Nat. Volatiles & Essent. Oils, 2021;8(2): 205-214

NVEO
Natural Volatiles & Essential Oils

Control Of Cotton Pest (Mylabris Cichorii) Using Azadirachta Indica Leaf And Stem Bark Extracts

Y.S. Santhi Pon Indira[1*]

[1*]Associate Professor of Zoology, Pope's College, Sawyerpuram – 628251
shanthiyesudian@gmail.com

***Corresponding Author:** Y.S. Santhi Pon Indira
*Associate Professor of Zoology, Pope's College, Sawyerpuram – 628251
shanthiyesudian@gmail.com

ABSTRACT

The present study was investigated important medicinal plant extract *A. indica* stem bark aqueous extract against the fourth instars larvae of cotton Pest, During the experimental period insects' weight were significantly decreased from 24, 48, 72 and 96 hrs of exposure time of leaves and stem bark aqueous extract of *A. indica* treated against *M. cichorii*. The high percent mortality presents in the 800-ppm concentration of *T. arjuna* at 96 hrs exposure time of leaves extract followed by 600, 400, and 200 ppm, respectively. The high percentage mortality was observed in the 800-ppm concentration of *A. indica* at 96 hrs exposure time of leaves extract followed by 600, 400, and 200 ppm, respectively. The high percentage mortality was observed in the 400-ppm concentration of *A. indica* at 96 hrs exposure time of stem bark extracts followed by 800, 600, and 200 ppm, respectivel. These results have been suggested that the *A. indica* plant leaves and stem bark aqueous extracts were used as the integral pest management studies of the cotton pest, *M. cichorii*.

Key words: Biocidal activity, cotton pest management, *M. pustulata*, *A. indica,* mortality rate, weight of the insect.

INTRODUCTION

India is gifted with varied agro-climatic conditions for growing an array of vegetable crops to combat the present ill-balanced diet. The eggplant/brinjal belongs to the family Solanaceous and to the genus Solanum, species melongena. The egg plant, Guinea squash are some synonyms to brinjal. It is a hardy crop and does best in worm and moist climate. The crop is generally grown twice or thrice in a year. The edible part, fruit is of high nutritive value and can well be compared with tomatoes. Insect pest constitutes the major limiting factors in the successful production of eggplant. In the sub-Himalayan region of north east India eggplant is cultivated at a commercial scale but insect and mite pest damage constitutes a limiting factor for its successful production (Ghosh 1999). In the subHimalayan region of north east India major vegetables like eggplant, ladysfinger cabbage, cauliflower etc are cultivated at a commercial scale but insect and mite pest damage constitutes a limiting factor for its successful production (Ghosh et al., 1999; Ghosh et al., 2000; Ghosh and Senapati 2001a; Ghosh and Senapati 2001b; Chaudhury et al., 2001). Hadda/ spotted beetle (Epilachne vigintioctopunctata), aphid (Aphis gossypii), leafhopper (Amrasca biguttula biguttula), thrips (Thrips tabaci), spider mite (Tetranychus spp.), blister beetle (Mylabris pustulata Thunberg) and white fly (Bemisia tabaci) are the important pests of eggplant causes heavy damage (Ghosh, 1999). Pest complex of eggplant is very high and blister beetle causes heavy 118 damage to the crop. These beetles are brightly colored insects that secrete a compound containing cantharidin when disturbed. Cantharidin, a terpenoid, produces blisters on human skin upon contact and hence these beetles are called "blister" beetles. In general, this is a minor pest, although occasional outbreaks can occur.

MATERIALS AND METHODS

Collection and preparation of stem bark and leaves of *A. indica*

The barks and leaves of *A. indica* were collected from our college campus, The barks of the plant were washed thoroughly with distilled water to remove dust and other particles. The washed plant part is then dried at room temperature. The collected *A. indica* barks and leaves were cut into small pieces. The plant parts were dried in an incubator for 7 days at 40^0C, crushed in an electrical grinder and then the powder was separated.

Extraction Methods

For extraction of secondary metabolites cold percolation methods (Thillairajasekar *et al*., 2009; Das *et al*., 2010) was followed.

Cold percolation method

For cold percolation method, 250 gm of the powdered stem bark of *A. indica* material was soaked with 750 ml (1:3 w/v) of selected aqueous in an aspirator bottle for 48 hrs at room temperature. The extract was filtered through a funnel with Whatman number 1 filter paper. After filtration, the filtered extract was poured into the distillation unit at 20º C for separation of the solvent and the secondary metabolites residue (10 mL) was evaporated and dried over sodium sulphate in a desiccator under vacuum. The crude extracts were stored in the refrigerator (LG, India) for further use. The extraction rate was calculated by weighing the crude extracts obtained from 100 g of dry plant material after extraction with respective solvent.

Pest collection and rearing

Nymphs and adults of *M. cichorii,* were collected from cotton fields. The collected pests were maintained in the insectory under laboratory conditions (temperature 28 ± 2°C, 70 ± 5 % RH and a photoperiod of 11L: 13D hrs) in transparent plastic containers (8cm height × 6.5cm diameter) containing a layer of sterile coarse sand (4cm thick). Insects were fed with its natural host cotton flower and also cotton bolls. Insects were maintained at least for 2 generations. The laboratory emerged 6-12 hrs old third stadium *M. cichorii* were used for this experiment.

2.8. Nymphicidal activity bioassay

Bioassay studies were carried out using uniform sized (24.7±0.4 mg weight), 6-12 hrs old third stadium *M. cichorii.* which was selected randomly from the stock culture. Five insects were placed in a transparent plastic container (8 cm height × 6.5 cm diameter). Different concentrations of *A. indica* stem bark aqueous extracts [200, 400, 600 and 800ppm (4mg extract in 5ml diet- 800 ppm)] mixed in aqueous. Experimental animals were allowed to feed for 96 hrs continuously. 200µL of aqueous extracts of stem bark was pour into the small cotton flowers and provided to the insects. The food was changed every day. Three replications were maintained for each concentration. Mortality was recorded every 24 hrs, till 96 hrs. The mortality was corrected using Abbott's formula (Abbott, 1925), if more than 10% mortality was observed in control category. The corrected mortality data was subjected to probit analysis (Finney, 1971) to find out the LC_{50}, Chi square, df and p values. After 96 hrs, live nymphs were provided with water-soaked cotton flowers till their death.

