Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(5): 243-2146

Received: 18-07-2020
Accepted: 29-08-2020

Manjushree BJ
Student, Department of Agricultural Entomology, College of Agriculture, University of Agricultural and Horticultural Sciences, Navile, Shivamogga, Karnataka, India

Jayalaxmi Narayan Hegde
Professor, Department of Agricultural Entomology, College of Agriculture, University of Agricultural and Horticultural Sciences, Navile, Shivamogga, Karnataka, India

Rajashekarappa K
Assistant Professor, Department of Agricultural Entomology, Zonal Agricultural and Horticultural Sciences, Navile, Shivamogga, Karnataka, India

Gangadhara Naik B
Professor, Department of Plant Pathology, College of Agriculture, University of Agricultural and Horticultural Sciences, Navile, Shivamogga, Karnataka, India

Nagarajappa Adivappar
Assistant Professor, Department of Horticulture, Zonal Agricultural and Horticultural Sciences, Navile, Shivamogga, Karnataka, India

Corresponding Author:
Manjushree BJ
Student, Department of Agricultural Entomology, College of Agriculture, University of Agricultural and Horticultural Sciences, Navile, Shivamogga, Karnataka, India

Efficacy of organic molecules against tobacco cut worm, *Spodoptera litura* Fabricius on Amaranthus

Manjushree BJ, Jayalaxmi Narayan Hegde, Rajashekarappa K, Gangadhara Naik B and Nagarajappa Adivappar

Abstract
Amaranthus is one of the important leafy vegetables and we consume the whole plant parts except root for our diet regularly. Hence, use of synthetic pesticides poses serious challenge to health and environment. Hence, a field experiment was conducted to assess the efficacy of organic molecules against tobacco cut worm, *Spodoptera litura* Fabricius on Amaranthus was conducted at Zonal Agricultural and Horticultural Research Station (ZAHRS), Shivamogga, Karnataka during 2019-20. *S. litura* was not a regular pest on Amaranthus, but it was outbroken in the field during *Kharif*. Six organic molecules *viz*., Neem Seed Kernel Extract 5%, azadirachtin 10,000 ppm, pongamia oil 5%, *Beauveria bassiana* 1g / lt, Garlic extract 2%, *Lecanicillium lecanii* 1 g / lt along with one standard check Malathion 50 EC @ 2ml/lt and one untreated control were tested. Among them, *Beauveria bassiana* recorded maximum reduction in pest population (64.92%), followed by NSKE 5% (53.04%). With respect to the cost benefit ratio, among the organic molecules, NSKE 5% recorded highest cost-benefit ratio of 1: 2.45, followed by azadirachtin 10,000 ppm with 1: 2.16 and *Beauveria bassiana* 1×10^9spores with 1: 2.12. Standard check Malathion 50 EC recorded cost benefit ratio of 1: 3.07.

Keywords: Amaranthus, azadirachtin, *Beauveria bassiana*, NSKE 5%, organic management, *Spodoptera litura*

1. Introduction
The Indian sub-continent is the bowl of many vegetable crops, among them leafy vegetables are the important group, since it plays an important role in the diet due to their taste and nutritional value. The most important leafy vegetables is Amaranthus. Amaranth means "never fading flower" in Greek word which belongs to the family Amaranthaceae. Amaranthus is very popular due to early maturity, high nutritive value and palatability. It is a good source of vitamins (mg/100g) like beta-carotene (3.29), thiamine (2.75), riboflavin (4.24), niacin (1.54), pyridoxine (2.33), ascorbic acids (25.40), alpha-tocopherol (0.50) and minerals (mg/100g),especially rich in calcium (44.15), sodium (7.43), potassium (54.20), magnesium (231.22), iron (13.58), zinc (3.80) and phosphorus (34.91). It also contains seventeen amino acids *viz*., isoleucine, leucine, lysine, methionine, cysteine, phenylalanine, tyrosine, threonine, valine, alanine, arginine, aspartic acid, glutamic acid, glycine, histidine, proline and serine which are limiting factors in the conventional food grains [1]. Regular consumption of Amaranthus reduces the cholesterol level in blood serum which prevents the blood pressure and the cardio-vascular disease. This also improves the immunity and body's antioxidant which helps to reduce inflammation [6].

Amaranthus were attacked by a number of insect and non-insect pests *viz.*, leaf webbers, tobacco cut worm, leaf miner, Amaranthus bug, aphid, flea beetle, stem weevil, stink bug, grasshopper, thrips, mites and whitefly. Among them, Amaranthus production was hindered by major insect pests *viz.*, *Spoladea recurvalis* (Fabricius) (beet webworm), *Spodoptera littoralis* (Boisduval) (cotton leafworm), *Hypolixus* sp. (Fabricius) (amaranth stem weevils), *Liriomyza huidobrensis* (Blanchard) (pea leaf miner) and *Myzus persicae* (Sulzer) (green peach aphid) [7]. The tobacco cut worm was the most damaging insect pest of leafy vegetables. Young larvae fed gregariously and scraped the leaves. Older larvae spread out and completely devoured the leaves resulting in poor growth of plants [5]. The tobacco cut worm, *Spodpptera litura* Fabricius (Lepidoptera: Noctuidae) which is a polyphagous pest was recognised as one of the major pest of Amaranthus. Since, Amaranthus is consumed daily by the human beings and since it is short duration crop, the use of synthetic insecticide pose problem on human beings,

animals and environment, Hence, use of synthetic insecticides in the management of the tobacco cut worm result in environmental pollution, pest resurgences, resistance, lethal effect to non target organisms in the agro-ecosystems and direct toxicity to users. Therefore, it has become necessary to search alternative options for the management of pests; organic molecules and biopesticides are the important alternatives for the organic management of this pest and also there are no concrete research studies on the organic management of this pest on Amaranthus. Organic molecules have low mammalian toxicity thus lead to no or least health problem, no resistance development, less hazardous to non target organism, less expensive and cheaply available [8]. Hence, the a research study was conducted to know the efficacy of Organic molecules against tobacco cut worm, *Spodoptera litura* Fabricius on Amaranthus to evolve with good organic molecules against *S. litura*.

