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Original Research Article

Activity of Different Botanicals on Biological Parameters against *Spodoptera litura* (Lepidoptera: Noctuidae) in Soybean

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A B S T R A C T

Efficacy of crude aqueous extracts of three plant species and three plant oils against *Spodoptera litura* second instar larvae at 2 and 5 % concentrations under controlled laboratory conditions. Leaf extracts of *Datura stramonium* and among plant oils Eucalyptus oil, Neem oil were found most promising. Eucalyptus oil was the most effective botanical causing Least larval growth index in all larval instars, Pupal growth index (0.44), Adult index (0.52), Oviposition index (2) and total growth index (2.55). While, major biological parameters like weight reduction was seen highly reduced in treatment with Eucalyptus oil in 3rd, 4th, 5th, 6th larval instar (51, 98.80, 260.33, 350) and pupa (207). The Eucalyptus oil also inflicted reduced development period with reduction in each stage during development with 2.94, 2.80, 4.60, 1, 4.5 and 6 days for 3rd, 4th, 5th, 6th instar, pupa and adult stage. However, Eucalyptus oil was observed to be the most promising botanical while in plant extracts Datura extract (*Datura stramonium*) was the next best botanical next to eucalyptus oil.

Keywords

Botanicals, Larval growth index, Growth index, *Spodoptera litura*, Eucalyptus, *Datura stramonium*

Introduction

Soybean (*Glycine max* L. Merril) is the world's most important legume, which contributes to 25 % of edible oil worldwide and also nearly two-thirds of the world's protein concentrate for livestock feeding. Due to high protein content (>40%) and high oil content (>20%), soybean is considered to be an important food commodity (Mehto, 2016; Thombre *et al.*, 2017). There is a gradual reduction in the soybean yield because of various biotic interferences in crop growth in the field, such as interference by different pests and diseases. The pests on soybean attack the leaves, pods and stems. *Spodoptera litura* (F.) (Lepidoptera: Noctuidae) is a polyphagous pest, widely distributed throughout the Asia. It has a wide range of hosts of which 40 species are known in India (Krishnaveni *et al.*, 2013; Singh *et al.*,1998 and Paulraj, 2001; Lakshman *et al.*, 2017). *S. litura* is an economically important pest that has developed insecticide resistance in India (Chandrayudu *et al.*, 2017). It led to sporadic outbreaks of the pest and failure of the crops (Ahmad *et al.*, 2006). It has also developed manifold resistance against conventionally

used insecticides. The excessive usage of chemical insecticides has resulted in serious problems like development of resistance. The growing awareness of the hazards of excessive use of pesticides globally has led researchers to search for safer and more environment-friendly alternative methods for insect pest control. Over the last three to four decades greater attention has been focused on the bioactivity of phytochemicals for their potential as pesticides against phytophagous insect parts (Sahayaraj, 2011; Anbalagan *et al.,* 2014 and Manju *et al.,* 2016). On the other hand several plant species have been reported to possess insecticidal properties (Singh *et al.,* 2001; Anna Senrung *et al.,* 2014). They are also responsible for affecting the food consumption and utilization by insects (Rajguru *et al.,* 2010), also their oviposition is affected (Raja *et al.,* 2003; Jeysankar *et al.,* 2013).Therefore, the present study was carried out to screen selected botanicals for their ovicidal and repellent activities against *S. litura* in soybean.

Materials and Methods

Insect culture

Laboratory culture of tobacco caterpillar, *Spodoptera litura* maintained on soybean leaves (cv. JS 95-60) following Rajguru *et al.,*(2010) at 27±2^{o}C, 70±5% RH and natural photoperiod conditions was used for the experiment.

Preparation of plant extracts

Six botanicals were used out of which three were plant oils while the remaining three were leaf extracts (Table 1). The leaf extracts was prepared by collecting 500g of fresh leaves and soaked them in 100ml water overnight followed by macerating them using a blender and filter the extract with Whatman filter paper and preparing the solutions based on the concentrations required. The plant oils were mixed with sticker (Teepol) before they were used. The different treatments and their concentrations used for the experiment are tabulated below:

