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LABORATORY EVALUATION OF SOME PLANT EXTRACTS AGAINST *SPODOPTERA LITURA* [FABRICIOUS]*

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ABSTRACT

Bio–efficacy of aqueous extracts from *Acacia arabica*, *Annona squamosa, Datura stramonium*, *Eucalyptus globulus, Ipomoea carnea*, *Lantana camara*, *Nicotiana tabacum* and *Pongamia pinnata* was tested against a polyphagous pest *Spodoptera litura* (Fab.) larvae. Larval mortality increased with time and concentration. After a period of six days of treatment, maximum mean larval mortality was exhibited by *Datura stramonium* leaf extract (69.44 %) followed by *Annona* (66.77 %), *Acacia* (64.88 %) and *Ipomoea* (57.33 %) leaf extracts. Mean larval mortality of 50.20 % was recorded with lowest concentration i.e. 25 % which increased to 76.76 % with 100 % concentration. Sequence of efficacy of different extracts given in this paper will help using the most ideal extract depending upon larval stage and its population.

Key words: *Spodoptera litura*, aqueous extracts, efficacy

Extensive and irrational use of synthetic chemical insecticides leads to several hazardous consequences. Hence, emphasis is now being given to environmentally safer alternative methods of insect management. Higher plants are a rich source of novel natural substances that can be used to develop environmentally safe methods for insect control (Jacobson, 1989). Use of bio–pesticides, especially of plant origin, could be the key for insect management in future. Thousands of plant species with insecticidal properties have been reported (Bowers, 1992; Jacobson, 1989; Raheja, 1998; Singh, 2000) which can compete with the synthetic insecticides for their efficacy against insect pests. Among soybean insect–pests, *Spodoptera litura* has assumed great significance in recent past in major soybean growing states viz. Madhya Pradesh, Maharashtra and Rajasthan. Being a polyphagous insect–pest, it has developed resistance against several commonly used synthetic insecticides (Ramakrishnan *et al*., 1984; Murugesan and Dhingra, 1995). Potential of natural products as insect growth regulators and chemosterilants has been demonstrated by several workers (Rembold, 1989; Banerjee *et al.*, 1995, 2001). But for practical utility of the plant extracts only a few studies have been undertaken against insect–pests of soybean, particularly *Spodoptera litura* (Behera and Satpathy, 1996). This study was, therefore, undertaken to exploit the potential of insecticidal properties of some plant species for the management of *Spodoptera litura*.

MATERIAL AND METHODS

Eight popular and commonly available plant species (Table 1) were used to assess their bio–efficacy. The leaves / seeds were washed thoroughly in tap water then through distilled water thrice to remove any surface contaminants. The leaves were then chopped and immersed in distilled water for over night. Next day they were crushed in mixer–grinder with distilled water. After crushing, the material was filtered through Whatman No. 42 filter paper. 100 gm of leaves and seeds were taken along with 500 ml of distilled water and the filtrate obtained was used as the stock solution and was diluted to obtain different concentrations viz. 25 %, 50 %, 75 % and 100%.

The initial population of *S. litura* larvae was collected from the Research Farm of Directorate of Soybean Research (ICAR), Indore. These larvae were reared on soybean leaves till pupation, in entomological chamber (Make–Spectrum, Mumbai) maintained at 75 $\pm$ 5 % RH and 26 $\pm$ 1 ^{0} C temperatures in the laboratory. The healthy pupae were used for the next generation in the laboratory.

To test the bio–efficacy of plant extracts, ten pre–starved (for 3 hr) 3rd instar *S. litura* larvae were released in Petri–plates (Borosil; 6 inch diameter) having fresh soybean leaves. Different concentrations of extracts were sprayed on the leaves as well as on the larvae with the help of hand sprayer. Three replications were maintained for each concentration along with control. Observations on larval mortality were recorded every 24 hours up to 6 days of treatment. The rationale of taking observations up to 6 days was to assess the efficacy of plant extracts in a similar way as done with chemical insecticides. The percentage of larval mortality was transformed to arcsine values before statistical analysis. All the data collected was then subjected to analysis of variance (ANOVA) using

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MSTAT–C programme and the critical differences were calculated to see the differences between the means.

