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Bio-efficacy of Algal Extract on Larval Development of *Spodoptera litura* (Lepidoptera: Noctuidae)

S. A. Gaikwad*[1], S. P. Nalawade[2] and A. M. Momin[3]

[1] Yashavantrao Chavan Institute of Science, Satara - 415 001, Maharashtra, India
[2] D. P. Bhosale College, Koregaon, Satara - 415 501, Maharashtra, India
[3] Dr. Patangrao Kadam Mahavidyalaya, Ramanandnagar (Burli) - 416 308, Maharashtra, India

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Abstract

Spodoptera litura (Lepidoptera: Noctuidae) is a polyphagous pest having a large host range and it causes, economic damage to crops such as soybean, groundnut, cotton, marigold, tomato, cauliflower, sweet potato, etc. Generally, synthetic or chemical pesticides are used to control this pest but extensive use of these pesticides results in the development of resistance in this pest and synthetic pesticides adversely affect the non-targeted organisms, the yield of the crop, and human health. Therefore, it is essential to find natural pesticide which is environmentally safe. Cyanobacteria (blue-green algae) are the producers of secondary metabolites with toxic properties known as cyanotoxins and these secondary metabolites are the source of natural pesticides. The present study was undertaken to evaluate the potential of cyanobacteria (blue-green algae) to explore their larvicidal activity against larval instars of *Spodoptera litura*. The algal extract obtained from cyanobacteria was tested against the different instars of *Spodoptera litura*.

Key words: *Spodoptera litura*, Cyanobacteria, Cyanotoxins, Larvicidal activity, Natural pesticide

Spodoptera litura (Lepidoptera: Noctuidae) is an important and most detrimental pest of India and is widely dispersed throughout Asia. It is a polyphagus pest of large host range including cotton, groundnut, soybean, tomato, sweet potato, and many other crops [1]. *Spodoptera litura* has been reported to attack 150 plant species and causing 26 -100% yield loss under field conditions [2-3]. Young larvae of *Spodoptera litura* eat entire leaves, and even flowers and fruits. The larvae are leaf eaters and they defoliate many economically important crops. On most crops, damage arises from extensive feeding by larvae. Therefore, there is a need to control these larvae. Generally, synthetic or chemical pesticides are used to control this pest but extensive use of these pesticides results in the development of resistance in this pest and synthetic pesticides adversely affect the non-targeted organisms, the yield of the crop, and human health. Controlling these larvae is essential to mitigate the economic impact on agriculture. Therefore, it is essential to find natural pesticide which is environmentally safe. Cyanobacteria (Blue-green algae) are the producers of secondary metabolites with toxic properties known as cyanotoxins and these secondary metabolites are the source of natural pesticides [4]. The cyanotoxins are grouped according to the physiological system, organ, tissues, or cells which are primarily affected. These toxins can have adverse effects on various physiological systems, organs, tissues, or cells in organisms exposed to contaminated water. Cyanotoxins are generally categorized based on their primary modes of action and the target sites within living organisms. They are classified as neurotoxins, hepatotoxins, cytotoxins, irritants, and gastrointestinal toxins. The hepatotoxins include two cyclic peptides which are microcystins and nodularin. The present study was undertaken to evaluate the potential of cyanobacteria (Blue-green algae) to explore their larvicidal activity against first to fifth instar larvae of *Spodoptera litura.*