Effect of plant extracts on *S. litura* development

The second instar larvae were used for the experimental study and soybean plants were raised in the pots outside the lab in open conditions. The trifoliate leaves were collected and they were treated with the plant extract solutions by leaf dip method and the leaves were kept aside to let them dry. Then, the treated leaves were placed in the petridishes as well as 10 second instar larvae were released in each treatment in a petridish and the petridishes number were replicated according to the statistical design followed. The petridishes were kept inside the BOD Chamber where the temperature was maintained but, the humidity was maintained by placing glass troughs at the bottom shelf of the BOD Chamber. The first observation was taken 24hrs after treatment (1DAT) after that the treated leaves were changed with untreated leaves, the soybean leaf petioles were wrapped with wet cotton swab in order to keep the leaves fresh for 24hrs, the rest of the experiment only untreated leaves were used to study the effect of these plant extracts on the biological parameters of the test insect. The observations were taken as 3DAT, 5DAT, 7DAT till the end of the life cycle of Spodoptera. The parameters like weights of larvae, lengths of larvae, number of larvae that reached the next instar, duration of every instar of the larvae, the number of larvae that reached pupation, the weights of pupae, lengths of pupae, percentage of pupation, sex ratio, duration of pupal stage, the number of adults emerged, adults longevity and fecundity were recorded and compared with control plot. Further during adult stage the

pre oviposition, oviposition and post oviposition periods are evaluated under the adult longevity. Growth index and percent survivability of the test insect under each treatment and compared to control plot in order to conclude the effect of the plant extracts on the development (Arivoli, 2013). Larval growth index, pupal growth index, survival index and total growth index will also be evaluated. All this methodology was followed based on the methodology followed by Rajguru *et al.*, 2010.

Larval growth index

$$= \frac{\text{Weight of larva which fed on treated leaves}}{\text{Weight of larva which fed on untreated leaves}}$$

Pupal growth index

$$= \frac{Weight\ of\ pupa\ in\ treatment}{Weight\ of\ pupa\ in\ control}$$

Total growth index

$$= \frac{percent\ pupation}{larval\ period}$$

Percent survivability

$$= \frac{number\ of\ adults\ completing\ development\ in\ treatment}{number\ of\ adults\ completing\ development\ in\ control} \times 100$$

Adult index

$$= \frac{average\ adult\ longevity\ in\ treatment}{average\ adult\ longevity\ in\ control}$$

Oviposition index

$$= \frac{number\ of\ eggs\ laid\ by\ adults\ that\ emerged\ from\ treated\ leaves}{number\ of\ eggs\ laid\ by\ adults\ that\ emerged\ from\ untreated\ leaves}$$

Percent pupation

$$= \frac{number\ of\ healthy\ pupae\ formed}{number\ of\ larvae\ taken\ initially} \times 100$$

Percent adult emergence

$$= \frac{number\ of\ healthy\ adults\ emerged}{number\ of\ healthy\ pupae\ formed} \times 100$$

The data wherever percentages are calculated, it will be transformed using arcs in transformation

Results and Discussion

The weights of different stages of *Spodoptera litura*(F.) were recorded in milligrams and calculated by following square root transformation of data and analysis was done Completely Randomized Design. As, per the Table 2., the resulted data implied that maximum reduction in weight in second instar larva was observed marigold leaf extract treatment (39.52) and similarly the weight of larvae in Datura leaf extract (39.90) was also found at par with marigold leaf extract while, the least reduction in weight was found to be seen in Eucalyptus oil treatments (45.98) and also in control (51.06). The resulted data implied that maximum reduction in weight in third instar larva was observed Eucalyptus oil treatment (51.0) followed by datura leaf extract (89.62) while, the least reduction in weight was found to be seen in datura leaf extract (99.20) and also in control (114.20). The resulted data could be concluded that maximum reduction in weight in fourth instar larva was observed Eucalyptus oil treatment (98.80) followed by neem oil (114.60) while, the least reduction in weight was found to be seen in annona leaf extract (193.20) and also in control(210.40). The resulted data could be concluded that maximum reduction in weight in fifth instar larva was observed Eucalyptus oil treatment (260.33) followed by neem oil (310.20) while, the least reduction in weight was found to be seen in annona leaf extract (426.80) and also in control (495.20). The resulted data could be concluded that maximum reduction in weight in sixth instar larva was observed Eucalyptus oil treatment (350.0) followed by datura leaf extract (403.75) while, the least reduction in weight was found to be seen in annona leaf extract (639.20) and also in control (674). The computed data showed that maximum reduction in weight in pre-pupa was observed Eucalyptus oil treatment (114.0) followed by

marigold leaf extract (256.68) while, the least reduction in weight was found to be seen in neem oil (409.80) and also in control(387.80). The resulted data could be concluded that maximum reduction in weight in pupa was observed Eucalyptus oil treatment (207.0) followed by neem oil (316.33) while, the least reduction in weight was found to be seen in marigold leaf extract (339.20) and also in control (436.0).