RESULTS AND DISCUSSION

Data presented in Table 1 showed that larval mortality increased with time and concentrations with all the extracts. After a period of six days, highest mean larval mortality was observed due to extracts from leaves of *Datura stramonium* (69.44 %) which was followed by leaf extracts of *Annona* (66.77 %), *Acacia* (64.88 %), *Ipomoea* (57.33 %) and *Eucalyptus* (54.33 %). Likewise with respect to concentrations, highest mean larval mortality of 76.76 % was recorded with 100 % concentration which was superior with that obtained in cases of 25, 50 and 75 % concentrations.

The interaction of aqueous extracts and concentrations on larval mortality at different post treatment periods is given in Table 2.

Table 1. Effect of plant extracts and concentrations on mortality of *Spodoptera litura* larvae

	1 Day	2 Days	3 Days	4 Days	5 Days	6 Days	MEAN
Plant Extracts							
A. arabica	40.66 (36.54)	54.66 (46.92)	66.00 (54.83)	69.33 (57.83)	78.66 (70.23)	80.00 (72.00)	64.88 (56.39)
A. quamosa	42.67 (37.67)	54.00 (44.60)	71.33 (61.92)	72.66 (63.69)	80.00 (72.50)	80.00 (72.00)	66.77 (58.73)
D. stramonium	55.33 (48.34)	63.33 (55.13)	68.00 (58.92)	72.66 (63.69)	78.66 (70.23)	78.66 (70.23)	69.44 (61.09)
E. globulus	34.00 (31.53)	45.33 (40.33)	51.33 (44.92)	54.66 (47.90)	69.33 (60.69)	71.33 (61.92)	54.33 (47.88)
I. carnea	28.00 (26.86)	48.66 (43.23)	58.66 (49.37)	62.00 (52.37)	72.66 (63.69)	74.00 (65.46)	57.33 (50.16)
L. camara	31.33 (28.87)	39.33 (34.67)	49.33 (42.69)	53.33 (45.15)	66.00 (57.69)	69.33 (60.69)	51.44 (44.96)
N. tabacum	39.33 (36.74)	51.33 (44.02)	59.33 (45.05)	59.33 (49.82)	60.66 (51.59)	64.66 (55.92)	39.33 (47.19)
P. pinnata	4.00 (4.43)	10.66 (10.43)	20.66 (19.43)	31.33 (28.87)	50.00 (42.15)	58.00 (49.92)	29.11 (25.87)
A. arabica (Seed)	8.00 (8.86)	18.00 (17.86)	26.66 (25.09)	40.66 (33.99)	59.33 (49.82)	64.00 (55.57)	36.11 (31.87)
A. squamosa (Seed)	36.00 (32.76)	39.33 (35.76)	40.66 (36.54)	48.66 (42.34)	48.66 (42.34)	56.00 (48.59)	44.88 (39.72)
D. stramonium (Seed)	12.66 (12.64)	25.33 (24.30)	36.00 (32.76)	42.00 (37.33)	64.00 (54.59)	66.66 (57.15)	41.11 (36.46)
SEm +	(4.24)	(4.30)	(4.74)	(4.71)	(3.92)	(3.58)	–
CD at 5%	(11.89)	(12.05)	(13.29)	(13.20)	(10.99)	(10.03)	–
CD at 1%	(15.74)	(15.94)	(17.58)	(15.13)	(14.55)	(13.28)	–
Concentration (%)							
0	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
25	23.06 (22.98)	33.63 (32.08)	47.26 (42.56)	51.81 (46.20)	71.20 (62.84)	74.23 (65.12)	50.20 (45.30)
50	23.02 (22.98)	51.20 (44.95)	59.69 (51.43)	67.26 (57.09)	80.60 (70.32)	86.05 (74.53)	61.30 (53.55)
75	40.60 (36.75)	56.05 (48.35)	66.96 (58.10)	73.93 (63.21)	87.57 (75.44)	90.60 (79.47)	69.28 (60.22)
100	51.81 (45.71)	63.63 (55.17)	75.14 (62.21)	82.72 (71.19)	91.51 (80.02)	95.75 (85.17)	76.76 (66.58)
SEm ±	(2.86)	(2.90)	(3.19)	(3.17)	(2.64)	(2.41)	–
CD (P=0.05)	(8.02)	(8.12)	(8.96)	(8.90)	(7.41)	(6.76)	–

