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Antifeedant and Growth Inhibitory Effects of Medicinal Plant Extracts against Tobacco Caterpillar, *Spodopteralitura* Fab.

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Abstract—*The intensive and indiscriminate use of pesticides in agriculture has caused many problems to the environment such as water, soil, animal, food contamination and elimination of non-target organisms. The plant extracts not only act as insecticides but also function as antifeedants, oviposition deterrents and ovicides. Keeping in view the imperative demand of safer plant protects and aiming to minimize the negative effects of pesticides, present study is undertaken to study the impact of aqueous medicinal plant extracts on growth and development parameters of 7 days old larvae of Spodopteralitura. Among the twelve plants tested, Cinnamoumcamphora and Withaniasomnifera showed strong antifeedant activity with C-value of 0.41 and 0.42 respectively. High feeding deterrent property was exhibited by C. camphora with feeding inhibition of 59.18 followed by W. somnifera 57.89% and a low level of deterrent activity was exhibited by E. cardamomum (4.53%) followed by B. orellana (7.23%). The significant impact was observed on pupal deformity with all the plant extracts. Maximum pupal deformity was observed with W. somnifera 10.37 and 10.73% followed by A. paniculata, 8.09 & 8.33% at 25 & 50 % concentration respectively. All the plant extracts at 50% concentration significantly reduced the growth index, the values for the different plant species were; P. zeylanica (2.01), A. paniculata (2.06), B. monnieri (2.44), W. somnifera (2.51), R. serpentina (3.15) and C. camphora (3.35) in comparison to control (3.80). The extracts of W. somnifera and B. orellanapossess insecticidal and juvenomimetic properties against S. litura, as total growth and development were reduced, resulting in deformed individuals which will ultimately affect the future generation of the test insect.*

1. INTRODUCTION

Tobacco caterllar, *Spodopteralitura* Fab. (Lepidoptera: Noctuidae), is a serious polyphagous pest distributed throughout the tropical and subtropical parts of the world including India, Japan, China and South East Asia causing damage to more than 150 species of host plants [5,8].This is an important pest and considered as one of the major threats to the present day intensive agriculture under changing cropping pattern. It also challenges majority of conventional control strategies. However, their indiscriminate use resulted in several problems such as resistance to pesticides, resurgence of pests, elimination of natural enemies, toxic residues in food, water, air and soil which affect human health and disrupt the ecosystem, leading to the threat of further harm to the environment. Problems associated with widespread pesticide usage have been pronounced from several decades. Under such alarming situations, plants and plant derived products offered a tremendous advantage over synthetic pesticides in use as control agents andthere is imperative need for the development of safer, alternative crop protectants such as botanical insecticides and antifeedants. The deleterious effects of crude plant extracts on insects are manifested in several ways, including toxicity [3], feeding inhibition [16].In recent years, attempts are being made to identify plants, including herbs and weeds, for their insecticidal property with a view to find out suitable alternatives to replace hazardous synthetic pesticides utilized in large scale in India. Great emphasis is given on the use of natural products, which are non-toxic, safe and biodegradable alternative to the conventional control of insects by synthetic pesticides [11-12]. Keeping in view the imperative demand of safer plant protects and aiming to minimize the negative effects of pesticides, present study is undertaken to study the impact of aqueous medicinal plant extracts on biological parameters of 7 days old larvae of *Spodopteralitura*.

2. MATERIALS AND METHODS

2.1 Collection of plants and preparation of plant extracts

A total of twelve plants belonging to diverse families and genera were collected from Medicinal Plant Research and Development Center (MRDC), Pantnagar. The plants were selected based on available literature, abundant availability,

medicinal and insecticidal properties. List of plants collected and utilized for present study are detailed in Table 1. The aqueous plant extracts was prepared by grinding the fresh plant sample under running tap water. The weighed fresh plant samples were crushed and brought in form of a fine paste in an electric grinder and extracted in fresh water. It was passed through layers of Whatman filter paper to obtain clear extract of 25& 50%.

