UTTAR PRADESH JOURNAL OF ZOOLOGY

43(18): 26-31, 2022
ISSN: 0256-971X (P)

ENHANCED TOXICITY OF BROWN ALGAL SEAWEED *Sargassum wightii* GREVILLE WITH ORGANIC INPUTS AGAINST RICE LEAF FOLDER *Cnaphalocrocis medinalis* GUENEE (LEPIDOPTERA: CRAMBIDAE) UNDER LABORATORY CONDITIONS

S. BALAMURUGAN [a*] AND R. KANNAN [a]

[a] Department of Entomology, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India.

AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.56557/UPJOZ/2022/v43i183167

Editor(s):
(1) Dr. Ana Cláudia Correia Coelho, University of Trás-os-Montes and Alto Douro, Portugal.
Reviewers:
(1) I Dewa Ayu Ratna Dewanti , University of Jember, Indonesia.
(2) Iqtidar Hussain , Gomal University, Pakistan.
(3) Carlos Henrique Marchiori , Instoituto Federal Goiano, Brazil.

Received: 25 July 2022
Accepted: 29 September 2022
Published: 07 October 2022

Original Research Article

ABSTRACT

Rice leaf folder (*Cnaphalocrocis medinalis* Guenee) as a key pest have imparted extensive leaf damage during the tillering stage of the crop and has been reported to cause more than 15% damage. The experiment was conducted to evaluate the enhanced insecticidal and IGR activity of solvent extracts (Acetone) of brown algal seaweed *Sargassum wightii* Greville in combination with organic inputs (Neem Leaf Extracts 3% and 5%) against rice leaf folder *C. medinalis* in the Seaweed Laboratory, Department of Entomology, Faculty of Agriculture, Annamalai University, Tamil Nadu, India during 2021-2022. The seaweed Extracts @ 6, 7 and 8 per cent alone and in combination of seaweed 6, 7, 8 percent with Neem Leaf Extracts 3 and 5 per cent concentrations were investigated for their enhanced toxicity (larvicidal and Insect Growth Regulator activity) against rice leaf folder compared with standard checks (Neem Leaf Extracts 3% and 5%). The highest mortality (66.66%) was observed in the combination treatment *S. wightii* seaweed extract 8 per cent + Neem Leaf Extract 5 per cent followed by *S. wightii* seaweed extract 8% with Neem Leaf Extract 3% which exerted 60.00 per cent mortality. The larva to adult conversion ratio of 1:0.13 in *S. wightii* seaweed extract 8% with Neem Leaf Extract 5% was the least when compared with other treatments whereas *S. wightii* seaweed extract 8% with Neem Leaf Extract 3% was the effective treatment in the second experiment with a larval and adult conversion ratio of

**Corresponding author: Email: sbala512945@gmail.com;*

1:0.20 meanwhile no mortality was observed in both untreated controls in both the experiments. The combination effect of *S. wightii* seaweed extract 8% with Neem Leaf Extract 5% was superior than other treatments in reducing the larval vitality, pupation and also influenced insect growth regulator activity in the pupal and adult stages of insect which would be recommended for the future IPM programmes.

Keywords: Rice; leaf folder; brown algal seaweed; *Sargassum wightii;* combination effect; insecticidal activity; insect growth regulator activity.