RESULTS

During the experimental time the weight of the insect was significantly decreased in 800 ppm (t=3.5; df= 5; p=0.057), 400 ppm (t=10.07; df=5; p=0.000) and 600 ppm (t=18.31; df=5; p=0.000) at 24 hrs of exposure time of stem bark aqueous extract compare to control at 200 ppm the weight was increased when compare to control (Figure 1). During the experimental time the weight of the insect was significantly decreased in 800 ppm (t=5.5; df= 5; p=0.057), 200 ppm (t=10.07; df=5; p=0.000), 400 ppm (t=17.31; df=5; p=0.000) and 600 ppm (t=10.07; df=5; p=0.000) and 800 ppm (t=16.07; df=5; p=0.000) at 48 hrs of exposure time of stem

bark aqueous extract when compare to control (Figure 2). During the experimental time the weight of the insect was significantly decreased in 400 ppm (t=32.55; df=5; p=0.000), 200 ppm (t=19.20; df=5; p=0.000), 600 ppm (t=16.10; df=5; p=0.000) and 800 ppm (t=17.10; df=5; p=0.000) at 72 hrs of exposure time of stem bark aqueous extract when compare to control (Figure 3). During the experimental time the weight of the insect was significantly decreased in 800 ppm (t=26.55; df=5; p=0.000), 200 ppm (t=19.10; df=5; p=0.000), 600 ppm (t=15.00; df=5; p=0.000) and 400 ppm all the animals are dead at 96 hrs of exposure time of stem bark aqueous extract when compare to control. The high percentage mortality was observed in the 400-ppm concentration of *A. indica* at 96 hrs exposure time of stem bark extracts followed by 800, 600, and 200 ppm, respectively (Figure 4).

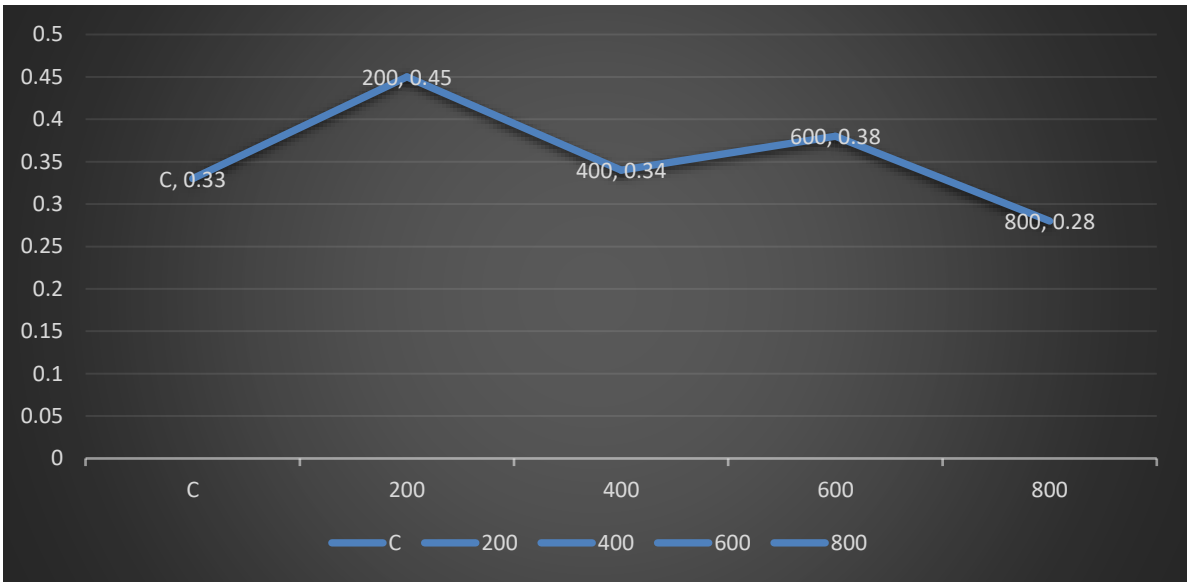

Figure 1. Effect of *A. indica* stem bark aqueous extract on whole body wet weight (g) of *M. cichorii* nymphs at 24 hrs

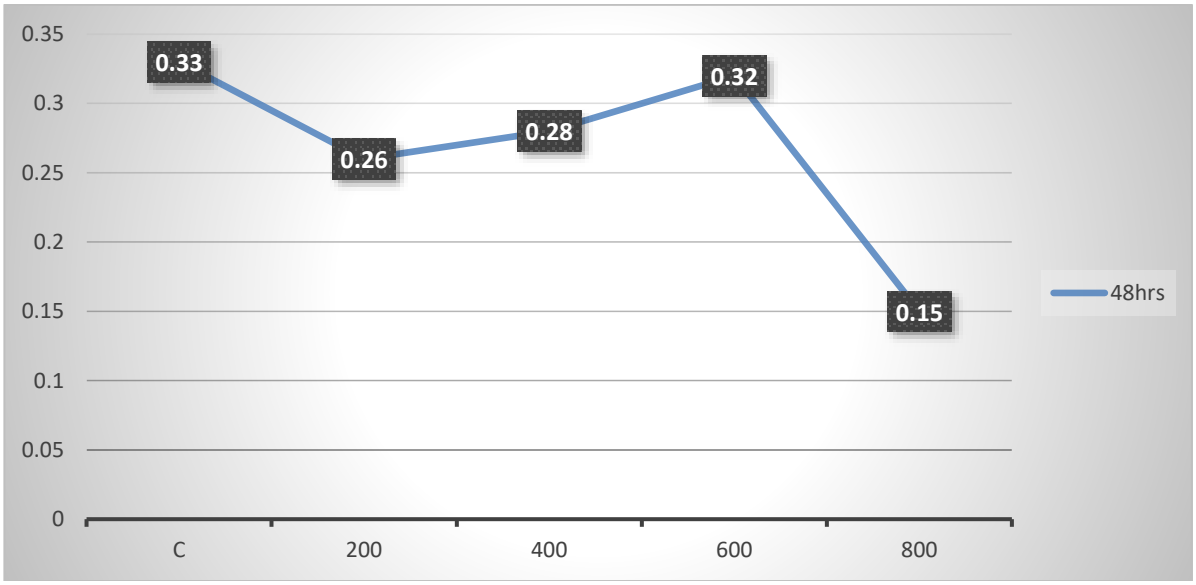

Figure 2. Effect of *A. indica* stem bark aqueous extract on whole body wet weight (g) of *M. cichorii* nymphs at 48 hrs

