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Short Communication

Feeding inhibition of natural products against *Agrotis segetum* (Denis and Schiffermuller)

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Abstract

The feeding inhibition (FI) of different natural products viz., *Neemastra*, *Agniastra*, *Brahmastra* and garlic + chilli extract was evaluated against the third and sixth instar larvae of *Agrotis segetum* (Denis & Schiffermuller). The concentrations tested ranged from 2 to 32 per cent. The mortality due to natural products was found to be non significant in third and sixth instar larvae but resulted in significant feeding inhibition (FI). Based on FI_{50} values, the order of feeding inhibition of the natural products tested against the third and sixth instar larvae was observed as *Brahmastra* (5.81 and 6.61%) > *Neemastra* (6.12 and 7.04%) > garlic + chilli extract (6.39 and 7.49%) > *Agniastra* (6.44 and 8.62%), respectively.

Key words: *Agrotis segetum*, natural products, feeding inhibition

Cutworms are economically important polyphagous and cosmopolitan pests that target a variety of crops all over the world, including India (Mrowzynski *et al*., 2003; Napiorkowska and Gawowska, 2004). The damage is caused by the larvae which are commonly found in soil. Often, the damage goes unnoticed until a large number of plants are affected. They are voracious feeders of leaves, buds, and stems, and can completely devastate plants. Cutworms primarily feed at night and hide during the day time in cracks and crevices or under clods, burrows or debris around the plant beneath the soil surface.

The moths of *A. segetum* initially appear in the field in the last week of February, peaking in the first week of April. After that, the population declines, and the moths vanish by mid-September (Verma and Verma 2001). There are 26 species of cutworms known to exist in India, however *A. ipsilon* (Hufnagel) and *A. segetum* (Denis and Schiffermuller) are the most frequent species found throughout the country (Chandel and Chandla 2003). In Himachal Pradesh, greasy or black cutworm, *A. ipsilon* and common cutworm, *A. segetum* are the two predominant cutworm species accompanied with various crops causing 3-18 per cent infestation (Verma and Verma 2002). The cutworm species *A. ipsilon* mostly occurs in the low and mid-hills, whereas *A. segetum* is more prevalent in higher elevations. Infestation of these two species in various vegetables and field crops ranges from 1.5 to 23.8 percent in Himachal Pradesh (Pathania 2010).

Cutworms are usually controlled by using insecticides such as pyrethroids, organochlorines, and organophosphate compounds. Their widespread and indiscriminate use have resulted in pesticide resistance, secondary pest outbreaks, pest rebound, bioaccumulation in the food chain, pollution, and the extinction of non-target taxa (Sharma and Verma 2015). Because of the issues associated with the use of numerous synthetic chemical pesticides, it is inevitable that their use should be limited and alternative control options should be identified. Synthetic insecticides might be replaced by biological pesticides, or a combination of these agents could be used to minimise hazardous chemical levels in the environment. The deleterious effects of plant products on insects can be manifested in several manners including toxicity, mortality, antifeedant growth inhibitor, suppression of reproductive behavior and

reduction of fecundity and fertility, growth inhibition, perturbation of reproductive behavior (Sharaby and Nojiban 2014). Therefore, it is crucial to study the effect of natural products for the effective management of cutworms. Feeding inhibition due to these natural products on the third and sixth instar larvae of *A. segetum* has been evaluated under laboratory conditions.

The experimental studies were conducted out during 2020–2021 in the Department of Entomology, CSK Himachal Pradesh Krishi Vishvavidyalaya (CSK HPKV), Palampur (32.11°N, 76.23°E, 1290 m asl). The rearing was done in a controlled environment with a temperature of 25 ± 2°C and a relative humidity of 75 per cent under 16:8 (L:D) photoperiod. For rearing cutworms in laboratory, the initial culture was started from the adult moths of both sexes of *A. segetum* collected on light trap and kept in the glass chimneys (20 x 13 cm) for mating and egg laying. One pair of moths was released into each chimney. The moths were given a crumpled piece of paper to use as a resting and oviposition site in the chimney. A muslin cloth was draped over the top of the chimney. The adults were provided with 10 per cent honey solution soaked in cotton swab and placed in small Petri plate as a food source. The females typically oviposited on crumpled paper and muslin cloth. The eggs laid along the chimney's sides were moistened before being separated with a camel hair brush. The egg masses were then placed into plastic jars using these papers and the muslin cloth. The jars were frequently checked for egg hatching on a daily basis. After the eggs turned black, fresh and soft cabbage leaves were placed in the jars as food for the freshly emerged larvae.

The freshly hatched larvae were kept collectively in plastic jars (100 ml) and fed on fresh cabbage leaves to obtain insects of the proper age for study. The leaf petioles were wrapped in moist cotton plugs to keep the leaves fresh for longer. The first and second instar larvae were raised collectively in the plastic jars on tender cabbage leaves. From the third instar onwards, ten larvae were placed into each plastic jar (100 ml) containing a layer of roughly 5 cm moist soil-sand mixture. Fresh cabbage leaves were given to these larvae on a regular basis. The fully fed larvae pupated in soil, after which they were separated on the basis of sex and placed in a separate plastic jar. The successive generations were reared using the same method. From time to time, the culture obtained was utilized for various laboratory experiments.