1. INTRODUCTION

Rice is a key cereal crop and a staple meal for a large proportion of the world's population, especially in Southeast Asia. In agriculture, rice covers around 162 million hectares of land worldwide, yielding 755 million tonnes [1]. With 43.76 million hectares under cultivation and 124.36 million tonnes produced at a yield of 2717 kg per hectare, India was the world's largest rice producer [2]. Damage caused by insect pests was one of the most prominent limiting factors among the different biotic stresses that have hampered the successful growth of rice crop. "The Rice leaf folder *Cnaphalocrocis medinalis* Guenee (Lepidoptera: Crambidae) has been reported as a major problem in rice growing areas of South East Asia in recent years" [3]. Young larvae eat on the tender leaves that are not folded whereas the older larvae secrete a sticky material to adhere the longitudinal margins of the leaf together and scrap the green matter inside the fold to feed. The yield loss has been reported as 15 per cent from the leaf folder damage [4]. In conventional agriculture, farmers used variety of inputs including chemicals from seed to seed. In modern agriculture, chemical inputs (insecticide, herbicide, fungicide, fertilizers) are unavoidable and the detrimental effects due to their indiscriminate use also unavoidable which lead to many negative consequences which can be mitigated to some extent by utilizing alternative approaches. Plants are rich source of bioactive chemicals and secondary metabolites and several of these molecules have been extensively used in commercial botanical pesticide production and formulation [5]. "Researchers and researches were lured towards seaweeds which are abundant in oceans and seas around the world and have been discovered to contain various bioactive biogenic molecules and secondary metabolites with a wide array of biological functions such as antibacterial, antiviral, fungistatic, nematicidal, insecticidal activities etc". Xin Yu et al. [6]; Ishii et al. [7]; Kannan and Dharani Priya [8], have demonstrated that marine algae have the ability to combat several insect pests. In this context, the enhanced toxicity of brown algal seaweed *Sargassum wightii* Greville with organic inputs was investigated against the Rice leaf folder under laboratory conditions and the results were documented and presented.

2. MATERIALS AND METHODS

The brown algal seaweed, *S. wightii* was hand-picked from deep-sea regions of the coast of Rameswaram, Tamil Nadu in collaboration with Aquagri Processing Pvt Limited, Manamadurai, India. Collected algae were washed in seawater to remove salt, sand, and epiphytes, then it was washed three times with running tap water. The dried seaweeds were stored at room temperature under dry circumstances after being washed and shade dried for a fortnight.

"Rice leaf folder mass cultured under greenhouse conditions (25°C and 60% RH), the *C. medinalis* was kept alive on Taichung Native-1 (TN1) plants. Adult moths collected from the field were introduced (10 pairs) for oviposition on TN1 plants (20 to 25 days old) kept inside a screen house. Adults were given honey solution (20%) rinsed in a cotton swab soaked as a source of nourishment. The potted TN1 plants inhabit the adults for oviposition and the laid eggs were separated and retained for continued development after a 3-day pre-oviposition period. The neonates, third instar and newly emerged adult moths from this stock culture were utilized for the experiments" [9].

The solvent extract preparation by coarsely dusted *S. wightii* was separately weighed at 6, 7, 8 grams and for combination treatments seaweed 6, 7, 8 grams were mixed with Neem Leaf Extract 3% and 5% respectively Then it is homogenized in 100ml solvent (acetone) and digested for 12 hours at room temperature until being filtered. The filtered extracts were kept refrigerated at 4°C and used for bioassay.

The bioassay experiment was laid out in a completely randomized design with nine treatments under three replications. Five-centimeter rice leaf bits were dipped in one per cent Tween-20 solution to remove the wax layer. The leaf bits were soaked in respective concentration of extracts for 10 minutes and the dried treated leaf bits were placed inside the Petri dishes (five leaf bits per petri plate) separately and provided with required moisture using wet filter paper. Four hours pre-starved third instar (homogeneous population) were placed in each Petri plate and allowed to feed on the treated leaf bits. In order to compare the performance of the seaweed extract,

standard checks (Neem Leaf Extract 3% and 5%), solvent control (1%) and untreated control were maintained. The observations on larval mortality at 24, 48 and 72 hours of exposure and pupation percentage, pupal malformation, adult emergence and larva to adult conversion ratio was made and the data were pooled and statistically analyzed and presented.