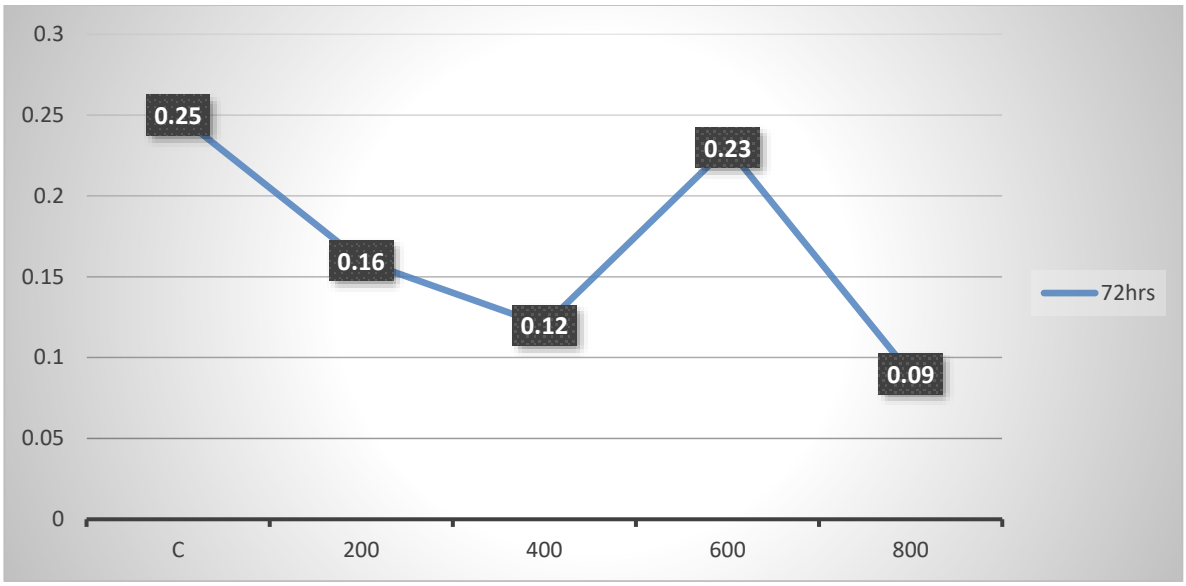

Figure 3. Effect of *A. indica* stem bark aqueous extract on whole body wet weight (g) of *M. cichorii* nymphs at 72 hrs

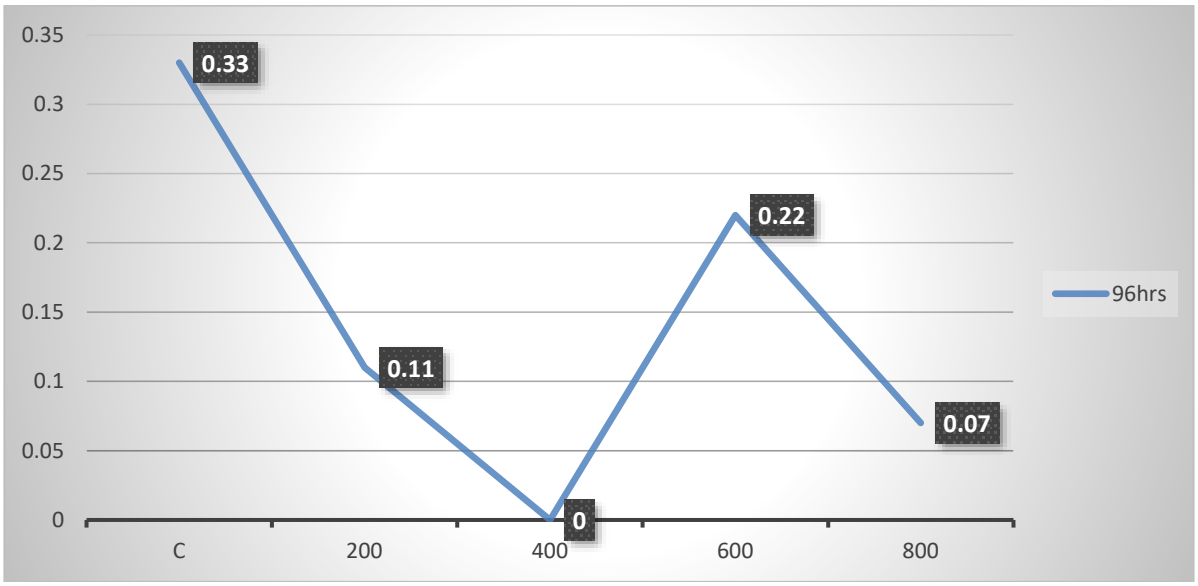

Figure 4. Effect of *A. indica* stem bark water extract on whole body wet weight (g) of *M. cichorii* nymphs at 96 hrs