Several workers have studied and formulated various ways of controlling and examining the infection caused by *Spodoptera* species. Sharanappa *et al.* [5] have shown the toxic effect of cyanobacterial extracts as natural pesticides for the control of Spodoptera species. Many kinds of literature have been studied showing the behavior of *Spodoptera litura* studies from Murugan and Dhingra [6]; Armes *et al.* [7]; Kranthi *et al.* [8]. Sreelakshmi *et al.* [9] they showed the assessment of insecticide resistance in field populations of *Spodoptera litura* collected from three districts of Kerala. Hong Tong *et al.* [10] they have studied the field resistance of *Spodoptera litura* (Lepidoptera: Noctuidae) to organophosphates, pyrethroids, carbamates and four newer chemistry insecticides in Hunan, China. Ahmad *et al.* [11] have reported the evidence for field evolved resistance to newer insecticides in *Spodoptera litura* from Pakistan. Pathak *et al*. [12] has shown adverse effects due to synthetic pesticide on pests and their subsequent impact on ecological imbalance demands eco-friendly alternatives. Mahakhant *et al.* [13]; showed the potential use of cyanobacteria in agriculture. Kiviranta *et al.* [14] and Sathiyamoorthy *et al.* [15] have shown the insecticidal and nematocidal activity of cyanobacteria is still largely unexplored and only a few studies of this subject have been published. Botanical pesticides are one such alternative and an important

***Correspondence to:** S. A. Gaikwad, E-mail: sonaliagaikwad22@gmail.com; Tel: +91 8975949010

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component in Integrated Pest Management (IPM) due to their advantages such as availability, less toxicity to beneficial fauna, quick degradation, and multiple functions [16]. The present idea can lead a new path in the research arena to search the diverse actions of selected algal species.

MATERIALS AND METHODS

Insect culture: Collection of different stages of *Spodoptera litura* from crop fields has been done and they were grown in laboratory condition.

The extraction process of blue-green algae: The freshly collected samples were washed and cleaned thoroughly in tap water to remove the sand and other unwanted debris. Then the algal samples were shed dried and powdered with the help of a domestic grinder and placed in an airtight container with an adequate volume of methanol for three days. The extracted solution was separated from the cell residue by filtration (Whatman filter paper No. 3). The filtrate was dried under reduced pressure using a rotary evaporator.

Rearing of *Spodoptera litura* larvae

Shed drying of Blue green algae

Control group *Spodoptera litura* larvae

Dead larvae after treatment of algal extract

Insect bioassay: In the experiment, soybean leaves were used. The soybean leaves were washed with sterilized water, air-dried, dipped into an algal extract, and provided to feed the larvae. The mortality was subjected to the Abbotts formula. For calculating corrected percentage mortality [17] and to calculate lethal concentration (LC_{50}) probit analysis method was used [18].

Statistical analysis: The LC_{50} values of first to fifth instar were calculated after 24 hours of algal extract treatment and corrected according to the Abbott formula [17]. The corrected data were analyzed using probit analysis [18] for the determination of median lethal concentration (LC_{50}) and their 95% fiducial limits.

RESULTS AND DISCUSSION

In bioassay experiment, the different concentration of algal extract (µl/ml) was applied against *Spodoptera litura* larvae under controlled laboratory conditions. The concentrations of 5 µl/ml to 45 µl/ml were applied for first instar larvae which resulted in 10 to 100% mortality within 24 hours post application. The mortality percentage changed with increasing concentration of algal extract. First instar larvae were most sensitive to the extract. The LC50 and slope values were evaluated and stated in (Table 1). The algal extract ranging from 10 to 60 µl/ml when applied to second instar larvae showed mortality of larvae and recorded 0 to 100% mortality. The highest mortality (100%) was observed at 60µl/ml concentration of algal extract. The LC_{50}, slope values, and fiducial limit were calculated for second instar *Spodoptera litura* larvae and stated in (Table 2). For third instar larvae, the concentration at 20 to 95 µl/ml was tested and observed 0 to 95% mortality. LC_{50} value was evaluated as 60.8 ug/ml. The LC_{50} value, the slope value, and fiducial limits are stated in (Table 3). The concentrations of 30 to 105 µl/ml were applied to 4^{th} instar larvae and observed 0 to 95% mortality of *Spodoptera litura*. The highest mortality percentage i.e. 95% was observed at 105 µl/ml. LC_{50} value, slope value and fiducial limits were noted in (Table 4). A mortality percentage of 0 to 70% was observed at 50 to 125 ug/ml concentration of algal extract for fifth instar larvae. Fifth instar larvae were the most resistant to the algal extract. The LC_{50} value at 101.65 ug/ml was observed. LC_{50} value, slope value and fiducial limits were noted in (Table 5). Mortality percentages of all instar larvae were changed with different concentrations.