Table 1: Details of the medicinal plant species used in the experiments

S. No	Scientific name	Common Name	Family	Plant part used	Location	Medicinal Value
1	Bacopamonieri	Brahmi	Scrophulraceae	Whole Plant	MRDC, Pantnagar	Mental Disorder, Cooling agent Leprosy
2	Plumbagozeylanica	Chitrak	Plumbagiaceae	Leaves & Twigs	MRDC, Pantnagar	Leprosy, Skin disease, Piles
3	Andrographispaniculata	Kalmegh	Acanthaceae	Leaves & Twigs	MRDC, Pantnagar	Antipyretic, Skin disease, Fever Bronchitis, Jaundice
4	Rauvolfiaserpentina	Sarpgandha	Apocynaceae	Leaves	MRDC, Pantnagar	Skin troubles
5	Withaniasomnifera	Ashwgandha	Solanaceae	Leaves	MRDC, Pantnagar	Health tonic
6	Aloe barbadensis	Aloe vera	Lilliaceae	Stem	MRDC, Pantnagar	Skin diseases ,jaundice, joint pain
7	Bixaorellana	Sinduri	Bixaceae	Leaves	MRDC, Pantnagar	Antipyretic
8	Mucunapruriens	Kaunch	Fabaceae	Leaves	MRDC, Pantnagar	Health tonic,Uretic disorder
9	Eletteriacardamomum.	Elaichigrass	Zingiberaceae	Whole Plant	MRDC, Pantnagar	Stomach problems
10	Cryptolepisbuchananii	Dudhibael	Asclepiadaceae	Leaves	MRDC, Pantnagar	Rickets in children
11	Cinnamomumcamphora	Camphor	Lauraceae	Leaves & Twigs	MRDC, Pantnagar	Fever, measles, whooping cough
12	Centellaasiatica	Mandokparni	Apiaceae	Whole Plant	MRDC, Pantnagar	Memory enhancer, jaundice, leprosy

- MRDC, (Medicinal Plant Research and Development Centre)

The common name in the respective plant species have been written in consultation with the book [9]

2.2 Establishing testInsect culture

Nucleus culture of the test insect *S. litura* was collected from the fields were collected from light source located near the Crop Research Centre of the University and reared under laboratory conditions in the glass jars (dia. 10 cm, ht. 12 cm) at 28±10^{0}C and 80±5% relative humidity. The criterion of selection of plant species, having bioactive compound was based on literature and experience. The plant species used for experimentation were collected from Medicinal Plant Research and Development Center (MRDC), Pantnagar and details of the species used are given in the Table 1.

2.3 Antifeedant Bioassay

Antifeedant activity of twelve medicinal plant extracts at 50% conc. was evaluated against the 7 d old larvae of *S. litura* under laboratory conditions following 'No choice' feeding bioassay technique [14-15].Control consisted of *Ricinuscommunis* leaf discs. The treated leaf discs (6x6cm2) were kept in the centre of presterilized corning glass petri dishes (dia.meter 9cm) containing an inner lining of moist filter paper. All the treatments were replicated three times. Control consisted of *Ricinuscommunis* leaf disc treated with distilled water. Prestarved (3h) and freshly moulted larvae (n=5) of same age were released in each petridish and were allowed to feed until more than 75% of the leaf disc area was

eaten away in control. The observations on leaf area consumed was recorded on graph paper sheets and used for calculations of other parameters viz., Mean leaf area consumed (MLAC, cm2), Feeding percentage (%), Antifeedant activity, Feeding inhibition (%), Preference index (C-value) by following standard methods [6,13].

Category C-value: 1. Extremelyantifeedant plant; extracts 0.1-0.25; 2. Strongly antifeedant plant extracts 0.26-0.50; 3. Moderately antifeedant plant extracts 0.51-0.75; 4. Slightly antifeedant plant extracts 0.76.

After preliminary screening, the plant extracts which showed the highest antifeedant activity were chosen for further investigations on growth and development at 25 & 50% conc. The larvae were fed *ad libitum* with treated leaves continuously for two days thereafter and with fresh untreated leaves until pupation. The observations were recorded on the following parameters- weight gain/larva, larval period (d), mortality (%), pupal period (d), pupal weight (g), pupation (%),adult emergence (%), growth Index (GI) (Pant and Dang, 1969), Howe's growth index (HI) [4].

3. RESULTS AND DISCUSSIONS

3.1 Antifeedant Activity

The No-choice bioassay was conducted with twelve aqueous medicinal plants extracts at 50% conc. against 7 days old larvae of *spodopteralitura*. Leaf area consumption on treated leaf surface was significantly lower (P<0.05) with all the extracts as compared to control leaf surface (MLAC = 29.21 cm2) except C. asiatia (29.45cm2), in which feeding was non-significantly higher than control. The extract of *C. camphora* (74.35%) showed highly significant antifeedant properties, followed by *W. somnifera* (73.33%) and *A. paniculata* (55.18%). While *C. asiatica* showed slight stimulant effect with -0.83% antifeedant activity.(Table 2).The extracts of *C. camphora* and*W. somnifera* proved to be strong antifeedant with C- value of 0.41 and 0.42 respectively (i.e. in between 0.26-0.50). The extracts of *A. paniculata* (0.62), *B. monnieri* (0.68), *P. zeylanica* (0.72) and *A. barbadensis* (0.74) were categorized as under moderately antifeedant; and *M. pruriens* (0.77) *R. serpentina* (0.89), *C. buchananii* (0.90), *B. orellana* (0.93) and *E. cardamomum*(0.96) as slightly antifeedant.[2] suggestedthat *W. somnifera* acts as an insect growth regulator causing disruption of the endocrine mechanism regulating molting and metamorphosis.

