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FEEDING INHIBITION WITH BIOFORMULATIONS IN CUTWORMS *AGROTIS IPSILON* (HUFNAGEL)

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ABSTRACT

Feeding inhibition study of bioformulations viz., *Neemastra, Agniastra, Brahmastra, Dashparni ark* and garlic + ginger + mint mixture was carried out against fourth, fifth and sixth instar larvae of *A. ipsilon*. These bioformulations were observed to be not giving significant mortality in the fourth, fifth and sixth instar larvae but result in feeding inhibition. Concentrations ranging from 1.5% to 24% were evaluated for this action. It was observed that *Dashparni ark* was the most effective causing maximum feeding inhibition to later instar larvae of *A. ipsilon* followed by *Brahmastra*, *Agniastra, Neemastra* and garlic+ ginger+ mint mixture. *Dashparni ark* was found 1.35, 1.34 and 1.26x more effective compred to the least effective garlic + ginger + mint mixture against fourth, fifth and sixth instar larvae of *A. ipsilon*, respectively.

Key words: *Agrotis ipsilon*, feeding inhibition, bioformulations, *Neemastra, Agniastra, Brahmastra, Dashparni ark*, garlic + ginger + mint, FI_{50}

Cutworms are polyphagous and cosmopolitan pests attacking large number of crops worldwide including India (Ram et al. 2001; Mrowczynski et al. 2003; Napiorkowska and Gawowska 2004). The larvae usually hide in cracks and crevices in the soil or under the clods or debris around the plants during day time and cut the young plants at ground level and eat only the tender parts (Bhattacharyya et al. 2014). These feed on variety of hosts namely potato, barley, oats, mustard, linseed, cabbage, peas, gram, tobacco etc. However, they prefer gram over pea, potato and cabbage (Ram and Mishra 2002). In Himachal Pradesh, greasy or black cutworm *Agrotis ipsilon* and common cutworm *A. segetum* are the two major ones (Verma and Verma 2002). *A. ipsilon* is prevalent in low and mid-hills, whereas *A. segetum* is more abundant in higher elevations (Pathania 2010).

Use of insecticides for the management of cutworms is common practice but it causes many undesirable effects (Sharma and Verma 2015). Biorational approaches by utilizing botanical preparations, natural products, insect growth regulators and entomopathogenic microorganisms are gaining significance as possible alternatives (Ramesh et al. 2014). The deleterious effects of plant products on insects can be manifested in several manners including toxicity, mortality, antifeedant, growth inhibitor, suppression of reproductive behaviour and reduction of fecundity and fertility, growth inhibition and perturbation of reproductive behaviour (Sharaby and Nojiban 2015). *Brahmastra*, *Agniastra*, *Neemastra*, *Dashparni ark* and garlic+ ginger+ mint mixture are few indigenous bioformulations available. These need evaluation for effective management of cutworms, and hence the present study. Feeding inhibition due to these bioformulation on the fourth, fifth and sixth instar larvae of cutworm, A. ipsilon has been evaluated under laboratory conditions.

MATERIALS AND METHODS

The experiment was conducted from July 2018 to May 2019 in the Post Graduate Laboratory of the Department of Entomology, CSK Himachal Pradesh Krishi Vishvavidyalaya (CSK HPKV), Palampur (32.11° N, 76.23° E, 1290 masl). The initial culture of *A. ipsilon* was obtained in the form of adult moths collected in light trap installed at the Entomology Farm in CSK HPKV, Palampur and brought to laboratory. The moths were transferred to glass chimneys (20 x 10 cm) for mating and oviposition. In each chimney, one pair was released. A crumpled paper was placed in the chimney as a resting as well as oviposition site for the moths. The top of the chimney was covered with white muslin cloth. A piece of cotton soaked in honey (10%) kept in small petri plate served as food to the moths. The females mostly oviposited on the white muslin cloth and the crumpled paper. The egg masses laid by the moths were collected daily and the paper and muslin cloth were replaced. The eggs which were laid on the

sides of the chimney were moistened before separating them with the help of camel hair brush. Such papers and the muslin cloth bearing the egg masses were then transferred into plastic jars. The jars were then examined daily for egg hatching.

Fresh and soft cabbage leaves were placed in such jars after blackening of the eggs, as food to the newly emerging larvae. The larvae of each day hatching were kept separately in individual plastic jars (100 ml) and provided with fresh food for getting the insects of desired age for bioassay purpose. To keep the leaves fresh for longer duration, the leaf petioles were wrapped with wet cotton plugs. The larvae were reared *en masse* in the early instars. Later on, third instars onward, 10 larvae were transferred to each plastic jar (100 ml) containing a layer of about 5 cm moist soil-sand mixture. These larvae were provided with fresh cabbage leaves from time to time as per their requirement. The full fed larvae pupated in soil which were then sexed and kept separately in another plastic jar (100 ml) for further culture. The culture so obtained was used, with 25 ± 1°C temperature and 75 ± 5% RH and 16:8 (L:D) photoperiod maintained.