The durations of different stages of *Spodoptera litura* (F.) in days, percent pupation, percent adult emergence and percent survival were calculated. As, per the Table 3., the larval duration in second instar showed no much significant difference among all the treatments. The larval duration of third instar larva was reduced maximum in Eucalyptus oil (2.94) followed by neem oil (3.48), while it was only 4.82 days in control. The larval duration of fourth instar larva was reduced maximum in Eucalyptus oil (2.80) followed by neem oil (3.42), while it was only 4.26 days in control. The larval duration of fifth instar larva was reduced maximum in Eucalyptus oil (4.60) followed by pongamia oil (5.0), while it was only 8.10 days in control. The larval duration of sixth instar larva was reduced maximum in Eucalyptus oil (1.0) while neem oil and datura (1.0) while it was only 1.40 days in control. In pre-pupal period, there was no significant difference among all the treatments.

The pupal period was found least in eucalyptus oil (4.50) followed by neem oil (5.0) while it was only 7.60 days in control. In adult longevity, the minimum number of days was recorded in eucalyptus oil (6.0), followed by neem oil (8.0) which was at par with control (11.40). The minimum number of days in female was recorded in neem oil (6.66), followed by datura (7.33) while it was 9.60 in control. The percent pupation was least in eucalyptus oil (40%) which was at par with neem oil (41.33%), meanwhile it was (94.80%) in control. The percent adult emergence was least in eucalyptus oil (75.38%), followed by neem oil (78.10%), while (94.17%) in control. The percent survival was least in eucalyptus oil (33.22%), followed by neem oil (35.33%), meanwhile (97.83%%) in control. The number of adults emerged were least in eucalyptus (2.50 males and 1.00 females) followed by neem (1.66 males and 2.50 females) and highest in control (4.80 males and 4.20 females).

The adult longevity of female the pre-oviposition period had no significant difference among treatments. The oviposition period was least in eucalyptus oil (3.00), followed by neem oil (3.33) meanwhile its only 3.60 days in control. The least post oviposition period was recorded in neem oil (2.33) followed by datura (3.00) while it was 5 days in control. The fecundity recorded as number of eggs showed that though there was significant reduction in fecundity in all treatments minimum fecundity was found in eucalyptus (163.50) followed by neem (176.00) while maximum fecundity was found in control (756.60). The percent fertility of female moths was evaluated and found least in eucalyptus as 20.10%, followed by neem oil 23.34% while highest was recorded as 96.91% in control.

The growth indices were calculated it is nothing but the rate of growth of treated test insect over the control and the results obtained delved that the larval growth index in second instar showed no significant difference among all the treatments while, the least larval growth index in all larval instars in eucalyptus oil (0.45 in 3^{rd} instar, 0.47 in 4^{th} instar, 0.58 in 5^{th} instar, 0.51 in 6^{th} instar and 0.61 in pre-pupa). The pupal growth index recorded show that the least index was found in eucalyptus oil (0.44), followed by pongamia oil (0.77).

Table.1 Treatment details of botanicals used in the experiment

T_1	Datura leaf extract(*Datura stramonium*)	5%(v/v)* (Kulkarni *et al*. , 2014)
T_2	Annona leaf extract (*Annona squamosa)*	5% (v/v) (Babu *et al*., 1998)
T_3	Marigold leaf extract *(Tagetus erecta)*	5% (v/v) (Kulkarni *et al*., 2014)
T_4	Neem oil *(Azardirachta indica)*	5% (v/v) (Sueli *et al*., 2001)
T_5	Pongamia oil (*Pongamia pinnata)*	5% (v/v) (Babu *et al*., 1998)
T_6	Eucalyptus oil *(Eucalyptus glabrous)*	2% (v/v) (Baskaran *et al*., 2012)
T_7	Control	---

Table.2 Effect of different botanicals on the weight (mg) of *Spodoptera litura* (F.)