Table 2: Antifeedant activity of twelve aqueous medicinal plant extracts (50% concentration) against 7 d old larvae of S. litura(Fab.)

S. No	Scientific name	Common Name	MLAC (cm2)	Mean Feeding (%)	Feeding Inhibition (%)	Antifeedant Activity (%)	Preference Index (C-Value)
1	Bacopamonnieri	Brahmi	15.02	41.72	32.08	48.58	0.68
2	Plumbagozeylanica	Chitrak	16.49	45.81	27.83	43.54	0.72
3	Andrographispaniculata	Kalmegh	13.09	36.36	38.11	55.18	0.62
4	Rauvolfiaserpentina	Sarpgandha	23.39	64.97	11.07	19.93	0.89
5	Withaniasomnifera	Ashwgandha	7.79	21.64	57.89	73.33	0.42
6	Aloe barbadensis	Aloe vera	17.27	47.97	25.69	40.88	0.74
7	Bixaorellana	Sinduri	25.27	70.19	7.23	13.5	0.93
8	Mucunapruriens	Kaunch	18.15	50.42	23.35	37.86	0.77
9	Eletteriacardamomum	Elaichigrass	26.68	74.11	4.53	8.66	0.96
10	Cryptolepisbuchananii	Dudhibael	24.09	66.92	9.61	17.53	0.9
11	Cinnamomumcamphora	Camphor	7.49	20.81	59.18	74.35	0.41
12	Centellaasiatica	Mandokparni	29.45	81.81	-0.41	-0.83	1
	Control	-	29.21	81.14	-	-	1
	SEm±	-	1.37	-	-	-	-
	CD at 1%		5.36				
	CD at 5%		3.97				
	F-value		S				

3.2 Grọwth and Development Parameter

The aqueous extracts of all the medicinal plant species at 25% concentration had no significant impact on the larval weight gain (were at par with the control), however, *R. serpentina* at both 25&50% concentrations could significantly (p= 0.05) reduce the larval weight gain in *S. litura*. The larval weight gain at 2 DAF at 25 & 50 % conc. with *R. serpentina* extracts were showed significant reduction (10.47 mg and 7.40 mg respectively) in comparison to control (21.17 mg). However, all the extracts had non-significant impact on larval weight gain at 4 DAF and were at par with control (549.40mg/larva)(Table 3). The extract of *R. serpentina* was found to be the most toxic among all the plant species by causing terminal larval mortality of 6.67 and 20.00 % at 25 & 50 % concentration respectively followed by *A. paniculata* where terminal larval mortality was 10.00 and 16.67 % at 25 & 50 % concentration respectively.However per cent pupation was slightly reduced with all the medicinal plant extracts.Pupal deformity was present in all the plant extracts. Maximum pupal deformity 10.37 and 10.73% was observed with *W. somnifera* followed by 8.09 & 8.33% *A. paniculata*, at 25 & 50 % concentration respectively(Table 3). In case of pupal weight none of the plant extracts caused greater reduction. However Adult emergence per cent was significantly reduced by all the plant extracts at both concentrations.

All the plant extracts at 50% concentration significantly reduced the growth index, the values for the different plant

species were: *P. zeylanica*(2.01), *A. paniculata*(2.06),*B. monnieri*(2.44), *W. somnifera*(2.51), *R. serpentina*(3.15) and *C. camphora*(3.35) in comparison to control (3.80) (Table 4).The fresh leaves of *Madhucaindica* and *B. orellana* proved strongly antifeedant and detrimental to the growth and development of tobacco caterpillar, *S. litura*[1]. [12]evaluated at 10% conc *C. camphora*. (hexane, diethyl ether, and acetone) was found to be extremely antifeedant against the larvae of both insects (*S.litura* and *S.obliqua*) while *C.zeylanicum* (hexane, diethyl ether, and acetone) and *P.roxbughii* (diethyl ether, and acetone), *B.orellana* (Acetone) showed extremely antifeedant activity only against the larvae of *S.litura*.This investigation showed promising results with these medicinal plant extracts against the feeding and management of insect pest of agricultural importance.