3. RESULTS AND DISCUSSION

Investigations to assess the larvicidal and insect growth regulator activity of *S. wightii* individually and its combination with organic inputs (Neem Leaf Extracts 3% and 5%) on *C. medinalis* have demonstrated the following results. The larval death was observed only after 24 hours of treatment and gradually increased up to 72 hours and the per cent morality was ranged between 0.00 and 66.66 per cent. After 24 hours, larval mortality was exhibited at the highest level (53.33%) in the combination treatment (*S. wightii* seaweed extract 8% with Neem Leaf Extract 5%). Among the different concentrations, the minimum larval mortality was noticed in *S. wightii* seaweed extract 6 per cent alone, but the effect differs with concentrations and no larval mortality was observed in untreated and solvent control treatments (Fig. 1). At 48 hours, *S. wightii* seaweed extract @ 6 per cent alone performed low (26.66%) when compared to combination of *S. wightii* seaweed extract 7 and 8% with Neem Leaf Extract 5% showed 60 per cent mortality (Fig. 2). The data obtained after 72 hours reiterated that seaweed alone performed the least level of mortality when compared to combination of organic products (Neem Leaf Extracts 3% and 5%). The seaweed alone treatment (6%) showed 40 per cent mortality and *S. wightii* seaweed extract 8% with Neem Leaf Extract 5% demonstrated 66.66 per cent mortality (Fig. 3). The pre pupal mortality was higher in seaweed extracts with combination of Neem Leaf Extract 3% and 5% recorded 13.33%. The pupation percentage was maximum in lower concentration of seaweed alone and minimum in combination of *S. wightii* seaweed extract 8% with Neem Leaf Extract 5% was 20 per cent. The toxic effect of acetone solvent extracts of *S. wightii* with combination of Neem Leaf Extracts 3% and 5% was observed as pupal malformation and the deformed pupae were not converted in to adults. The adult emergence per cent was reduced, probably due to toxic effect exposed in the larval, pre-pupal and pupal stage of the test insect. The adult emergence percentage was recorded higher in seaweed 6% alone and lower in combination of *S. wightii* seaweed extract 8% with Neem Leaf Extract 5% was 13.33% (Fig. 4). In absolute and solvent control, the larva to adult conversion ratio was 1:1 whereas in combination of *S. wightii* seaweed extract 8% with Neem Leaf Extract 3% displayed 1:0.20 ratio (Table 1) and in combination of *S. wightii* seaweed extract 8% with Neem Leaf Extract 5% revealed 1:0.13 ratio (Table 2). These findings are in close proximity to the results observed from the investigations of following researchers and their views are disclosed as given below. Silver nano particles synthesized from aqueous extract of *Sargassum muticum* (SmAgNps) reported a greater toxic effect on Lepidopteran insect *Ergolis merione* [10]; Ethanol extract of *Dictyota dichotoma* proved its toxicity against the larvae of *Aedes albopictus* with 90 per cent larval mortality [11]; Insecticidal property of different solvent (chloroform, methanol, petroleum ether and acetone) extracts of *Padina gymnospora* and *Caulerpa racemosa* against the larvae of *Aedes aegypti* and *Culex quinquefaciatus* [12]; "Methanol extracts of brown algal seaweed *Sargassum cristaefolium* against *Spodoptera litura* with a higher level of larval mortality and insect growth regulator activity of *S. litura"* [13]; Examination of repellent and insecticidal activity of *Caulerpa sertularioides, Laurencia johnstonii* and *Sargassum horridum* extracts on *Diaphorina citri* fetched a higher level of success [14]. Toxic effect of *Spirulina platrnsis* and *Sargassaum vulgar* against *Spodoptera littoralis* were found greater mortality on different instars of the tested larvae [15]; Acetone extracts of *S. wightii* (200µl/ml) showed 60 per cent mortality against *Spodoptera litura* [16].

Table 1. Evaluation of larva to adult conversion ratio of acetone extracts of *Sargassum wightii* and its combination with neem leaf extract 3% against rice leaf folder

Treatment	Larval: Adult conversion ratio
SW6%	1:0.53
SW7%	1:0.53
SW8%	1:0.46
SW6%+NLE 3%	1:0.26
SW7%+NLE 3%	1:0.26
SW8%+NLE 3%	1:0.20
NLE 3%	1:0.46
Solvent control	1:1
Untreated control	1:1

**SW - Sargassum wightii, NLE - Neem Leaf Extract*

Table 2. Evaluation of larva to adult conversion ratio of acetone extracts of *Sargassum wightii* and its combination with neem leaf extract 5% against rice leaf folder