The bioformulations evaluated include *Brahmastra, Neemastra, Agniastra, Dashparni ark* and garlic+ ginger+ mint mixture and their details of preparation are as follows:

Dashparni ark	
Cow urine (5 L) Cow dung (3 kg) Neem (*Azadirachta indica*) leaves (5 kg) Karanja (*Millettia pinnata*) leaves (2 kg) Nirgudi (*Vitex negundo*) leaves (2 kg) Custard apple (*Annona reticulata*) leaves (2 kg) Red corner (*Adenanthera pavonina)* leaves (2 kg) Papaya (*Carica papaya*) leaves (2 kg) Green chilli (*Capsicum annuum*) paste (2 kg) Castor (*Ricinus communis*) leaves (2 kg) Garlic (*Allium sativum*) paste (250 g) Water (200 L)	Known quantity of crushed neem leaves, nirgudi leaves , papaya leaves, custard apple leaves, karanja leaves, castor leaves, red corner leaves, green chili paste, garlic paste, cow dung, cow urine, water taken in a 500 l capacity drum and ferment for one month. Keep the drum in shade and cover with gunny bag. Shake regularly three times a day. Extract the solution after filtering through cloth.

Agniastra	
Cow urine (10 L) Tobacco (*Nicotiana tabacum*) leaves (1 kg) Green chili (*Capsicum annuum*) leaves (500g) Garlic (*Allium sativum*) paste (500 g) Neem (*Azadirachta indica*) leaves pulp (5 kg)	10 l of cow urine poured in pot; 1 kg tobacco added by crunching it. Crushed 500 g of chilli added in urine. Crushed 500 g of local garlic added in urine and then 5 kg neem leaves pulp added. Boiled this solution well 5 times continuously. Let this solution to fermented for 24 hr. Filtered this by cloth and then used it for presnt investigation.

Neemastra	
Cow urine (5 L) Cow dung (5 kg) Neem (*Azadirachta indica*) leaves pulp (5 kg) Water (100 L)	100 l water taken in pot, 5 l local cow urine added in it and 5 kg local cow dung added in it. Crushed 5 kg neem leaves and added this pulp in water. Let this solution to ferment for 24 h. Stirred this solution twice a day by any stick. Filtered this by cloth and then used it in insect control.

Brahmastra	
Cow urine (10 L) Neem (*Azadirachta indica*) leaves (3 kg) Custard apple (*Annona reticulate*) leaf (2 kg) Papaya (*Carica papaya*) leaf (2 kg) Pomegranate (*Punica granatum*) leaves (2 kg) Guava (*Psidium guajava*) (2 kg) *Lantana camera* leaves pulp (2 kg) White dhatura (*Datura* sp.) leaves (2 kg)	10 l local cow urine taken in pot. Crushed 3 kg of neem leaves and added this pulp in water. Then 2 kg pulp of sitaphal (custard apple) leaves, 2 kg pulp of pomegranate leaves, 2 kg of guava leaves pulp, 2 kg *Lantana camera* leaves pulp and 2 kg white dhatura leaves pulp added in it. Then boiled this solution for 5 times. Filtered this solution by cloth. Let this solution to ferment for 24 hr and then used it in field.

Garlic + ginger + mint mixture

Ginger (*Zingiber officinale*) (200 g) Garlic (*Allium sativum*) (200 g) Mint (*Mentha* sp.) leaves (200 g) Water (600 ml)	200 g each of ginger, garlic and leaves of mint taken and added 600 ml of water in it. Grinded all ingredients with the help of electric mixture. Stirred this solution for three times in 24 h for two days. Filtered this solution by cloth and used against pest species.

The above were procured from Department of Organic Agriculture, Navsari Agricultural University, Gujarat and garlic + ginger + mint mixture was self prepared in the laboratory. The products procured from NAU, Gujarat were filtered through Whatman filter paper No. 9 and collected in glass bottles. The filtrate of each natural product was considered as 100% stock solution from which the desired concentrations for bioassay purpose were prepared.

Feeding inhibition study with 1.5% to 24% was done with fourth to sixth instar larvae. Cabbage leaves of equal thickness and consistency were cut in to disc of 28.44 cm^2 size measured with leaf area metre were dip-treated for 2 min in each concentration, shade dried and placed in glass jars. Each test concentration was replicated three times. A control experiment was also run simultaneously with equal number of replication. In each jar 10 larvae, prestarved for 2-3 hr were released in each treatment and allowed to feed for 48 hr after which the leaf area was again measured. A control experiment was conducted simultaneously with equal number of replications. The % feeding inhibition (FI) was calculated as:

The FI_{50} and FI_{90} values on the basis on feeding inhibition over control was estimated by probit analysis (Finney 1971) The heterogeneity, FI_{50} values, FI_{90} values and their fiducial limits were computed, and lines were plotted and slopes of the regression were determined. The relative feeding inhibition values were worked out as FI_{50} and FI_{90} values taking the least toxic compound as unity.