Table 2. Effect of aqueous extracts and concentrations at different period of exposure

Treatments	After 1 day						After 2 days					
	0 %	25 %	50 %	75 %	100 %	Mean	0 %	25 %	50 %	75 %	100 %	Mean
A. arabica	0.00 (0.00)	36.66 (37.14)	46.66 (43.29)	50.00 (45.00)	70.00 (57.29)	40.66 (36.54)	0.00 (0.00)	66.66 (60.00)	66.66 (60.00)	70.00 (57.29)	70.00 (57.29)	54.66 (46.92)
A. quamosa	0.00 (0.00)	43.33 (41.07)	50.00 (45.00)	60.00 (51.15)	60.00 (51.15)	42.67 (37.67)	0.00 (0.00)	60.00 (51.15)	70.00 (57.29)	70.00 (57.29)	70.00 (57.29)	54.00 (44.60)
D. stramonium	0.00 (0.00)	36.66 (37.14)	76.66 (66.15)	76.66 (66.15)	86.66 (72.29)	55.33 (48.34)	0.00 (0.00)	43.33 (41.07)	86.66 (72.29)	86.66 (72.29)	100.00 (90.00)	63.33 (55.13)
E. globulus	0.00 (0.00)	26.66 (26.07)	43.33 (41.07)	46.66 (43.29)	53.33 (47.22)	34.00 (31.53)	0.00 (0.00)	30.00 (33.21)	60.00 (51.15)	66.66 (60.00)	70.00 (57.29)	45.33 (40.33)
I. carnea	0.00 (0.00)	26.66 (26.07)	26.66 (26.07)	26.66 (26.07)	60.00 (56.07)	28.00 (26.86)	0.00 (0.00)	33.33 (30.00)	60.00 (51.15)	66.66 (60.00)	83.33 (75.00)	48.66 (43.23)
L. camara	0.00 (0.00)	16.66 (15.00)	36.66 (37.14)	50.00 (45.00)	53.33 (47.22)	31.33 (28.87)	0.00 (0.00)	26.66 (26.07)	50.00 (45.00)	60.00 (51.15)	60.00 (51.15)	39.33 (34.67)
N. tabacum	0.00 (0.00)	30.00 (33.21)	53.33 (47.22)	53.33 (47.22)	60.00 (56.07)	39.33 (36.74)	0.00 (0.00)	30.00 (33.21)	70.00 (57.29)	70.00 (57.29)	86.66 (72.29)	51.33 (44.02)
P. pinnata	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	10.00 (11.07)	10.00 (11.07)	4.00 (4.43)	0.00 (0.00)	0.00 (0.00)	16.66 (15.00)	16.66 (15.00)	20.00 (22.14)	10.66 (10.43)
A. arabica (Seed)	0.00 (0.00)	0.00 (0.00)	10.00 (11.07)	10.00 (11.07)	20.00 (21.14)	8.00 (8.86)	0.00 (0.00)	16.66 (15.00)	20.00 (22.14)	20.00 (22.14)	33.33 (30.00)	18.00 (17.86)
A. squamosa (Seed)	0.00 (0.00)	26.66 (26.07)	36.66 (37.14)	46.66 (43.29)	70.00 (57.29)	36.00 (32.76)	0.00 (0.00)	36.66 (37.14)	36.66 (37.14)	53.33 (47.22)	70.00 (57.29)	39.33 (35.76)
D. stramonium (Seed)	0.00 (0.00)	10.00 (11.07)	10.00 (11.07)	16.66 (15.00)	26.66 (26.07)	12.66 (12.64)	0.00 (0.00)	26.66 (26.07)	26.66 (26.07)	36.66 (32.22)	36.66 (37.14)	25.33 (24.30)
Mean	0.00 (0.00)	23.06 (22.98)	23.02 (22.98)	40.60 (36.75)	51.81 (45.71)	30.18 (27.75)	0.00 (0.00)	33.63 (32.08)	51.20 (44.95)	56.05 (48.35)	63.63 (55.17)	40.90 (36.11)
Significance level:				**SEm ±**	**P=0.05**					**SEm ±**	**P=0.05**	
Concentrations				(2.86)	(8.02)					(2.89)	(8.12)	
Plant Extracts				(4.24)	(11.89)					(4.29)	(12.05)	
Concentrations × Plant Extracts				(9.48)	(26.59)					(9.60)	(26.94)	