LC 50 concentrations of 1^{st} to 5^{th} instars of Spodoptera litura treated with algal extract for 24 hours

Table 1 Effect of algal extract on first instar larvae of *Spodoptera litura*

Concentration of algal extract (µl/ml)	Percentage mortality	Log of concentration	Probit mortality
5	10	0.6989	3.72
15	30	1.176	4.48
25	50	1.3979	5
35	70	1.544	5.52
45	100	1.6532	6.28
LC_{50}		25.119	
Fiducial limits	Lower	Upper	
	13.65	36.35	
Slope		Y=2.477x + 1.7947	

Table 2 Effect of algal extract on second instar larvae of *Spodoptera litura*

Concentration of algal extract (µl/ml)	Percentage mortality	Log of concentration	Probit mortality
10	0	1	0
20	20	1.301	4.26
30	40	1.4771	4.75
40	50	1.602	5

50	80	1.6989	5.84
60	100	1.7781	6.477
LC_{50}		36.1	
Fiducial limits	Lower		Upper
	21.29		48.71
Slope		Y=7.5921x – 6.8195	

Table 3 Effect of algal extract on third instar larvae of *Spodoptera litura*

Concentration of algal extract (µl/ml)	Percentage mortality	Log of concentration	Probit mortality
20	0	1.301	0
35	20	1.544	4.26
50	35	1.6989	4.59
65	50	1.8129	5
80	70	1.903	5.52
95	95	1.9777	6.64
LC_{50}		60.8	
Fiducial limits	Lower		Upper
	34.96		80.04
Slope		Y=8.5783x - 10.302	

Table 4 Effect of algal extract on fourth instar larvae of *Spodoptera litura*

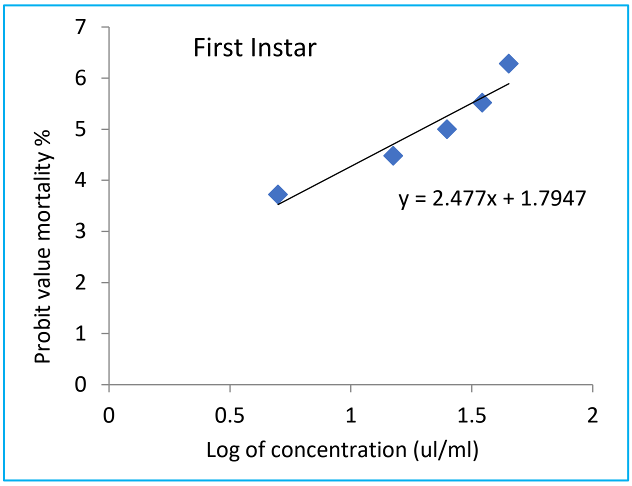
Concentration of algal extract (µl/ml)	Percentage mortality	Log of concentration	Probit mortality
30	0	1.4771	0
45	10	1.6532	3.72
60	30	1.7781	4.48
75	50	1.875	5
90	70	1.9542	5.52
105	95	2.021	6.64
LC_{50}		73.13	
Fiducial limits	Lower		Upper
	44.8		90.2
Slope		Y=10.89x - 15.301	

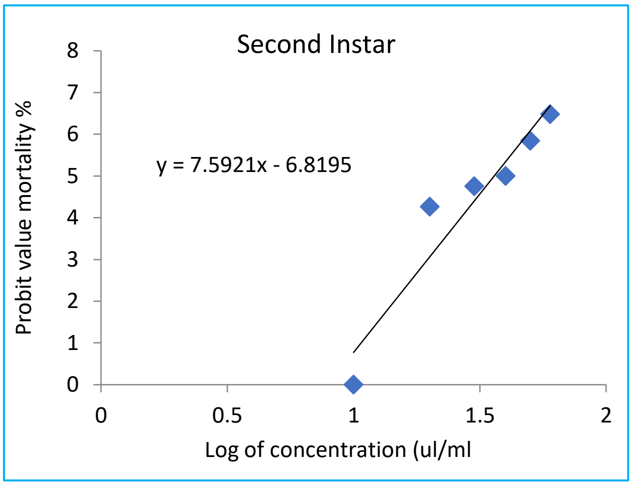
Table 5 Effect of algal extract on fifth instar larvae of *Spodoptera litura*