Treatment detail	LARVA						PUPA
	2^{ND} INSTAR	3^{RD} INSTAR	4^{TH} INSTAR	5^{TH} INSTAR	6^{TH} INSTAR	PRE-PUPA	
T_1 (*Datura stramonium*)	39.90 (6.31)	89.62 (9.42)	148.00 (12.56)	345.20 (18.55)	403.75 (15.30)	386.33 (12.08)	324.00 (11.09)
T_2 (*Annona squamosa*)	41.70 (6.44)	90.00 (9.05)	193.20 (13.89)	426.80 (20.55)	639.20 (25.28)	346.80 (17.73)	336.20 (18.33)
T_3 (*Tagetus erecta*)	39.52 (6.26)	99.20 (9.92)	176.80 (13.28)	364.40 (18.01)	609.00 (24.68)	256.68 (13.68)	339.20 (18.42)
T_4 (*Azardirachta indica*)	45.46 (6.73)	95.60 (9.46)	142.60 (11.93)	310.20 (17.58)	482.80 (21.94)	279.20 (15.09)	316.33 (10.96)
T_5 (*Pongamia pinnata*)	44.26 (6.65)	95.20 (9.72)	163.40 (12.76)	383.40 (19.52)	584.00 (24.17)	409.80 (20.25)	324.20 (18.01)
T_6 (*Eucalyptus globules*)	45.98 (6.78)	51.00 (7.11)	98.80 (9.93)	260.33 (9.96)	353.00 (7.94)	114.00 (7.12)	207.00 (6.18)
T_7 (Control)	51.06 (7.14)	114.20 (10.67)	210.40 (14.48)	495.20 (22.16)	674.00 (25.94)	387.80 (18.75)	436.00 (20.18)
SE(M)±	0.126	0.655	0.261	2.004	2.472	3.491	2.610
C.D. @5%	0.368	1.907	0.760	5.836	7.199	NS	7.60

( ) figures in parentheses are square root transformed values ($\sqrt{x}$ + 0.5). C.D. @ 5% , NS: Non significant

Table.3 Effect of different botanicals on the development of *Spodoptera litura* (F.)

Treatment	Duration (days)							Pupation (%)	Adult longevity (days)		Adult emergence (%)	Survival (%)
	LARVAL INSTAR						Pupa					
	2nd	3rd	4th	5th	6th	Pre-pupa			Male	female		
T_1 (*D.stramonium*)	3.02 (1.74)	4.16 (2.03)	4.14 (2.03)	8.10 (2.93)	1.00 (1.18)	1.00 (1.01)	6.00 (1.81)	56.66 (31.20)*	9.00 (2.13)	7.33 (1.93)	88.46 (44.31) *	58.76 (32.36) *
T_2 (*A.squamosa*)	3.00 (1.73)	5.16 (2.27)	5.06 (2.25)	10.48 (3.31)	2.00 (1.58)	2.00 (1.58)	9.00 (3.08)	82.40 (65.95) *	13.60 (3.75)	12.00 (3.53)	94.46 (77.91) *	82.12 (65.63) *
T_3 (*T.erecta*)	3.00 (1.73)	5.08 (2.56)	5.12 (2.26)	9.12 (3.10)	2.00 (1.58)	1.00 (1.22)	8.00 (2.92)	74.20 (60.68) *	12.00 (3.54)	13.6 (3.75)	92.98 (76.31) *	70.58 (57.90) *
T_4 (*A.indica*)	3.00 (1.73)	3.48 (1.86)	3.42 (1.84)	6.32 (2.61)	1.00 (1.22)	1.00 (1.22)	5.00 (1.69)	41.33 (25.72) *	8.00 (2.03)	6.66 (1.89)	78.10 (40.28) *	35.33 (23.53) *
T_5 (*P.pinnata*)	3.00 (1.73)	4.72 (2.17)	4.32 (2.07)	5.00 (2.33)	2.00 (1.58)	1.00 (1.22)	7.60 (2.84)	66.20 (55.17) *	10.40 (3.30)	11.00 (3.39)	87.13 (71.79) *	64.48 53.97) *
T_6 (*E.globules*)	3.00 (1.73)	2.94 (1.70)	2.80 (1.65)	4.60 (1.63)	1.00 (0.91)	1.00 (1.22)	4.50 (1.32)	40.00 (18.23) *	6.00 (1.44)	7.50 (1.55)	75.38 (26.72) *	33.22 (16.63) *
T_7 (control)	3.00 (1.73)	4.82 (2.19)	4.26 (2.06)	8.10 (2.93)	1.40 (1.36)	1.40 (1.36)	7.60 (2.84)	94.80 (78.85) *	11.40 (3.45)	9.60 (3.18)	94.17 (78.18) *	97.83 (82.80) *
SE(M)±	0.002	0.045	0.049	0.150	0.069	0.075	0.270	7.036	0.346	0.334	10.432	6.805
C.D. @5%	NS	0.131	0.143	0.438	0.202	0.217	0.788	20.487	1.008	0.973	30.375	19.815