Table 2. Continued...

Treatments	After 3 day						After 4 days					
	0 %	25 %	50 %	75 %	100 %	Mean	0 %	25 %	50 %	75 %	100 %	Mean
A. arabica	0.00 (0.00)	76.66 (66.15)	80.00 (63.44)	86.66 (72.29)	86.66 (72.29)	66.00 (54.83)	0.00 (0.00)	86.66 (72.29)	86.66 (72.29)	86.66 (72.29)	86.66 (72.29)	69.33 (57.83)
A. quamosa	0.00 (0.00)	83.33 (75.00)	86.66 (72.29)	93.33 (81.15)	93.33 (81.15)	71.33 (61.92)	0.00 (0.00)	83.33 (75.00)	86.66 (72.29)	93.33 (81.15)	100.00 (90.00)	72.66 (63.69)
D. stramonium	0.00 (0.00)	60.00 (51.15)	86.66 (72.29)	93.33 (81.15)	100.00 (90.00)	68.00 (58.92)	0.00 (0.00)	76.66 (66.15)	93.33 (81.15)	93.33 (81.15)	100.00 (90.00)	72.66 (63.69)
E. globulus	0.00 (0.00)	43.33 (41.07)	66.66 (60.00)	70.00 (57.29)	76.66 (66.15)	51.33 (44.92)	0.00 (0.00)	43.33 (41.07)	76.66 (66.15)	76.66 (66.15)	76.66 (66.15)	54.66 (47.90)
I. carnea	0.00 (0.00)	53.33 (42.29)	70.00 (57.29)	83.33 (75.00)	86.66 (72.29)	58.66 (49.37)	0.00 (0.00)	53.33 (42.29)	70.00 (57.29)	86.66 (72.29)	100.00 (90.00)	62.00 (52.37)
L. camara	0.00 (0.00)	50.00 (45.00)	60.00 (51.15)	60.00 (51.15)	76.66 (66.15)	49.33 (42.69)	0.00) (0.00)	50.00 (45.00)	60.00 (51.15)	76.66 (66.15)	80.00 (63.44)	53.33 (45.15)
N. tabacum	0.00 (0.00)	53.33 (47.22)	76.66 (66.15)	80.00 (63.44)	86.66 (48.44)	59.33 (45.05)	0.00 (0.00)	53.33 (47.22)	76.66 (66.15)	80.00 (63.44)	86.66 (72.29)	59.33 (49.82)
P. pinnata	0.00 (0.00)	16.66 (15.00)	16.66 (15.00)	26.66 (26.07)	43.33 (41.07)	20.66 (19.43)	0.00 (0.00)	16.66 (15.00)	26.66 (26.07)	36.66 (37.14)	76.66 (66.15)	31.33 (28.87)
A. arabica (Seed)	0.00 (0.00)	20.00 (22.14)	33.33 (30.00)	36.66 (37.14)	43.33 (36.15)	26.66 (25.09)	0.00 (0.00)	36.66 (37.14)	50.00 (37.14)	53.33 (42.29)	63.33 (53.36)	40.66 (33.99)
A. squamosa (Seed)	0.00 (0.00)	36.66 (37.14)	43.33 (41.07)	53.33 (47.22)	70.00 (57.29)	40.66 (36.54)	0.00 (0.00)	43.33 (41.07)	53.33 (47.22)	70.00 (57.29)	76.66 (66.15)	48.66 (42.34)
D. stramonium (Seed)	0.00 (0.00)	26.66 (26.07)	36.66 (37.14)	53.33 (47.21)	63.33 (53.36)	36.00 (32.76)	0.00 (0.00)	26.66 (26.07)	60.00 (51.15)	60.00 (56.07)	63.33 (53.36)	42.00 (37.33)
Mean	0.00 (0.00)	47.26 (42.56)	59.69 (51.43)	66.96 (58.10)	75.14 (62.21)	49.81 (42.86)	0.00 (0.00)	51.81 (46.20)	67.26 (57.09)	73.93 (63.21)	82.72 (71.19)	56.72 (47.54)
Significance level:				**SEm ±**	**P=0.05**					**SEm ±**	**P=0.05**	
Concentrations				(3.19)	(8.96)					(3.17)	(8.90)	
Plant Extracts				(4.74)	(13.29)					(4.70)	(13.20)	
Concentrations × Plant Extracts				(10.59)	(29.17)					(10.52)	(29.51)	