Treatment	Larval: Adult conversion ratio
SW6%	1:0.60
SW7%	1:0.53
SW8%	1:0.53
SW6%+NLE 5%	1:0.20
SW7%+NLE 5%	1:0.20
SW8%+NLE 5%	1:0.13
NLE 5%	1:0.33
Solvent control	1:1
Untreated control	1:1

**SW - Sargassum wightii, NLE - Neem Leaf Extract*

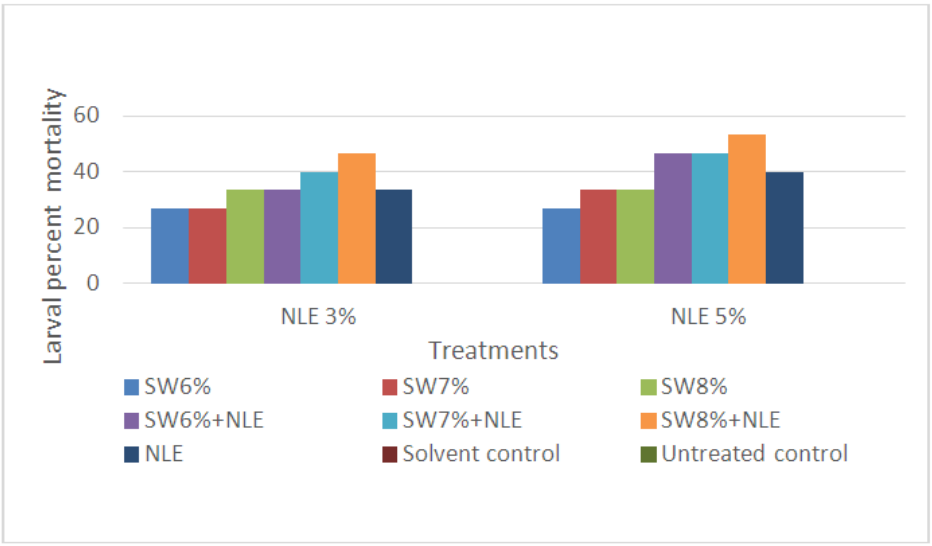

Fig. 1. Enhanced toxicity of *S. wightii* solvent extract alone and their combination treatments against rice leaf folder at 24 hrs

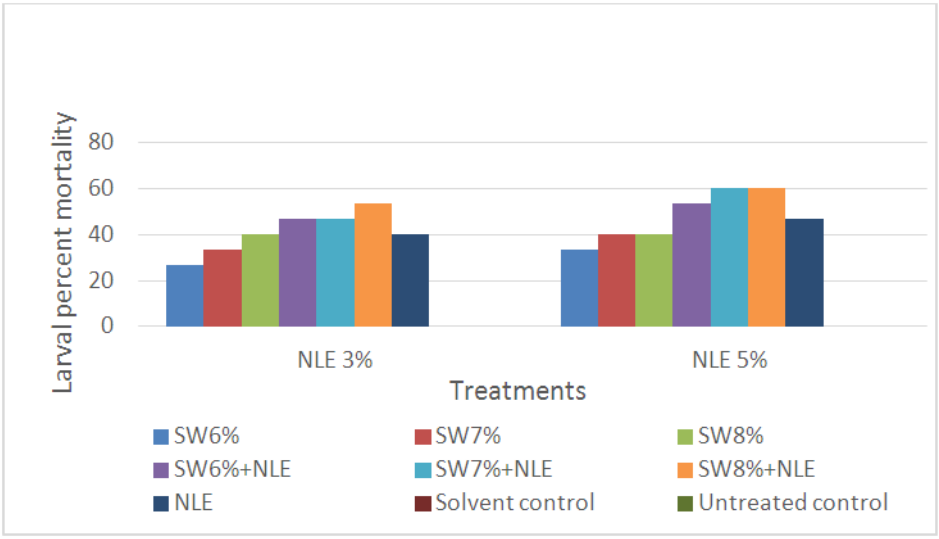

Fig. 2. Enhanced toxicity of *S. wightii* solvent extract alone and their combination treatments against rice leaf folder at 48 hrs