DISCUSSION

During this study, toxicity and effectiveness of 2 2-tridecanone formulations were assessed against S. invicta. In field path, at application rate of 5.28 ml/L and 14 days once mound drench treatment, 100% management was achieved for formulation with piperonyl butoxide (PBO) and 9th management for the formulation while not PBO (Chen, 2016). Signified that antifeedants can be found amongst all the major classes of secondary metabolites, viz., alkaloids, phenolics, and terpenoids which the most probable toxic substances against insects. The ethyl acetate extract of the plant diminished the feeding rate of *S. litura*. The is indicated that the active principles present in the plants retard larval feeding department or make the food unpalatable or the substances directly act on the chemo essentials of the larval resulting in feeding deterrence. Several investigators have already reported that botanicals offer antifeedant action against *S. litura* (Arivoli, 2012). Mendhulkar et al., 2014 investigation that the liquid extracts of *Couroupita guianensis* leaves show high insecticidal impacts on nymphs and adult flies, whereas low effect on the eggs of *Bemisia tabaci* as compared to regulate. Ahmad et al.2013 effectuality the insecticidal activity of *Allium sativum*, *Zingiber officinale*, and *Nigella sativa* extracts against the larvae of *Trogoderma granarium*. The

very best concentration of (6%) *Z. officinale* was found to be relatively a lot of cytotoxic (16.70%) than those of *A. sativum* (10.45%) and *N. sativa* (5.49%) at 96 hrs exposure. In conclusion, nourishment of *T. arjuna* and leaves and bark aqueous extracts were tested against fourth instars larvae of *M. pustulata*, the present investigation suggested that the *T. arjuna* plant leaves and stem bark aqueous extracts were used as the integral pest management studies of the cotton pest, *M. pustulata*.

REFERENCES

1. Abbott, W. S. 1925. Methods for comparing the effectiveness of an insecticide. *Journal of Economic Entomology,* **18**: 265-267.
2. Anand R. K. (1978) Blister beetle as pest on agricultural crops. Ind J Ent., 40: 472.
3. Argandona, V., Del Pozo, T., San Martin, A. and Rovirosa, J. 2000. Insecticidal activity of *Plocamium cartilagineum* monoterpenes. *Bolet del la Sociedad Chilena de Qu Ca*, **45**(3): 1-6.
4. Baerg, W.J. (1925). Control measures for blister beetles. University of Arkansas, College of Agriculture, Arkansas Agricultural Experiment Station, no. 201, 8pp.
5. Bailey, L. and Ball, B.V. (1991). Honeybee pathology. London, Academic Press limited, 2nd ed. p. 193.
6. Beach, K. S., Smith, C. M., Michael, T. M. and Shin, H. W. 1995. Photosynthesis in reproductive unicells of *Ulva fasciata* and *Enteromorpha flexuosa*: Implications for ecological success. *Marine Ecology Progress Series*, **125**:129-137.
7. Bharathi, D. and Govindappa, S. (1990). Effect of carbaryl on the oviposition, hatchability and organic constituents of the egg mass of blister beetle, Mylabris pustulata (Thunb) (Coleoptera: Meloidae). Indian J Entomol., 52 (4): 574-578.
8. Biju, B., Jacob, M., Padmakumar, K. and Muraleedhran, D. 2004. Effect of extract of the seaweed *Bryopsis plumose* (Huds.) (Ag) on the feeding rate and protein profile of haemolymph and fat body of *Hyblaea guera* (Cramer) (Lepidoptera: Hyblacidae). *Entomon,* **29**: 271-276.
9. Biswas, S., Das, K. and Ghosh. S.K. (2009). field efficacy of different insecticides and neem against Earias vittela fab. on okra. Journal of entomological Research 33 (4): 331-333. ISSN-0378-9519.
10. Blochtein, B. and Wittmann, D. (1988). Mating site specificity, reproduction and vector selection in Nemognatha nigrotarsata (Col., Meloidae), a nest parasite of leaf-cutter bees and other pollinators of crops in Rio Grande do. Sul. J. Appl. Entomol., 105(1-5): 414-419.
11. Blodgett, S., Denke, P.M. and Knerr, V. (2010). Blister beetles of Montana. Agriculture and Natural Resources (Pest Management), Montana State Univer., 4 pp.
12. Blodgett, S.L., Higgins, R.A. and Milliken, G.A. (1995). Blister beetle (Coleoptera: Meloidae) mortality evaluated during alfalfa harvest. J. Econ. Entomol., 88: 398-406.
13. Bologna, M.A., Olverio, M., Pitzalis, M. and Mariottini, P. (2008). Phylogeny and evolutionary history of the blister beetles (Coleoptera, Meloidae). Molec. Phylogen. Evol., 48: 679-693.
14. Capinera, J.L. (2003). Striped blister beetle, Epicauta vittata (Fabricius) (Coleoptera: Meloidae). EENY-280, Institute of Food and Agricultural Sciences, University of Florida. 134.
15. Cetin, H., Gokoglu, M. and Oz, E. 2010. Larvicidal activity of the extract of seaweed, *Caulerpa scalpelliformis*, against *Culex pipiens. Journal of American Mosquito Control Association,* **26**(4):433-435.
16. Chaudhury, N., Ghosh, S.K., Ghosh, J. and Senapati, S.K. (2001). Incidence of insect pests of cabbage in relation to prevailing climatic conditions of terai region. Indian Journal of Entomology. 63(4):421-428. ISSN0367-8288.
17. Cohen, A.C. and Cohen, J.L. (1990). Ingestion of blister beetles by a Texas horned lizard. Southwestern Naturalist, USA, 35(3): 369-371. COPR (Centre for Overseas Pest Research) (1981) Pest Control in Tropical Grain Legumes. London, UK. pp 206.
18. Cordeiro, R. A., Gomes, V. M., Carvalho, A. F. U. and Melo, V. M. M. 2006. Effect of proteins from the red seaweed *Hypnea musciformis* (Wulfer) Lamouraux as the growth of human pathogen yeasts. *Brazilian Archieves of Biology and Technology*. **49**(6): 915-921.
19. Del Val A. G., Platas, G. and Basilio, A. 2001. Screening of antimicrobial activities in red, green and brown macroalgae from Gran Canaria (Canary Islands, Spain). *International Microbiol*ogy, **4**: 35-40.
20. Dhaliwal, T.S., Singh, B. and Atwal, A.S. (1974). Cyaneolytta acteon (Laporte) (Coleoptera: Meloidae) a new pest of maize and bajra. Current Science, 43(23): 765.