( ) figures in parentheses are square root transformed values ($\sqrt{x}$ + 0.5), ( )* figures in parenthese are arcsin transformed values (x^{-1} + 0.5)

Table.4 Effect of different botanicals on biological parameters of adults of *Spodoptera litura* (F.)

Treatment	Adult longevity (days)				Fecundity	Fertility (%)	No. of adults emerged		Sex ratio ♂ : ♀
	Male	Female					male	female	
		Pre-oviposition period	Oviposition period	Post-oviposition period					
T_1 (*D.stramonium*)	9.00 (2.13)	1.00 (1.01)	3.33 (1.45)	3.00 (1.40)	199.60 (8.77)	26.47 (20.36)*	2.66 (1.32)	2.33 (1.29)	1.14:1.0
T_2 (*A.squamosa*)	13.60 (3.75)	2.00 (1.58)	3.40 (1.97)	6.60 (2.66)	392.00 (21.64)	52.36 (46.67) *	3.60 (2.00)	4.40 (2.20)	0.81:1.0
T_3 (*T.erecta*)	12.00 (3.54)	1.00 (1.22)	3.40 (1.97)	9.00 (3.08)	231.20 (35.17)	30.80 (33.98) *	3.60 (1.99)	3.40 (1.97)	1.05:1.0
T_4 (*A.indica*)	8.00 (2.03)	1.00 (1.01)	3.33 (1.45)	2.33 (1.29)	176.00 (27.42)	23.34 (19.26) *	1.66 (1.16)	2.50 (1.11)	0.66:1.0
T_5 (*P.pinnata*)	10.40 (3.30)	1.60 (1.43)	4.40 (2.21)	5.00 (2.35)	210.20 (8.64)	28.18 (32.34) *	2.40 (1.68)	3.40 (1.95)	0.7: 1.0
T_6 (*E.globules*)	6.00 (1.44)	1.00 (0.91)	3.00 (1.16)	3.50 (1.22)	163.50 (12.84)	20.10 (13.15) *	2.50 (1.16)	1.00 (0.812)	2.5:1.0
T_7 (control)	11.40 (3.45)	1.00 (1.22)	3.60 (2.20)	5.00 (2.35)	756.60 (26.11)	96.91 (81.40) *	4.80 (2.29)	4.20 (2.15)	1.14:1.0
SE(M)±	0.346	0.088	0.203	0.187	9.364	4.437	0.192	0.163	-
C.D. @5%	1.008	0.257	0.592	0.545	NS	12.920	0.559	0.473	-

( ) figures in parentheses are square root transformed values ($\sqrt{x}$ + 0.5), ( )* figures in parenthese are arcsin transformed values (x^{-1} + 0.5)

Table.5 Effect of different botanicals on growth indices of *Spodoptera litura* (F.)