RESULTS AND DISCUSSION

Observations on the feeding inhibition activity of bioformulations against fourth, fifth and sixth instar larvae of *A. ipsilon* were taken by exposing them to treated leaf surfaces for 48 h and the FI_{50} was calculated (Table 1). The results of feeding inhibition studies against the fourth instar larvae revealed *Dashparni ark* as the most effective bioformulation in terms of feeding inhibition followed by *Brahmastra, Agniastra, Neemastra* and garlic+ ginger+ mint mixture with FI_{50} values 5.11, 5.54, 5.76, 6.29 and 6.90 %, respectively. *Dashparni ark* was 1.35x more effective than the least effective garlic + ginger + mint mixture. The feeding inhibition for the fifth instar larvae revealed *Dashparni ark* as the most effective bioformulation in terms of feeding inhibition followed by *Brahmastra, Agniastra, Neemastra* and garlic+ ginger+ mint mixture with FI_{50} values 5.53, 5.76, 6.17, 6.67 and 7.39%, respectively. *Dashparni ark* was resulted 1.34x more effective than the least toxic garlic + ginger + mint mixture.

In case of sixth instar larvae, The feeding inhibition study revealed *Dashparni ark* as the most effective bioformulation in terms of feeding inhibition followed by *Brahmastra*, *Agniastra, Neemastra* and garlic+ ginger+ mint mixture with FI_{50} values 7.08, 7.29, 7.46, 7.85 and 8.89%, respectively. *Dashparni ark* was found 1.26x more effective than the least toxic Garlic + ginger + mint mixture in causing feeding inhibition. The results reveal that all the bioformulations has feeding deterrence against *A.ipsilon* and the results are in confirmation with finding of Anees (2018) who reported all the organics viz., cow urine, *Panchagavya*, *Darekastra*, *Agneystra*, *Dashaparni*, NSKE and one biopesticide i.e. Neem Baan 1500 ppm exhibited repellent, feeding deterrent and ovicidal activities against third instar larvae of *S. litura.*

Santhosh (2008) also recorded significantly higher protection (60.36 and 57.49%, respectively) after 48 h of *Agniasthra* and *Brahmasthra* treatment against insects-pests of soybean crop. Though no information is available on these products, the antifeedant activity could be because of neem, pongamia or custard apple leaves are used in some preparation. Barapatre and Lingappa (2003) reported high antifeedant property of cow urine when combined with pongamia, aloe, *V. negundo* and NSKE agains *H. armigera*. Barapatre (2001) recorded the antifeedant property of neem oil (2.5%) and garlic (0.5%) + chilli (1%) against *S.litura*. More et al. (1989) and Mathew (1997) reported antifeedant property of cow urine at 10 % against *S. litura*.

Sharaby and Nojiban (2015) reported that the garlic, mint, cumin, caraway and parsley oil had a stomach and contact toxicity through the larval feeding on treated

Table 1. Feeding inhibition due to bioformulations in larvae of *A. ipsilon*

S. No	Bioformulations	FI_{50} (%)	Regression equation	Slope (b)	Heterogeneity	Relative feeding inhibition
			4th instar			
1.	*Dashparni ark*	5.11	Y=4.01 + 1.39 X	1.39 ± 0.27	0.62	1.35
2.	*Brahmastra*	5.54	Y=3.96 +1.40 X	1.40 ± 0.28	0.42	1.25
3.	*Agniastra*	5.76	Y= 3.94 + 1.39 X	1.39 ± 0.28	0.29	1.19
4.	*Neemastra*	6.29	Y=3.90 + 1.38 X	1.38± 0.28	0.32	1.09
5.	Garlic + ginger + mint mixture	6.90	Y= 3.87 + 1.35 X	1.35 ± 0.27	0.28	1.00
			5th instar			
1.	*Dashparni ark*	5.53	Y=3.97 + 1.39 X	1.39 ± 0.28	0.38	1.34
2.	*Brahmastra*	5.76	Y=3.96 +1.37 X	1.37 ± 0.28	0.23	1.28
3.	*Agniastra*	6.17	Y= 3.93 + 1.36 X	1.36 ± 0.27	0.28	1.20
4.	*Neemastra*	6.67	Y=3.85 + 1.39 X	1.39 ± 0.28	0.30	1.11
5.	Garlic + ginger + mint mixture	7.39	Y= 3.81 + 1.37 X	1.37 ±0.28	0.23	1.00
			6th instar			
1.	*Dashparni ark*	7.08	Y=3.92 + 1.28 X	1.28 ± 0.27	0.17	1.26
2.	*Brahmastra*	7.29	Y=3.90 +1.28 X	1.28 ± 0.27	0.22	1.22
3.	*Agniastra*	7.46	Y= 3.89 + 1.27 X	1.27 ± 0.27	0.16	1.19
4.	*Neemastra*	7.85	Y=3.85 + 1.28 X	1.28 ± 0.27	0.06	1.13
5.	Garlic + ginger + mint mixture	8.89	Y= 3.78 + 1.29 X	1.29 ± 0.27	0.19	1.00

diet, also all the tested oils exhibited antifeedant and starvation effects on *A. ipsilon*.

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