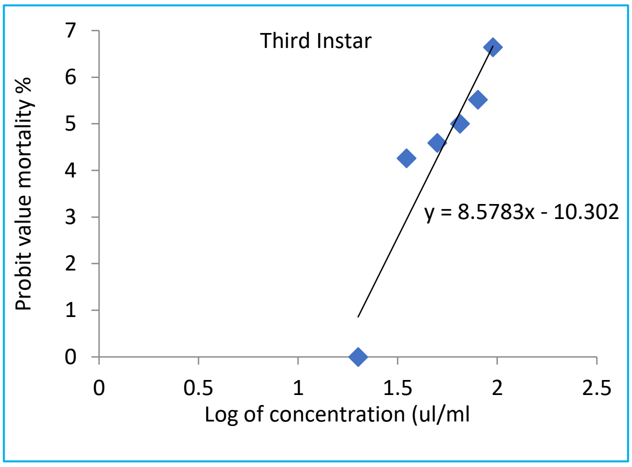
Concentration of algal extract (µl/ml)	Percentage mortality	Log of concentration	Probit mortality
50	0	1.6989	0
65	20	1.8129	4.26
80	30	1.903	4.48
95	40	1.9777	4.75
110	50	2.0413	5
125	70	2.096	5.52
LC_{50}		101.65	
Fiducial limits	Lower		Upper
	60.65		114.3
Slope		Y=11.678x - 18.439	

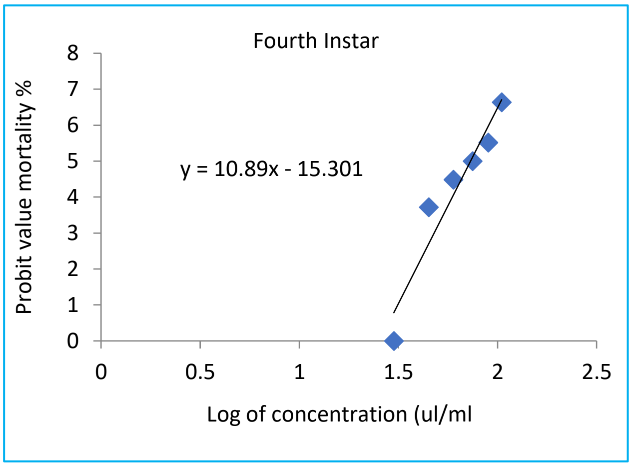
There is a global trend to reduce extensive use of synthetic pesticides to overcome the adverse effect of these pesticides. In last decade several studies were conducted to find an alternative to synthetic pesticides and to develop affordable new insecticides from natural sources [19]. Cyanobacteria (blue-green algae) are the producers of secondary metabolites with toxic properties known as cyanotoxins and these secondary metabolites are the source of natural pesticides [4]. The current findings indicated that the algal extract contained substances that were toxic to larvae of *Spodoptera litura*. Until now, there have been relatively few reports on the larvicidal activity of cyanobacterial toxins. Sharanappa *et al*. [5] have evaluated insecticidal activity of cyanobacteria extract (*Spirulina* sp. and *Nostoc muscorum)* against second instar larvae of *Spodoptera frugiperda* and concluded that the extract was type of biopesticides which is ecofriendly and serves as natural and alternative source to control *Spodoptera* sp. and other crop pest. Kiviranta [20] and Singh [21] have reported the larvicidal activity of cyanobacteria. In addition, this extract probably affects the molting process and subsequent developmental processes. Summarwar and Pandy [22] have shown effect of plant extract *Azadirachta indica* on feeding behaviour of *Spodoptera litura*. Leaf extract of *A. indica* showed complete inhibition of feeding at 5% extract. Pathipati and Rajasekharreddy [23] have shown that the seed extract of the *S. foitida* acts as potential insecticide to the third instar larva of *Spodoptera litura* as well as antifeedant to *A. janata*. Deepika and Vijay [24] shown that effect of medicinal plant extracts on growth and development of tobacco caterpillar, *Spodoptera litura* (Fabricius). The effect of the algal extract on larval development of *Spodoptera litura* seen in our study is consistent with the above studies. Thus, it appears that the algal extract is toxic to larvae and is responsible for the death of larvae.