Table 2. Continued

Treatments	After 5 day						After 6 days					
	0 %	25 %	50 %	75 %	100 %	Mean	0 %	25 %	50 %	75 %	100 %	Mean
A. arabica	0.00 (0.00)	93.33 (81.15)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	78.66 (70.23)	0.00 (0.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	80.00 (72.00)
A. quamosa	0.00 (0.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	80.00 (72.50)	0.00 (0.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	80.00 (72.00)
D. stramonium	0.00 (0.00)	93.33 (81.15)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	78.66 (70.23)	0.00 (0.00)	93.33 (81.15)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	78.66 (70.23)
E. globulus	0.00 (0.00)	76.66 (66.15)	83.33 (75.00)	93.33 (81.15)	93.33 (81.15)	69.33 (60.69)	0.00 (0.00)	83.33 (75.00)	86.66 (72.29)	93.33 (81.15)	93.33 (81.15)	71.33 (61.92)
I. carnea	0.00 (0.00)	76.66 (66.15)	86.66 (72.29)	100.00 (90.00)	100.00 (90.00)	72.66 (63.69)	0.00 (0.00)	76.66 (66.15)	93.33 (81.15)	100.00 (90.00)	100.00 (90.00)	74.00 (65.46)
L. camara	0.00 (0.00)	76.66 (66.15)	76.66 (66.15)	76.66 (66.15)	100.00 (90.00)	66.00 (57.69)	0.00 (0.00)	76.66 (66.15)	83.33 (75.00)	86.66 (72.29)	100.00 (90.00)	69.33 (60.69)
N. tabacum	0.00 (0.00)	53.33 (47.22)	76.66 (66.15)	86.66 (72.29)	86.66 (72.29)	60.66 (51.59)	0.00 (0.00)	60.00 (51.15)	86.66 (72.29)	83.33 (75.00)	93.33 (81.15)	64.66 (55.92)
P. pinnata	0.00 (0.00)	33.33 (30.00)	70.00 (57.29)	70.00 (57.29)	76.66 (66.15)	50.00 (42.15)	0.00 (0.00)	33.33 (30.00)	76.66 (66.15)	86.66 (72.29)	93.33 (81.15)	58.00 (49.92)
A. arabica (Seed)	0.00 (0.00)	60.00 (51.15)	63.33 (53.36)	86.66 (72.29)	86.66 (72.29)	59.33 (49.82)	0.00 (0.00)	63.33 (53.36)	70.00 (62.22)	86.66 (72.29)	100.00 (90.00)	64.00 (55.57)
A. squamosa (Seed)	0.00 (0.00)	43.33 (41.07)	53.33 (47.22)	70.00 (57.29)	76.66 (66.15)	48.66 (42.34)	0.00 (0.00)	53.33 (47.22)	70.00 (57.29)	76.66 (66.15)	80.00 (72.29)	56.00 (48.59)
D. stramonium (Seed)	0.00 (0.00)	76.66 (71.07)	76.66 (66.15)	80.0 (63.44)	86.66 (72.29)	64.00 (54.59)	0.00 (0.00)	76.66 (66.15)	80.00 (63.44)	83.33 (75.00)	93.33 (81.15)	66.66 (57.15)
Mean	0.00 (0.00)	71.20 (62.84)	80.60 (70.32)	87.57 (75.44)	91.51 (80.02)	66.17 (57.73)	0.00 (0.00)	74.23 (65.12)	86.05 (74.53)	90.60 (79.47)	95.75 (85.17)	69.33 (60.86)
Significance level:				**SEm ±**	**P=0.05**					**SEm ±**	**P=0.05**	
Concentrations				(2.64)	(7.41)					(2.41)	(6.76)	
Plant Extracts				(3.91)	(10.99)					(3.58)	(10.03)	
Concentrations × Plant Extracts				(8.76)	(24.58)					(8.00)	(22.43)	