21. Dhamdhere, S. V. and Bhonsle, S. (1992) Foliage feeding insects of brinjal and their control. Rural India. 55: 92-95.
22. Dhamdhere, S., Dhamdhere, S. V. and Mathur, R. (1995) Occurrence and succession of pests of brinjal, Solanum melongena Linn. at Gwalior (Madhya Pradesh), India. J Ent Res 19: 71-77. Dhingra, S. (1996). Effect of different vegetable oils on the toxicity of cypermethrin in mixed formulations to the adults of Mylabris pustulata Thunb. J. Entomol. Res., 20(1): 19-22.
23. Dhingra, S. and Prakash, S. (1992). Detection of resistance in the blister beetle, Mylabris pustulata Thunb. to various insecticides evaluated during the last quarter century. J. Entomol. Res., 16(3): 231-235.
24. Dorow, E. and Rembold, H. (1993). Present practices of controlling desert locust outbreaks. New strategies, pp 89.
25. Durairaj, C. and Ganapathy, N. (1999) Toxicity of nine insecticides to three species of blister beetle (Mylabris spp.) in pigeonpea (Cajanus cajan). Indian J agric Sci 69: 468-69.
26. Dutta, M. and Singh, V. (1989) Blister beetle (Mylabris phalerata), a serious pest of pigeonpea in the lower hills of Uttar Pradesh. Int Pigeonpea Newsl., 10: 29-30.
27. EI Sayed, K. A., Dunbar, D. C., Perry, T. L., Wilkins, S. P. and Hamann, M. T. 1997. Marine natural Products as Prototype insecticidal agents. *Journal of Agriculture Food*
28. El-Gharbawy, A.A. (2006). Taxonomic revision of the genus Meloe Linnaeus (Meloidae: Coleoptera) in Egypt. Al-Azhar Bull. Sci., 17(2): 91-101.
29. Ely, R., Supriya, T. and Naik, C. G. 2004. Antimicrobial activity of marine organisms collected off the coast of South East India. *Journal of Experimental Biology and Ecology,* **309**: 121-127.
30. Febles, C. I., Arias, A., Gil-Rodriguez, M. C. 1995. *In vitro* study of antimicrobial activity in algae (Chlorophyta, Phaeophyta and Rhodophyta) collected from the coast of Tenerife (in Spanish). *Anuario del Estudios Canarios*, **34**: 181-192.
31. Finney, D. J. 1971. Probit analysis Cambridge University Press, London. Fuseini, B. A. and Kumar, R. 1975. Ecology of cotton strainers (Heteroptera: Pyrrhocoridae) in southern Ghana. *Biological Journal of Linnaean Society*, **7**: 113-146.
32. Gaglianone, M.C. (2005). Nesting biology, seasonality and flower hosts of Epicharis nigrita (Friese, 1900) (Hymenoptera: Apidae: Centridini), with a comparative analysis for the genus. Studies Neotropical Fauna Environ., 40: 1-10.
33. Gahukar, T.(1991). Pest status and control of blister beetles in West Africa. Trop. Pest Manage., 37(4): 415-420.
34. Garg, D. K. (1985) Blister beetles feeding on pigeonpea and other crops in Kumaon Hills of Uttar Pradesh, India. Int Pigeonpea Newl 4: 54-55.
35. Ghosh, J., Ghosh, S.K., Chatterjee, H. and Senapati, S.K. (1999). Pest constraints of Okra under terai region of West Bengal. Indian Journal of Entomology. 61: 362-71.
36. Ghosh, J., Ghosh, S.K., Chaudhuri, N. and Senapati, S.K (2000). Preliminary studies on the insect pest complex of cauliflower in terai region. of West Bengal.. Hariyana Journal of Horticultural Sciences. 29 (1 & 2): 118-119. ISSN-0970-2873.
37. Ghosh, S.K. (1999). Studies on the pest constraints of brinjal and their management under terai region of West Bengal. Doctoral thesis, BCKV, Mohanpur, India.
38. Ghosh, S.K. and Chakraborty, K. (2014). Bio-Efficacy of plant extracts against red spider mite (Tetranychus spp.) infesting brinjal (Solanum melongena L.). Research journal of Agricultural and Environmental Sciences. 1 (1): 26-31.
39. Ghosh, S.K. and Senapati, S, K. (2002). Field evaluation of pesticides from different origin against pest complex of brinjal under terai region of W. B. Crop Research, 23(1): 108-115. ISSN-0972-3226 136.
40. Ghosh, S.K. and Senapati, S.K. (2001a). Biology and seasonal fluctuation of Henosepilachna vigintioctopunctata Fabr. on brinjal under Terai region of West Bengal. Ind. J. Agric. Res., 35: 149-154.
41. Ghosh, S.K. and Senapati, S.K. (2001b). Seasonal incidence and biology of brinjal shoot and fruit borer (Leucinodes orbonalis Guen.) under terai region of West Bengal, India. Annals of Entomology. 19(1):13-18.ISSN-0970-3721