Feeding inhibition studies were conducted on third and sixth instar larvae using all natural products viz., *Brahmastra*, *Neemastra*, *Agniastra* and garlic + chilli extract. *Brahmastra*, *Neemastra*, *Agniastra* procured from the Department of Organic Agriculture and Natural Farming of CSK HPKV, Palampur and garlic + chilli extract was self prepared in laboratory. Five (2, 4, 8, 16 and 32%) concentrations each of *Brahmastra, Neemastra, Agniastra* and garlic + chilli extract were evaluated against third and sixth instar larvae of *A. segetum*.

For feeding inhibition studies, cabbage leaves of equal thickness and consistency were cut into discs measuring 16.6 cm^2 with a leaf area meter (Systronics Leaf Area Meter 211) and then dipped into each test concentration for 30 seconds, shade dried, and placed in containers or Petri dishes pre-fitted with moistened filter paper. The test concentrations were replicated three times. Simultaneously, a control experiment with an equal number of replications was carried out.

Ten larvae were released in a container after being pre-starved for 3-4 hours and the feeding inhibition was recorded after 48 hours of release of test insects. Simultaneously, a control experiment with an equal number of replications was also carried out. The percent feeding inhibition (FI) of third and sixth instar larvae of *A. segetum* over control was estimated using the formula:

$$\text{Feeding deterrence (\%)} = \frac{\text{Mean area consumed in control - Mean area consumed in treatment}}{\text{Mean area consumed in control}} \times 100$$

Probit analysis was used to calculate the FI_{50} and FI_{90} values on the basis of feeding inhibition over control (Finney 1971).

Feeding inhibition studies on third instar larvae indicated *Brahmastra* to be the most effective natural product, followed by *Neemastra*, garlic + chilli extract and *Agniastra* with FI_{50} values of 5.81, 6.12, 6.39 and

6.44 per cent, respectively (Table 1). *Brahmastra* was found to be most effective in inhibiting the feeding of third instar larvae among the tested products and it is about 1.11 times more inhibiting than the least toxic *Agniastra*.

Feeding inhibition studies on sixth instar larvae revealed *Brahmastra* to be the most effective among natural products, followed by *Neemastra*, garlic + chilli extract and *Agniastra* with FI_{50} values of 6.61, 7.04, 7.49 and 8.62 per cent, respectively. *Brahmastra* was found most inhibiting feeding among the tested natural and it is about 1.30 times more inhibiting than the least toxic *Agniastra*.

The results reveal that all the natural products has feeding deterrence against *A. segetum* and the results are in confirmation with finding of Joshi *et al*. (2019) who reported among all the bioformulations viz., *Brahmastra*, *Agniastra*, *Neemastra*, *Dashparni ark* and garlic+ ginger+ mint mixture, *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 1.26 times more effective compared to the least effective garlic + ginger + mint mixture against fourth, fifth and sixth instar larvae of *A. ipsilon*, respectively.

Jamalli (2020) studied the feeding inhibition of different natural products concentration ranges from 1.25 to 20 per cent against the third, fourth, fifth and sixth instar larvae of *H. armigera.* Based on FI_{50} values, the order of feeding inhibition of natural products tested against the third, fourth, fifth and sixth instar larvae was observed as: *Brahmastra* (2.92, 3.80, 4.20, 6.61%) > *Agniastra* (3.72, 4.55, 5.11, 7.76%) > *Neemastra* (3.46, 4.46, 5.28, 7.01%), respectively.

Dhar (2020) evaluated the crude extracts of the three plants products namely ginger, garlic and neem in different concentrations (0.25%, 0.5%, 0.75% and 1%) for their repellent and antifeedant activity against the third instar larvae of *Spodoptera litura*. The maximum antifeedant activity was noted in garlic extracts while neem and ginger showed a moderate or lesser toxic effects at 1 per cent concentration. Ling *et al*. (2020) assessed the antifeedant activity of itol A against *S. litura* with AFC_{50} values of 562.05 mg/L in the no-choice and 81.47 mg/L in the choice tests.

Conclusion

The order of feeding inhibition of third instar larvae on the basis of FI_{50} values was obtained as *Brahmastra* > *Neemastra* > garlic+chilli extract > *Agniastra* with FI_{50} values 5.81, 6.12, 6.39 and 6.44 per cent, respectively. The order of feeding inhibition of sixth instar larvae on the basis of FI_{50} values was obtained as *Brahmastra* > *Neemastra* > garlic + chilli

Table 1. Relative feeding inhibition of natural products to third and sixth instar larvae of *A. segetum*

S. No.	Natural products	FI_{50}(%)	Regression equation (Y=a+bX)	Slope (b)	Heterogeneity (χ^2_{cal})	Relative feeding inhibition
			3rd instar			
1.	*Brahmastra*	5.81	4.03+1.27 X	1.27	0.08	1.11
2.	*Neemastra*	6.12	4.03+1.23 X	1.23	0.21	1.05
3.	Garlic + chilli extract	6.39	4.01+1.23 X	1.23	0.21	1.01
4.	*Agniastra*	6.44	4.03+1.20 X	1.20	0.21	1.00
			6th instar			
1.	*Brahmastra*	6.61	3.96+1.24 X	1.24	0.20	1.30
2.	*Neemastra*	7.04	3.93+1.24 X	1.24	0.20	1.22
3.	Garlic + chilli extract	7.49	3.91+1.23 X	1.23	0.09	1.15
4.	*Agniastra*	8.62	3.83+1.25 X	1.25	0.11	1.00

extract > *Agniastra* with FI_{50} values 6.61, 7.04, 7.49 and 8.62 per cent, respectively. Hence *Brahmastra* resulted in maximum feeding inhibition against third and sixth instar larvae of *A. segetum*.

Conflict of interest: The authors declare no conflict of interest in this research paper.

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