On the very first day after treatment, leaf extract of *Datura* recorded the highest mean larval mortality of 55.33 % which was significantly more than the mortality recorded with *Eucalyptus* (34.00 %), *Ipomoea* (28.00 %), *Lantana* (31.33 %), *Pongamia* (4.00 %), *Acacia* seed (8.00 %), *Annona* seed (36.00 %) and *Datura* seed (12.66 %), but was *on par* with that observed in cases of leaf extracts of *Acacia* (40.66 %), *Annona* (42.67 %) and *Nicotiana* (39.33 %). According to Baskaran and Narayanasamy (1995) *Datura stramonium* leaves possess insecticidal properties and show contact nature of action against insects. The insecticidal properties could be attributed to high content of Hyoscyamine found in the leaves of *Datura* (Elisabetta *et al*, 2001). With lowest concentration i.e. 25 %, best results were given by leaf extract of *Annona* showing 43.33 % larval mortality, which was significantly more than that exhibited by other treatments viz. *Pongamia*, *Acacia* (seed) and *Datura* (seed), and was *on par* with larval mortality caused by other extracts even at higher concentrations, except that caused by *Datura* leaf extract i.e. 86.66 % mortality with 100 % concentration. The differences in chemical constituents in leaves and seeds of *Acacia, Datura* and *Annona* could possibly explain the reasons for differential response of extracts.

The larval mortality increased with increase in concentration and the differences among the treatments reduced with passage of time. On 3rd day after treatment, leaf extract of *Annona* exhibited 83.33 % larval mortality which was *on par* with that recorded with leaf extracts of *Acacia* and *Datura*. Likewise, by 6th day after treatment even 25 % concentration of *Acacia* and *Annona* leaf extracts exhibited 100 % larval mortality which was significantly superior as compared to larval mortality recorded with many of the treatments at higher concentrations. Sharma and Bhadauria (2009) reported 10 % and 15 % mortality in *Helicoverpa armigera* larvae exposed to 1000 ppm and 2000 ppm of water extract of *Datura*. The insecticidal properties of *Annona squamosa* have been exploited mostly against storage insect pests viz., *Sitophilus oryzae* (Rout, 1986), *Callosobruchus chinensis* (Islam, 1987), *Corcyra cephalonica* (Chauhan *et al*, 1987) etc. However, among a very few relevant studies, more than 60 % mortality in *Spodoptera litura* larvae with 5 % concentration of *Annona squamosa* seed extract was reported by Babu *et al*, (1998), while reduction in weight and length of *S.litura* larvae was reported by Boreddy and Chitra, (2001). Kotkar *et al* (2002) isolated certain flavonoids from *Annona* which consists of insecticidal as well as antimicrobial activity.