42. Giraddi, R. S., Goudreddy, B. S. and Lingappa, S. (1992). Survey and surveillance of insect pests of red gram with special reference to Heliothis armigera (Hb.) in Bider district, Karnataka. J Agric Sci 5: 273-74.
43. Hall, M.J.R. (1984). Trap-oriented behaviour of red-banded blister beetles, Mylabris designata var. hacolyssa Rochebrune (Coleoptera: Meloidae), in the Sudan. Bull. Entomol. Res., 74(01): 103-112.
44. Hansa Jat, Ameta O. P. and Saminathan. R. 2014. Antifeedant activity of some botanicals against blister beetle, *Mylabris pustulata* Thunbergh (Coleoptera:Meloidae), *Indian Journal of Applied Entomology*, 28 (1):1-3.
45. Hiller, B. and Wittmann, D. (1994). Seasonality, nesting biology and mating behavior of the oil-collecting bee Epicharis dejeanii (Anthophoridae, Centridini). Biociências, 2: 107-124.
46. Isikber, A. A. and Copland, M. J. W. 2002. Effects of various aphid foods on *Cycloneda sanguinea*. *Entomologia Experimentalis et Applicata,* **102**: 93-97.
47. Iwata, K. 1975. Shizen kansatsusha no shuli (Memoirs on Nature by an observer). Asahi Shimbun Co., Tokyo. 584 **PP**.
48. Jallow, M.F.A., Paul Cunningham, J.and Zaluckim M,P, (2004). Intra– specific variation for host plant use in Helicoverpa armigera (Hubner) (Lepidoptera: Noctuidae): implications for management. Crop Prod. Serv., 23: 955-964.
49. Johri, P.K. and Johri, R. (2011). Comparative ovicidal action of seven plant origin insecticides against the eggs of Bagrada cruciferarum (Kirk.), Pieris brassicae (L.) and Mylabris pustulata (Thunb.). Indian J. Entomol., 73(3): 204-206.
50. Johri, P.K., Singh, D., Mourya, R., Tiwari, D., Bajpai, A. and Johri, R. (2004). Ovicidal action and feeding response of certain plant extracts against Bagrada cruciferarum (Kirk), Pieris brassicae (Linn.) and Mylabris pustulata (Thunb). J. Appl. Zool.., 15: 37-42.
51. Kashyap, N. P. and Adlakha, R. L. (1971) New Res records of insect pests of soybean crop. Indian J Ent 40: 467-68.
52. Kashyap, N. P., Mehta, P. K. and Dhindsa, S .S. (1990) Insect pest associated with pigeonpea at Palampur, Himachal Pradesh. Int Pigeonpea Newsl 12: 26-27.
53. Khan, S.A., Benford, D.J., Clements, D.L., Moseley, S.H., Shafer, R.A. and Sumner, T.J. (2005). Mylabris pustulata. The 38th Annual Meeting of the Society for Invertebrate Pathology, August 7-11, 2005, Anchorage, Alaska, USA.
54. Kinney,. KK., Peairs, F.B., Swinker, A.M. (2010). Blister beetles in forage crops. Colorado State University Extension, 5: 524.
55. Kohno, K. and Ngan, B.T. 2004. Effects of host plant species on the development of *Dysdercus cingulatus* (Heteroptera: Pyrrhocoridae). *Applied Entomology and Zoology,* **39**(1): 183-187.
56. Kundu, G.G., Kishore, P. and Sukhani, T.R. (1971). Occurrence of blister beetles, Mylabris pustulata Thunb. and Lytta tenuicollis (Pallas) as serious pests of sorghum in Rajasthan. In: (Pradhan, S., ed.) "Invest On Insect Pests Of Sorghum & Millets". 1965/70 (Pub. Feb. 1971).
57. Lal, O.P. (1973). Record of Epicauta sp. (Coleoptera:Meloidae) on soybean and eggplant from Himachal Pradesh. Indian J. Entomol., 35(4): 342- 343.
58. Landolt, J.P. (1997). Sex attractant and aggregation pheromones of male phytophagous insects. Amer. Entomol., 43(1): 12-22.
59. Larson, N.P. (1943). The common toad as an enemy of blister beetles. J. Econ. Entomol. Soc., 36: 480.
60. Lawrence, J.F., Newton, A.F. (1982). Evolution and classification of beetles. Annu. Rev. EcoSyst., 13: 261-290.
61. Leka, A. (1986). Some parasites of bees. Buletini-i-Shkencave Zooteknike Veterinare., 4(1): 39-44.
62. Liakos, B.P., Katrali, M. (1984). First-stage larvae of Meloidae (triungulinus) as enemies of the honey bee in Greece (Deltion tes Ellenikes Kteniatrikes Etaireias). Bull. Hellenic Vet. Med. Soc., 35 (3): 184-188.
63. Mahal, M. S., Singh, R. and Singh, B. (1989) Behavioural studies on adults of Blister beetle, Mylabris pustulata (Thunb.) and a plan for its sampling on pigeonpea. J Res Punjab Agric Univ 26: 237-40.
64. Maheshwari, U. K. (1986). Biological control of major agricultural pulse pest, Mylabris pustulata- A new approach. Indian J Ent 48: 381-87.