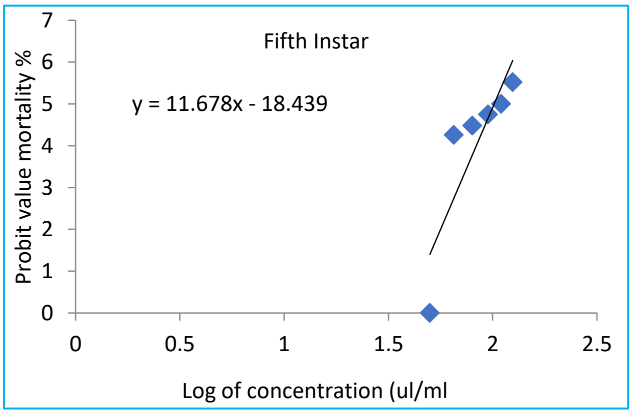
Relation between probit mortality and algal extract concentration showing regression line in first to fifth instar larvae of Spodopetra litura











CONCLUSION

The present study revealed the efficacy of algal extract against *Spodoptera litura* hence; we can conclude from the present study that it is possible to use the algal extract to control *Spodoptera litura* larvae. It suggests that the algal extract has demonstrated effectiveness against *Spodoptera litura* larvae, indicating a potential use for controlling the *Spodoptera litura* larvae.

LITERATURE CITED

1. Sahayaraj K, Paulraj MG. 1998. Screening the relative toxicity of some plant extracts to *Spodoptera litura* Fab. (Insecta: Lepidoptera: Noctuidae) of groundnut. *Fresenius Environ Bulletin* 7: 557-560.
2. Prashant K, Natikar, Balikai RA, 2015. Tobacco caterpillar, *Spodoptera litura* (Fabricius): toxicity, ovicidal action, oviposition deterrent activity, ovipositional preference and its management. *Biochem. Cell. Arch*. 15(2): 383-389.
3. Dhir BC, Mohapatra HK, Senapati B. 1992. Assessment of crop loss in groundnut due to 94 tobacco caterpillar, *Spodoptera litura* (F.). *Indian Journal of Plant Protection* 20: 215-217.
4. Carmichael WW. 1997. The cyanotoxins. *Advances in Botanical Research* 27: 212-256.
5. Sharanappa CH, Bheemanna M, Prabhuraj A, Naik Harischandra R, Naik Nagaraj M, Rao Saroja N, Kariyanna B. 2023. Toxic effect of cyanobacterial (blue–green algae) extracts as natural pesticides for the control of *Spodoptera frugiperda* (J. E.Smith) (Lepidoptera: Noctuidae). *Egyptian Journal of Biological Pest Control* 33: 77.
6. Murugan K, Dhingra S. 1995. Variability in resistance pattern ofvarious groups of insecticides evaluated against *Spodoptera litura* (Fabricus) during a period spanning over three decades. *Journal Entomology Research* 19: 313-319.