Although Behera and Satpathy (1996) reported 50 % mortality in *S. litura* larvae feeding on castor leaves dipped in aqueous extract of *P. pinnata*, but in present study *P. pinnata* leaf extract gave higher mortality of 76.66 % with 100 % concentration in 4 days only, which increased to 93.33 % in 6 days.

Extract of *Ipomoea carnea* leaves at 1, 2 and 3 % concentrations was reported to be effective by Arivudainambi and Nachiappan (1993) against castor semilooper, *Achaea janata* Linn. Murugan *et al*. (1998) found antifeedant and toxic properties in ethanol extract of *Nicotiana tabacum* and *Datura metel* leaves to the tune of 98 % and 74 % respectively against *S. litura* larvae. *Eucalyptus* extract was found to be the best treatment against thrips, *Scritothrips dorsalis* in groundnut by (Senguttuvan (1999) resulting in 29 % reduction in its population.

The symptomatological observations revealed that although there were no marked treatment differences, but the dead larvae had abnormal pattern of colour on the integument with prominent black spots. Some thoracic segments or in some cases even entire body was swollen dorsally. Expulsion of gut contents due to complete disintegration of integument was also noticed.

The results of this study clearly revealed that leaf extract of *Annona squamosa* was consistently effective at lowest concentration i.e. 25 % on all days of exposure except on 2nd day. Similarly, leaf extract of *Datura stramonium* was also found to be consistently effective at 50 % and above concentration. These findings have tremendous practical value, as these extracts can be applied for effective and early management of *Spodoptera* larvae.

On the basis of sequence given in Table 3, it is again evident that in general extracts of *Annona* leaf, *Acacia* leaf and *Datura* leaf have performed better than other extracts at all the concentrations. These extracts have shown promise in inflicting larval mortality within 24 hrs of exposure and hence have tremendous practical value for the management of *Spodoptera litura* larvae as well as other lepidopteran larvae.