65. Mahr, D.L., Ridgway, N.M. (1993). Biological control of insects and mites: An introduction to beneficial natural enemies and their use in pest management. N. Central Reg. Ext. Publ., pp. 481. Mann, G. S. and Dhooria, M. S. (1993) Feeding and mating behaviour of blister beetle (Mylabris spp.) on pigeonpea. Int Pigeonpea Newsl 17: 40-42.
66. Manilal, A., Sujith, S., Kiran, G. S., Selvin, J., Shakir, C., Gandhimathi, R. and Nataraja panikkar, M.V. 2009. Bio potentials of seaweeds collected from south west coast of India. *Journal of Marine Science and Technology,* **17**: 67-73.
67. McBride, D.K. (2012). Blister Beetles. NDSU, Extension Service, www.ag.ndsu.edu, E-1002. Minkov, S.G., Moiseev, K.V. (1953). Experiments on control of Meloe larvae. Pchelovodstvo, 5: 53- 54.
68. Miranpuri, G.S. and Khachatourians, G.G. (1994). Pathogenicity of Beauveria bassiana (Bals.) Vuill. and Verticillium lecanii (Zimm.) toward blister beetle, Lytta nuttali Say (Col., Meloidae). J.Appl. Entomol., 118(1-5): 103-110.
69. Mohamedsaid, M. S. (1979). The blister beetles (Meloidae) of Sri Lanka. Ceylon J Sci 13: 203- 51.
70. Nead, B.A. (1994). The development of alternative control strategies for blister beetle (Coleoptera, Meloidae) on lupin in the northern Great Plains. Ph. D. Thesis, North Dakota State University, 214pp.
71. Nead, B.A., Weissa, M.J. and Milbratha, L.R. (1996). Feeding preferences of the ashgray blister beetle, Epicauta fabricii (LeConte) (Coleoptera: Meloidae), for four legumes. Can.Entomol., 128(2): 349-350.
72. Obeng-Ofori, D. and Sackey, J. (2003). Field evaluation of non-synthetic insecticides for the management of insect pests of okra Abelmoschus esculentus (L.) Moench in Ghana. Ethiopian J. Sci., 26(2): 145-150.
73. Panwar V P S (1995) Agricultural Insect Pests of Crops and their Control. Kalyani Publishers, New Delhi, pp. 73.
74. Parker, J.R., Wakeland, C. (1957). Grasshopper egg-pods destroyed by larvae of bee Plies, blister beetles, and ground beetles. Technical Bulletin. United States Department of Agriculture, pp. 29 pp.
75. Patnaik, H.P., Mohapatra, H.K. and Senapati, B. (1993) Blister beetle incidence and some observations on its ovipositional behavior on pigeonpea in Orissa, India. Int Pigeonpea Newsl 18: 27-30.
76. Prasad, C. S., Ram, B. and Singh, B. V. (1991) A serious threat in lower Kumaon hills. Nat Acad Sci Lett 14: 227-29.
77. Prasad, C.S. (1995). Insect pests of pigeonpea in Kumaon hills of Uttar Pradesh, India. Int Chickpea and Pigeonpea Newsl 2: 72-74.
78. Rajesh, S., Asha, A., Kombiah, P. and Sahayaraj, K. 2011. Biocidal activity of algal seaweed on insect pest and fungal plant pathogen. In: *National Seminar on Harmful Beneficial insects of Agricultural Importance* (Sabu K Thomas, ed.), 17-18 February 2011, P.G. and Research Department of Zoology, St. Joseph's College, Devagiri, Calicut, Kerala.
79. Ramamurthy, T.G., Selvaraj, S. and Regupathy, A. (1970). Occurrence of blister beetle, Mylabris pustulata Thunb. (Meloidae: Coleoptera) on cumbu, Pennisetum typhoides Stapf. and Hubb. and its damage. Madras Agric. J.: 57(2): 134-136.
80. Reddy, N. C., Singh, Y. and Singh, V. S. (2001) Influence of abiotic factors on the major insect pests of pigeonpea. Indian J Ent 63: 211-14.
81. Rees, N.E. (1973). Arthropod and nematode parasites, parasitoids, and predators of Acrididae in America north of Mexico. Tech. Bull. 1460.
82. Resh, V.H., Carde, R.T. (2003). Encyclopeida of Insects. Elsevier Science, USA (pp. 874-875). Rojas, C.J.J. (1983). Pathogenicity of the entomogenous fungi Beauveria in the control of three defoliating Coleoptera: Premnotripes suturicallus (Curculionidae), Epicauta (Meloidae) and Epitrix (Chrysomelidae). Convencion Nacional de Entomologia, Sociedad Entomologica del Peru, Lima.-Tingo Maria (Peru), p. 21.
83. Rolania, K., Yadav, S.S. and Saini, R.K. (2012). Insecticidal control of Mylabris pustulata Thunb., an emerging problem in pulses and kharif vegetables. National Seminar on Sustainable Agriculture and Food Security: Challenges in Changing Climate, India, March 27-28, 2012.
84. Rouxel, C., Bonnabeze, E., Daniel, A., Jerome, M., Etienne, M. and Fleurence, J. 2001. Identification by SDS PAGE of green seaweeds (*Ulva* and *Enteromorpha*) used in the food industry. *Journal of Applied Phycology*, **13**:215-218.

85. Sachan, J.N. (1990). Progress in Host–Plant Resistance Work in Chickpea and Pigeonpea against Helicoverpa armigera (Hübner). In: "Summary Proceedings of the First Consultative Group Meeting on the Host Selection Behavior of Helicoverpa armigera". pp. 19-22.
86. Sahayaraj, K. and Borgio, J.F. (2010). Virulence of entomopathogenic fungus Metarhizium anisopllae (Metsch.) Sorokin on seven insect pests. Indian J. Agric. Res., 44(3): 195- 200. Sahayaraj, K. and Namasivayam, K.R.S. (2008). Mass production of entomopathogenic fungi using agricultural products and byproducts. African J. Biote., 7(12): 1907-1910.
87. Sahayaraj, K. and Kalidas, S. 2011. Evaluation of nymphicidal and ovicidal effect of seaweed, *Padina pavonica* (Linn.) (Phaeophyceae) on cotton pest, *Dysdercus cingulatus* (Fab.). *Indian Journal of Geo-Marine Sciences,* **40**(1): 125- 129.
88. Sahayaraj, K. and Mary Jeeva, Y. 2012. Nymphicidal and ovipositional efficacy of seaweed *Sargassum tenerrimum* (J. Agardh) against *Dysdercus cingulatus* (Fab.) (Pyrrhocoridae). *Chilean Journal of Agricultural Research*, **72** (1): 152-156.
89. Sahayaraj, K., Majesh Tomson and Kalidas, S. 2011. Artificial rearing of *Dysdercus cingulatus* using cotton seed based artificial diet. *Entomologia Generalis*, **33** (4): (in press).
90. Sekhar, J. C. (1991) Pest management studies in pigeonpea, Cajanus cajan (L.) Millsp. Ph.D. Thesis. IARI, New Delhi.
91. Selander, R.B. (1981). Evidence for a third type of larval prey in blister beetles (Coleoptera: Meloidae). J. Kansas Entomol. Soc., 54: 757-783.
92. Selander, R.B. (1982). Further studies of predation on meloid egg by meloid larvae (Coleoptera), J. Kansas Entomol. Soc., 55: 427-441.
93. Selander, R.B. (1987). Biological observations in Cyaneolytta and a description of the triungulin larva of C. fryi (Coleoptera: Meloidae). J. Kansas Entomol. Soc., 60: 288-304.
94. Selander, R.B. and Fasulo, T.R. (2010). DPI Entomology Circular 268. Publication Number: EENY-166, University of Florida.
95. Selander, R.B.(1960). Bionomics, systematics, and phylogeny of Lytta, a genus of blister beetles (Coleoptera, Meloidae). Illinois Biol. Monog., 28:1-295.
96. Selander, R.B., Mille,r J.L. and Mathieu, J.M. (1963). Mimetic associations of lycid and cerambycid beetles. J. Kansas Entomol. Soc., 36:45-52.
97. Shanklin, D., Townsend, L. and Bessin, R. (2010). Three common Kentucky grasshoppers and their natural enemies. Univer. Kentucky, College of Agric., Derpt. Entomol., Ent.Fact., 116. Sharma, P. L., Agarwal, S. C. and Bhalla, O. P. (1964). New record of damage to silk and milky grains of maize by blister beetle. Indian J Ent 26: 238-39.
98. Sharma, P. L., Agarwal, S. C. and Bhalla, O. P. (1964). New record of damage to silk and milky grains of maize by blister beetle. Indian J Ent 26: 238-39.
99. Shukla, G.S. and Singh, G.C. (1982). Feeding activity of Rhabdopalpa atripennis F. on host plant Luffa cylindrica (Col. Meloidae). Deut. Entomol. Zeit., 29(1-3): 111-115.
100. Shukla, G.S. and Upadhyaya, V.K. (1973). Tecoma stans (L.) H. B. & K. as a new host record for Mylabris pustulata (Thunb.) (Coleoptera: Meloidae). Indian J. Entomol., 35(1): pp. 71.
101. Siddiqi, J. I. (1983). Some new host records for Mylabris pustulata Thunb. Bull Ento 24: 51-52. Smee, D. (2012). Species with a large impact on community structure. Nature Education Knowledge, 3(10): 40.
102. Soto, H. J. and San Martin, A. 2002. A new Diterpene from *Dictyopa crenubtu, Very der z. Naturforsch,* **586**: 795- 798.
103. Srinivasan, R. (2009). Insect and mite pest on eggplant: A field guide for identification and management. AVRDC-the world vegetable centre, Shanhua, Taiwan. AVRDC publication No. 09-729.pp.64.
104. Stebbing, E. P. (1977). Indian Forest Insects J.K. Jain Brothers, Bhopal, pp. 648.
105. Suasa-ard, W. (2010). Natural enemies of important insect pests of field crops and utilization as biological control agents in Thailand. In: (Yasuda, K.; Ihara, F. & Ku, T.-Y. eds)" International Seminar on Enhancement of Functional Biodiversity Relevant to Sustainable Food Production in ASPAC", Tsukuba, Japan.
106. Suman, C.L. and Wahi, S.D. (1981) Distribution pattern of blister beetle, Mylabris pustulata (Thunb.) under natural conditions. Entomon 6: 271-74.