	Larval growth index						Pupal growth index	Adult index		Oviposition index	Total growth index
	2nd instar	3rd instar	4th instar	5th instar	6th instar	Pre-pupa		Male	Female		
T_1 (*D.stramonium*)	0.78	0.80 (0.88)	0.71 (0.82)	0.72 (1.10)	0.79 (1.05)	0.83 (0.98)	0.83 (0.97)	0.77 (0.94)	0.75 (0.94)	0.23 (0.82)	2.64 (1.33)
T_2 (*A.squamosa*)	0.81	0.99 (1.00)	0.93 (0.94)	0.86 (1.16)	0.95 (1.20)	0.90 (1.18)	0.79 (1.13)	1.20 (1.30)	1.25 (1.32)	0.52 (1.00)	2.97 (1.86)
T_3 (*T.erecta*)	0.77	0.88 (0.94)	0.85 (0.94)	0.85 (1.16)	0.91 (1.18)	0.88 (1.04)	0.80 (1.13)	1.06 (1.24)	1.40 (1.38)	0.31 (0.90)	2.93 (1.84)
T_4 (*A.indica*)	0.89	0.94 (0.94)	0.68 (0.82)	0.65 (1.06)	0.72 (1.10)	0.74 (1.16)	0.81 (0.97)	0.71 (0.90)	0.68 (0.94)	0.23 (0.80)	2.29 (1.28)
T_5 (*P.pinnata*)	0.87	0.84 (0.92)	0.78 (0.88)	0.81 (1.13)	0.87 (1.17)	0.88 (0.84)	0.77 (1.12)	0.93 (1.20)	1.15 (1.28)	0.28 (0.90)	3.30 (1.94)
T_6 (*E.globules*)	0.90	0.45 (0.66)	0.47 (0.68)	0.58 (0.90)	0.51 (0.82)	0.61 (1.20)	0.44 (0.814)	0.52 (0.82)	0.75 (0.86)	0.20 (0.76)	2.55 (1.12)
T_7 (control)	1.00	1.00	1.00 (1.00)	1.00 (1.22)	1.00 (1.22)	1.00 (1.20)	1.00 (1.22)	1.00 (1.20)	1.00 (1.20)	1.00 (1.20)	4.14 (2.15)
SE(M)±	0.018	0.049	0.023	0.042	0.046	0.065	0.066	0.060	0.068	0.032	0.173
C.D. @5%	0.053	0.142	0.068	0.124	0.133	0.191	0.191	0.175	0.197	0.092	0.504

The adult index was recorded lowest in eucalyptus (0.52) followed by neem oil (0.71) in case of males while lowest in neem oil (0.68), followed by eucalyptus (0.75) in case of females. The oviposition index was least in eucalyptus (0.20) followed by neem oil (0.23). The total growth index was found to be lowest in neem oil (2.29), followed by eucalyptus oil (2.55) when compared to control (4.14).

The state of pest management today mainly focuses not on the performance of the insecticide on the target pest but its environmental impact is of major importance, keeping this aspect in mind using botanical pesticides is one of the best alternative to chemical control. For lepidopteran pest oviposition deterrence, feeding deterrent activities have been reported by several researchers (Singh *et al.,* 2001). It is evident from the results that all the plant materials evaluated possess a certain degree of bioactivity against *S. litura.* The effects were more deleterious after 48 hours rather than 24 hours. The studies conducted by Kamaraj *et al.,* (2008) and Pavela, (2009) reveal that subja and karanj were effective against *S. littoralis,* respectively when administered at higher concentrations. A result of aqueous extraction method (Mamum *et al.,* 2009). Martinez and Emden (1999) reported that the sublethal concentrations of azadirachtin from neem caused reduced food intake with prolonged larval instars in *S. littoralis.* It suggests that the concentrations of plant extracts producing deformities and reduced development in the present study were quite enough to exert secondary antifeedant effects on *S. litura* manifested by remarkable reduction in larval weight with disturbed developmental period on treated foods as compared to untreated food (control). A compensatory feeding behavior commonly seen in insects whenever they are transferred to normal diet from contaminated food, a primary cause for delayed larval development (Saxena and Saxena, 1992; Daniel *et al.,* 1995; Martinez and Emden, 1999), was evidenced in the present study. The extent of reduction in larval period on eucalyptus oil, neem oil and datura leaf extract superceding marigold leaf extract, anonna leaf extract and karanj oil here indicate that the secondary antifeedant effects exerted by these treatments were long lasting and more deleterious. The lack of compensatory feeding behaviour by the *S. litura* larvae consequently reducing larval period on treated food, is a symbolic of moulting disruption as reported earlier by Carvalho (1996) in azadirachtin fed *S. litura.* It brings out the fact that some specific substances from eucalyptus oil, neem oil and datura leaf extract might be involved in preventing *S. litura* larvae from exhibiting this normal behaviour. This aspect needs to be thoroughly investigated, especially in case of eucalyptus oiland datura leaf extract to develop an effective botanical insecticide with potent antifeedant action.

This study was just an attempt to evaluate the different botanicals in form of plant extracts and oils for proving their effect on development activity against *S. litura*. The results indicate that eucalyptus oil, datura leaf extract and neem oil effected the most; hence the botanicals are reliable source for eco-friendly management of *S. litura* in soybean.

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