Table 3. Order of Efficacy of Ethanol Extracts

Day	Conc. (%)	Order of efficacy of Aqueous extracts
1	25	*Annona* > *Acaia* = *Datura* > *Nicotiana* > *Eucaluptus* =*Ipomoea* = *Annona* seed > *Lantana* > *Datura* seed > *Pongamia* = *Acacia* seed
	50	*Datura* > *Nicotiana* >*Annona* > *Acacia* > *Eucalyptus* > *Lantana* = *Annona* seed > *Ipomoea* > *Acacia* seed = *Datura* seed > *Pongamia*
	75	*Datura* > *Annona* > *Nicotiana* > *Acacia* = *Lantana* > *Eucalyptus* = *Annona* seed > *Ipomoea* > *Datura* seed > *Pongamia* = *Acacia* seed
	100	*Datura* > *Acacia* = *Annona* seed > *Annona* = *Ipomoea* = *Nicotiana* > *Eucalyptus* = *Lanatana* > *Datura* seed > *Acacia* seed > *Pongamia*
2	25	*Acacia* > *Annona* > *Datura* > *Annona* seed > *Ipomoea* > *Eucalyptus* = *Nicotiana* > *Lntana* = *Datura* seed > *Acacia* seed > *Pongamia*
	50	*Datura* > *Annona* = *Nicotiana* > *Acacia* > *Eucalyptus* = *Ipomoea* > *Lantana* > *Annona* seed > *Datura* seed > *Acacia* seed > *Pongamia*
	75	*Datura* > *Acacia* = *Annona* = *Nicotiana* > *Eucalyptus* = *Ipomoea* > *Lantana* > *Annona* seed > *Datura* seed > *Acacia* seed > *Pongamia*
	100	*Datura* > *Nicotiana* > *Ipomoea* > *Acacia* = *Annona* = *Eucalyptus* = *Annona* seed > *Lantana* > *Datura* seed > *Acaica* seed > *Pongamia*
3	25	*Annona* > *Acacia* > *Datura* > *Ipomoea* = *Nicotiana* > *Lantana* > *Eucalyptus* > *Annona* seed > *Datura* seed > *Acacia* seed > *Pongamia*
	50	*Annona* = *Datura* > *Acacia* > *Nicotiana* > *Ipomoea* > *Eucalyptus* > *Lantana* > *Annona* seed > *Datura* seed > *Acacia* seed > *Pongamia*
	75	*Annona* = *Datura* > *Acacia* > *Ipomoea* > *Nicotiana* > *Eucalyptus* > *Lantana* > *Annona* seed = *Datura* seed > *Acacia* seed > *Pongamia*
	100	*Datura* > *Annona* > *Acacia* = *Ipomoea* = *Nicotiana* > *Eucalyptus* = *Lantana* > *Annona* seed > *Datura* seed > *Pongamia* = *Acacia* seed
4	25	*Acacia* > *Annona* > *Datura* > *Ipomoea* = *Nicotiana* > *Lantana* > *Eucalyptus* = *Annona* seed > *Acacia* seed > *Datura* seed > *Pongamia*
	50	*Datura* > *Acacia* > *Annona* > *Eucalyptus* = *Nicotiana* > *Ipomoea* > *Lantana* = *Datura* seed > *Annona* seed > *Acacia* seed > *Pongamia*
	75	*Annona* = *Datura* > *Acacia* = *Ipomoea* > *Nicotiana* > *Eucalyptus* = *Lantana* > *Annona* seed > *Datura* seed > *Acacia* seed > *Pongamia*
	100	*Annona* = *Datura* = *Ipomoea* > *Acacia* = *Nicotiana* > *Lantana* > *Eucalyptus* = *Pongamia* = *Annona* seed > *Acacia* seed = *Datura* seed
5	25	*Annona* > *Acacia* = *Datura* > *Eucalyptus* = *Ipomoea* = *Lantana* = *Datura* seed > *Acacia* seed > *Nicotiana* > *Annona* seed > *Pongamia*
	50	*Acacia* = *Annona* = *Datura* > *Ipomoea* > *Eucalyptus* > *Lantana* = *Nicotiana* = *Datura* seed > *Pongamia* > *Acacia* seed > *Annona* seed
	75	*Acacia* = *Annona* = *Datura* = *Ipomoea* > *Eucalyptus* > *Nicotiana* = *Acacia* seed > *Datura* seed > *Lantana* > *Pongamia* = *Annona* seed
	100	*Acacia* = *Annona* = *Datura* = *Ipomoea* = *Lantana* > *Eucalyptus* > *Nicotiana* = *Acacia* seed = *Datura* seed > *Pongamia* = *Annona* seed
6	25	*Acacia* = *Annona* > *Datura* > *Eucalyptus* > *Ipomoea* = *Lantana* = *Datura* seed > *Acacia* seed > *Nicotiana* > *Annona* seed > *Pongamia*
	50	*Acacia* = *Annona* = *Datura* > *Ipomoea* > *Eucalyptus* = *Nicotiana* > *Lantana* > *Datura* seed > *Pongamia* > *Acacia* seed = *Annona* seed
	75	*Acacia* = *Annona* = *Datura* = *Ipomoea* > *Eucalyptus* > *Lantana* = *Pongamia* = *Acacia* seed > *Nicotiana* = *Datura* seed > *Annona* seed
	100	*Acacia* = *Annona* = *Datura* = *Ipomoea* = *Lantana* = *Acacia* seed > *Eucalyptus* = *Nicotiana* = *Pongamia* = *Datura* seed > *Annona* seed

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