107. Tahir, S., Anwar, T. and Jabbar, A. (1992). Acetylcholinesterase activity of blister beetle exposed to synthetic and natural insecticides. Pakistan J.Agric. Res., 13(4): 373-376.
108. Tanu Sharma, Ayesha Qamar and Absar Mustafa Khan, 2010. Evaluation of neem (*Azadirachta indica*) extracts against eggs and adults of *Dysdercus cingulatus* (Fabricius). *World Applied Sciences Journal*, **9** (4): 398-402.
109. Uthamasamy, S., Kannan, M. and Mohan, S. 2004. Impact of insecticides on sucking pests and natural enemy complex of transgenic cotton in India. *Current Science*, **86**: 726- 729.
110. Velay, F., Baudoin, J.P. and Mergeai, G. (2001) Characterization of indigenous traditional knowledge on insect pests of pigeonpea (Cajanus cajan (L.) Millsp.) in Northern Uganda. Agron Soc Environ 5: 105-14.
111. Vivekananthan, T. and Selvisabhanayagam Mathivannan, V. (2010). Effects of phytopesticide on the fat body of adult male blister beetle, Mylabris 142 indica (Thungberg) (Coleoptera: Meloidae) in relation to reproduction. World J. Zool., 5 (1): 01-06.
112. Washington, DC: U.S. Department of Agriculture, Agricultural Research Service. 288 pp.
113. Watanabe, K., Umeda, K. and Miyakado, M. 1989. Isolation and identification of three insecticidal principles from the red alga *Laurencia nipponica* Yamada. *Agricultural Biological Chemistry*, **53**: 2513-2515.
114. Waterhouse, D. F. 1998. Biological control of insect pest; Southeast Asian Prospects. Australian Centre for international Agriculture Research Canberra, 523 **PP**.
115. Yasuda, K. 1992. Cotton bug. In: *Insects pests of vegetables in tropics* (Hidaka, T. ed.), Association for International Cooperation on Agriculture and Forestry, Tokyo, Japan. 22-23 **P**.A.
116. Zanon, V. (1922). Contributo alla conoscenza della fauna entomologica di Bengasi. Coleotteri. Memorie della Società Entomologica Italiana, 1: 112-139.
117. Zethner, O. and Laurense, A.A. (1988). The economic importance and control of the adult blister beetle Psalydolytta fusca Olivier (Coleoptera: Meloidae). Trop. Pest Manage., 34(4): 407-412. Zethner, O. and Laurense,A.A. (1988). The economic importance and control of the adult blister beetle Psalydolytta fusca Olivier (Coleoptera: Meloidae). Trop. Pest Manage., 34(4): 407-412. Zhu, F., Li, H., Wang, Y., Wang, X-P., Zhou, X-M., Huang, W. and Lei, CL. (2008). Change of trehalose, glycogen and polyol contents of the diapausing larvae of Mylabris phalerata (Pallas) (Coleoptera: Meloidae) at different diapausing stages. Acta Entomologia Sinica, 51(1): 9-13.
118. Zhu, F., Xue, F. and Lei, C. (2006). The effect of environmental conditions on diapause in the blister beetle, Mylabris phalerata (Coleoptera: Meloidae). Eur. J. Entomol., 103: 531-535.
119. Zhu, Y.C. and Higgins, R.A. (1994). Host plant influences on feeding, survivorship, population distribution, and management of blister beetles (Coleoptera: Meloidae) in Kansas. Environ. Entomol., 23(6): 1472-1479.