7. Armes NJ, Wightman JA, Jadhav DR, Ranga Rao GV. 1997. Status of insecticide resistance in *Spodoptera litura* in Andhra Pradesh, India. *Pestic. Science* 50: 240-248. doi: 10.1002/(SICI)1096-9063(199707)50:3<240: AID-PS579>3.0.CO;2-9.
8. Kranthi KR, Jadhav DR, Wanjari RR, Ali SS, Russell D. 2002. Carbamate and organophosphate resistance in cotton pests in India, 1995 to 1999. *Bull. Entomol. Research* 91: 37-46.
9. Sreelakshmi P, Mathew TB, Muralikrishna P, Ambily P. 2017. Insecticide resistance in field populations of tobacco caterpillar, *Spodoptera litura* Fabricius (Lepidoptera: Noctuidae). *Entomon* 42(1): 41-46.
10. Hong T, Qi S, Zhou X, Bai L. 2013. Field resistance of *Spodoptera litura* (Lepidoptera: Noctuidae) to organophosphates, pyrethroids, carbamates and four newer chemistry insecticides in Hunan, China. *Jr. Pest Science* 86: 599-609.
11. Ahmad M, Arif MI, Ahmad M. 2008. Occurrence of insecticide resistance in field populations of *Spodoptera litura* (Lepidoptera: Noctuidae) in Pakistan. *Crop Protection* 26: 809-817.
12. Pathak VM, Verma VK, Rawat BS, Kaur B, Babu N, Sharma A, Dewali S, Yadav M, Kumari R, Singh S, Mohapatra A, Pandey V, Rana N, Cunill JM. 2022. Current status of pesticide effects on environment, human health and it's eco-friendly management as bioremediation: A comprehensive review. *Front Microbiology* 13: 962619.
13. Mahakhant A. 1998. Control of the plant pathogenic fungus *Macrophomina phaseolina* in mung bean by a microalgal extract. *Psychol. Research* 46: 3-7.
14. Kiviranta J, Elise Saario A, Abdel-Hameed. 1994. Larvicidal microcystin toxins of cyanobacteria affect midgut epithelial cells of Aedes aegypti mosquitoes. *Medical and Veterinary Entomology* 8: 398-400.
15. Sathiyamoorthy P, Shanmugasundaram S. 1996. Preparation of cyanobacterial peptide toxin as a biopesticide against cotton pests. *Microbiology and Biotechnology* 46: 511-513.
16. Isman MB. 2006. Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. *Annu. Rev. Entomology* 51: 45-66.
17. Abbott WS. 1925. A method of computing the effectiveness of an insecticide. *Jr. Econ. Entomology* 18: 265-267.
18. Finney DJ. 1971. *Probit Analysis*. 3rd Edition. Cambridge University Press, Cambridge. pp 1971.
19. Ahmad R, Chu WL, Lee HL, Phang SM. 2001. Effect of four chlorophytes on larval survival, development and adult body size of the mosquito Aedes aegypti. *Jr. Appl. Phycology* 13: 369-374.
20. Kiviranta J, Saario E, Neimela SI. 1991. Toxicity of planktonic cyanobacteria (blue-green algae) to mosquito larvae. *Planta Medica* (Suppl.) 57A: 21-22.
21. Singh, Dhananjay P, Kumar A, Tyagi MB. 2002. Biotoxic cyanobacterial metabolites exhibiting pesticidal and mosquito larvicidal activity. *Jr. Micribiology and Biotechnology* 13(1): 50-56.
22. Summarwar S, Pandy J. 2013. Effect of plant extract *Azadirachta indica* on feeding behaviour of *Spodoptera litura*. *Indian Journal of Fundamental and Applied Life Sciences* 3(3): 46-51.
23. Pathipati UR, Rajasekharreddy P. 2009. Toxic and antifeedant activity of *Sterculia foitida* (L.) seed crude extract against *Spodoptera litura* and *Achea janata*. *Journal of Biopesticides* 2(2): 161-164.
24. Deepika Ch., Vijay KM. 2016. Effect of medicinal plant extracts on growth and development of tobacco caterpillar, *Spodoptera litura* (Fabricius). *International Journal of Agriculture, Environment and Biotechnology* 9(3): 435-442.