pongamia oil with 0.026% endosulfan induced100% mortality of *Diacrisia oblique.*

After exposure to different concentrations of methanolic plant extracts the morphological deformities in Fall armyworm larva, pupa and adult stages (Table 3).

Larval deformities like larva with abdominal distension; Larva with point of necrosis in integument; Larva with incomplete molting. Pupal deformities like, Pupa with globular evagination in integument; Pupa failed to sclerotize; and adult deformities like adult emergence with rolled wings and failed to emerge from pupa were observed till death or adult emergence. Similar deformities were observed earlier by Marianna et al., (2012) with the effect of Saponins Extracted from *Passiflora alata* Dryander (Passifloraceae) on development of the *Spodoptera frugiperda*. Results are in accordance with the study of Pavela (2010) and Zapata et al., (2009) where they shown the deterrent effect which reduces the consumption of food producing nutritive deficiency causing deficient growth or deformities, which may lead to death or inhibit the progress for the next stage.

Conclusion: The weed plants *Parthenium hysterophorus* and *Ageratina adenophora* both have potential Antifeedant, Larvicidal and growth inhibiting activity against *Spodoptera frugiperda* (Fall Armyworm); a serious polyphagus pest.

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