Table 3: Effect of aqueous medicinal plant extracts on growth parameters of 7 d old larvae of *S. litura* (Fab.)

S. No	Scientificname	Common Name	Conc.	Wt Gain 2 DAF mg/larva	Wt Gain 4 DAF mg/larva	Larval Mortlaity 4 DAF	Termainal Larval Mortlaity (%)	Pupation (%)	Pupal Deformity (%)
1	Bacopamonieri	Brahmi	25	20.6	553.57	0	6.67	93.33	8.33
			50	20.17	492.03	0	3.33	93.33	3.7
2	Plumbagozeylanica	Chitrak	25	17.23	551.67	0	3.33	96.67	3.7
			50	17.47	526.2	6.67	10	90	7.5
3	Rauvolfiaserpentina	Sarpgandha	25	10.47	505.17	3.33	6.67	93.33	7.04
			50	7.4	486.13	3.33	20	90	7.5
4	Andrographis	Kalmegh	25	13.5	556.67	0	10	96.67	10.37
			50	20.03	517.27	3.33	16.67	80	10.37
5	Withaniasomnifera	Ashwgandha	25	17.17	498.6	6.67	3.33	83.33	8.09
			50	25.3	476.03	6.67	13.33	83.33	8.33
6	Cinnamomumcamphora	Camphor	25	21.97	509.63	0	3.33	96.67	10.37
			50	16.5	439	6.67	10	90	10.73
	Control	-	-	21.17	549.4	0	0	100	0
	SEm±		25	3.03	27.7	1.78	3.56	5.77	4.03
			50	3.1	47.78	4.71	3.78	7.13	5.17
	CD at 1%		25	12.76	116.59	7.5	15	24.3	16.97
			50	13.03	201.1	19.84	15.91	29.99	21.75
	CD at 5%		25	9.19	84.02	5.4	10.81	17.51	12.23
			50	9.39	144.92	14.3	11.46	21.62	15.68
	F- value		25	NS	NS	NS	NS	NS	NS
			50	S	NS	NS	S	NS	NS

Table 4: Effect of aqueous medicinal plant extracts on development parameters of 7 d old larvae of *S. litura* (Fab.)

S. No	Scientific name	Common Name	Conc.	Larval period (Days)	Pupal period (Days)	PupalWt (mg)	Adult Emergence (%)	Adult Deformity (%)	Growth Index	Howe's Growth Index
1	Bacopamonieri	Brahmi	25	14.62	10.36	304.97	76.67	4.76	3.09	1.1
			50	14.73	9.85	320.67	60.37	13.1	2.44	0.88
2	Plumbagozeylanica	Chitrak	25	14.8	9.46	299.58	63.43	4.76	2.63	0.95
			50	14.92	11.58	380.67	53.22	5.56	2.01	0.67
3	Rauvolfiaserpentina	Sarpgandha	25	14.52	10.08	363.02	82.23	8.93	3.34	1.21
			50	14.43	10.33	366	77.59	14.49	3.13	1.14
5	Andrographispaniculata	Kalmegh	25	14.42	10.4	338.26	82.96	3.7	3.35	1.2
			50	14.9	10.95	308	52.59	9.53	2.06	0.56
4	Withaniasomnifera	Ashwgandha	25	15.1	10.37	383.78	83.33	7.4	3.27	1.16
			50	15.39	10.58	350.33	65.28	6.67	2.51	0.91
6	Cinnamomumcamphora	Camphor	25	15.61	10.67	313.3	83.33	4.76	3.17	1.15
			50	15.15	10.41	253.33	80.38	17.03	3.15	1.14
	Control	-	-	15.13	10.34	343	96.67	0	3.8	1.33
	SEm±	-	25	0.4	0.29	21.62	7.83	4.73	0.33	0.11
			50	0.38	0.46	40.03	8.34	6.02	0.33	0.19

	CD at 1%		25	1.67	1.2	91	32.96	19.91	1.4	0.46
			50	1.59	1.95	168.45	35.12	25.34	1.39	0.79
	CD at 5%		25	1.12	0.87	65.58	23.75	14.35	1.01	0.33
			50	1.42	1.4	121.4	25.31	18.26	1	0.57
	F-value		25	NS	NS	NS	NS	NS	NS	NS
			50	NS	NS	NS	S	NS	S	NS

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