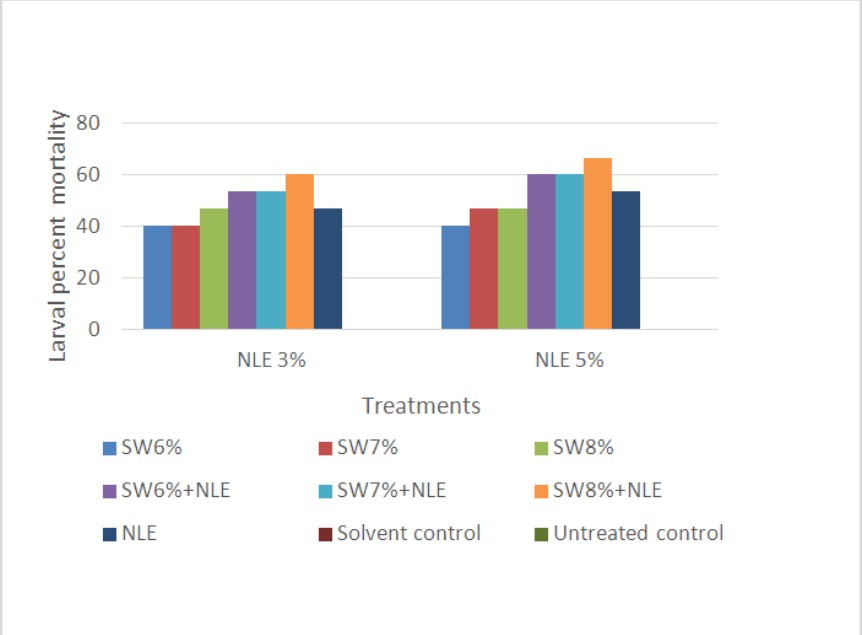

Fig. 3. Enhanced toxicity of *S. wightii* solvent extract alone and their combination treatments against rice leaf folder at 72 hrs

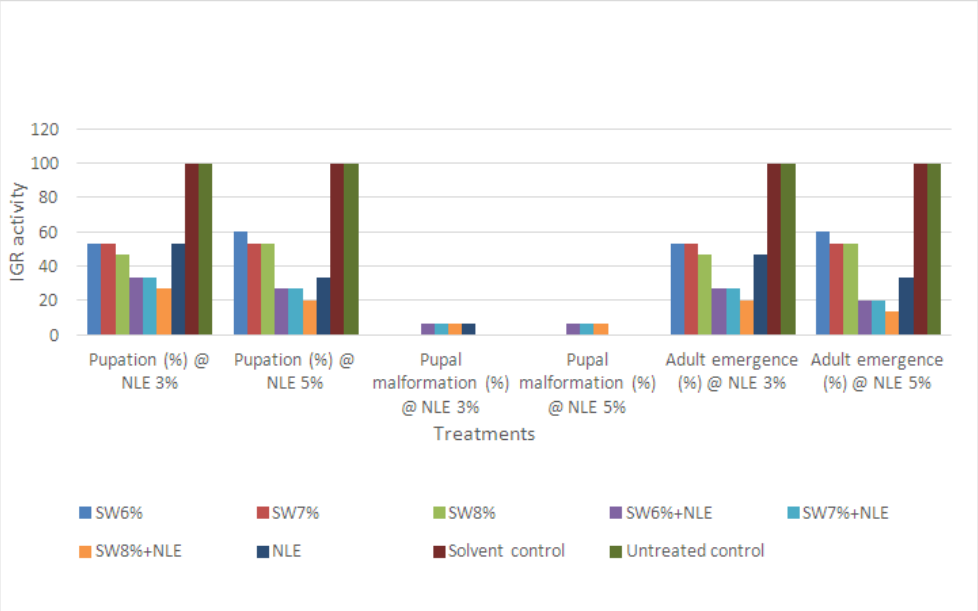

Fig. 4. IGR activity of *S. wightii* solvent extract alone and their combination treatments against rice leaf folder

4. CONCLUSION

The present investigation showed that the combination of the seaweed extract 8 per cent with Neem Leaf Extract 5 per cent performed better than the seaweed alone and it can be utilized in the formulation of botanical insecticide to manage the insect pests in field conditions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Shaheen SM, Antoniadis V, Shahid M, Yang Y, Abdelrahman H, Zhang T. Sustainable applications of rice feedstock in agro-environmental and construction sectors: A global perspective. Renew Sustain Energy Rev. 2022; 153:111791.
2. Agricultural Statistics at a Glance. New Delhi: Directorate of Economics and Statistics, Government of India, Ministry of Agriculture, Department of Agriculture and Cooperation; 2021 [cited Dec 5, 2021]. Available from: https://www.indiastat.com.
3. Rizwan M, Atta B, Rizwan M, Sabir AM, Tahir M, Sabar M. Silicon plays an effective role in integrated pest management against Rice Leaf folder Cnaphalocrocis medinalis Guenee (Lepidoptera: Pyralidae). Pak J Zool. 2021:1-7.
4. Kannan R, Kathirvelu C, Veeravel R. Crop pest management. Manibharathi Achagam Chidambaram Tamilnadu India. 2016:7-8.
5. Prakash N, Kumari B, Karn S. Biopesticides: introduction and its prospects. Int J Curr Microbiol Appl Sci. 2019;8(2):2960-4.
6. Yu X, Lee Wong C, Ahmad R, Jantan I. Larvicidal activity, inhibition effect on development, histo pathological alteration and morphological aberration induced by seaweed extracts in Aedes aegypti (Diptera: Culicidae). Asian Pac J Trop Biomed. 2015;8(12):1006-12.
7. Ishii T, Shinjo Y, Miyagi M, Matsuura H, Abe T, Kikuchi N. Investigation of insect repellent activity of cyclocolorenone obtained from the red alga Laurencia intricata. Rec Nat Prod. 2018;10(10):20.
8. Kannan R, Priya D, N. Studies on methanolic extract of brown algal seaweed Liagora ceranoides J.V. Lamouroux from Southern Coast of Tamil Nadu: in vitro anti-insect properties and phytochemicals. Nat Prod Chem Res. 2019;7(1):354.
9. Javvaji S, Maheswari Telugu U, Damarla Bala Venkata R, Sheshu Madhav M, Rathod S, Chintalapati P. Characterization of resistance to rice leaf folder, Cnaphalocrocis medinalis, in mutant Samba Mahsuri rice lines. Entomol Exp Appl. 2021;169(9):859-75.
10. Moorthi PV, Balasubramanian C, Mohan S. An improved insecticidal activity of silver nanoparticle synthesized by using Sargassum muticum. Appl Biochem Biotechnol. 2015;175(1):135-40.
11. Minicante SA, Carlin S, Stocco M, Sfriso A, Capelli G, Montarsi F. Preliminary results on the efficacy of macro algal extracts against larvae of Aedes albopictus. J Am Mosq Control Assoc. 2017;33(4):352-4.
12. Selvi V, Shameemrani K. Efficacy of Aedes aegypti and Culex quinquefasciatus against Sargassum wightii and Ulva fasciata. Int J Sci Appl Res. 2018;5(9):16-26.
13. Gowthish K, Kannan R. Bioefficacy of brown algal seaweed, Sargassum cristaefolium C. against a cosmopolitan pest, Spodoptera litura Fabricius (Lepidoptera: Noctuidae). Multilogic in Science. 2018; 8:56-7.
14. González-Castro AL, Muñoz-Ochoa M, Hernández-Carmona GH, López-Vivas JM. Evaluation of seaweed extracts for the control of the Asian citrus psyllid Diaphorina citri. J Appl Phycol. 2019;31(6):3815-21.
15. Rashwan RS, Hammad DM. Toxic effect of Spirulina platensis and Sargassum vulgaras natural pesticides on survival and biological characteristics of cotton leaf worm Spodoptera littoralis. Sci Afr. 2020;8:e00323.
16. Niroja D, Kannan R. Anti-insect properties of a potential marine algae Sargassum wightii against S. litura Fabricius. Pestology. 2020;44(2):17-20.