2. Material and Methods

The experiment was conducted at Zonal Agricultural and Horticultural Research Station (ZAHRS), Navile, Shivamogga during *Kharif* 2019. The experiment was laid out in the randomized complete block design (RCBD) with eight treatments and three replications. In each plot, five plants were selected randomly and tagged. Six organic molecules *viz*., Neem Seed Kernel Extract 5%, azadirachtin 10,000 ppm @ 2 ml / lt, pongamia oil 5%, *Beauveria bassiana* @ 1 g / lt, garlic extract 2% and *Lecanicillium lecanii* @ 1 g / lt along with standard check, malathion 50 EC @ 2 ml / along with untreated control were evaluated against *Spodoptera litura*. Pre-treatment counts were made a day before spraying and post treatment observations were recorded at 3, 5, 7 and 10 days after spraying. Yield also recorded and cost-benefit ratio was worked out for each treatment. Per cent reduction over control was also calculated.

2.1 Counting of *Spodoptera litura*

Ten plants were selected randomly, the number of larvae on each plant was counted and mean number of larvae per plant was calculated.

2.2 Preparation of 5 per cent Neem Seed Kernel Extract (NSKE)

Fifty gram of well dried neem seed kernels were powdered using pestle and mortar and soaked overnight in 500 ml of water. On the next day morning, the solution was stirred well with wooden stick till solution became milky white. One per cent detergent was added to the solution. Then the solution was filtered through double layered muslin cloth and volume was made to one liter by adding water.

2.3 Preparation of 2 per cent garlic extract

Two per cent garlic bulb extract was prepared by using 3 large sized healthy bulbs, one litre distilled water, electric blender and muslin cloth. Known amount of garlic cloves were grinded using electric blender. 20 grams of grinded garlic paste was soaked in 20 ml of kerosene for overnight. In the next day morning, the mixture was stirred well and one per cent detergent was added to the solution. Then the solution was filtered through muslin cloth and volume was made to one litre by adding water.

2.4 Statistical analysis

The statistical analysis of the data obtained from the insect pest management trial was done using analysis of variance (ANOVA) using Web Agri. Stat Package (WASP-2) developed by the Indian Council of Agricultural Research, Research Complex, Goa. The interpretation of the data was done by using the critical difference value calculated at 0.05 probability level, the level of significance was expressed at 0.05 probability level.

3. Results and Discussion

Amaranthus is a short duration crop nearly of 40 days, so one spray was enough for the management of insect pests and it was economical.

3.1 Efficacy of organic insecticides against *Spodoptera litura* on Amaranthus during 2019-20

Results of the experiment on the effectiveness of the organic insecticides against *S. litura* on Amaranthus are presented in table 1.

3.1.1 Pre count

Prior to the imposition of the treatment, the mean population of tobacco cut worm larvae ranged from 2.90 to 3.13 per plant and were statistically non-significant in different treatments.

3.1.2 At three days after spraying

At three days after spraying, significant difference was observed among the different treatments. Among the organic molecules evaluated, the lowest mean number of tobacco cut worm larvae was recorded with *Beauveria bassiana* @ 1 g / lt (1.88 larvae / plant), followed by azadirachtin 10,000 ppm @ 2 ml / lt which recorded 2.00 larvae per plant. Next best treatment was NSKE 5%, which recorded 2.06 mean number of larvae per plant. Garlic extract 2%, pongamia oil 5% and *Lecanicillium lecanii* @ 1 g / lt recorded 2.36, 2.48 and 2.78 larvae per plant, respectively and were on par with each other. Standard check malathion 50 EC @ 2 ml / lt was found superior over all the treatments which recorded the lowest mean larval population per plant (1.62 larvae / plant). Significantly highest larval population was recorded in untreated control (3.20 larvae / plant).

3.1.3 At five days after spraying

There was significant difference among the treatments at five days after spray. All the treatments recorded significantly lower larval population than untreated check. Among the organic molecules evaluated, the lowest larval population was observed with *Beauveria bassiana* @ 1 g / lt (1.26 larvae / plant), followed by botanical insecticide NSKE @ 5% (1.74 larvae / plant). Azadirachtin 10,000 ppm @ 2 ml / lt (1.86 larvae / plant) was found next best treatment in controlling pest population. Pongamia oil 5% (2.14) and garlic extract 2% (2.20) were on par with each other.

Standard check malathion 50 EC @ 2 ml / lt was found superior over all the treatments which recorded the lowest mean larval population per plant (0.98 larvae / plant). In untreated check, the larval population was 3.40 larvae per plant which was significantly higher as compared to other treatments.

3.1.4 At seven days after spraying

The data revealed that there was significant difference among the treatments at seven days after spraying. The least larval population was observed in plots treated with *Beauveria bassiana* @ 1g / lt (0.74 larvae / plant). Next best treatments were NSKE 5% and azadirachtin 10,000 ppm @ 2 ml / lt which recorded 1.26 and 1.52 mean number of larvae per

plant, respectively. Among these higher larval population per plant was recorded with *Lecanicillium lecanii* @ 1g / lt (2.42). Standard check malathion 50 EC @ 2 ml / lt recorded least larval population per plant (0.62) and was found superior over all other treatments. In untreated control, highest mean population of larvae was recorded (3.60 larvae / plant).

3.1.5 At ten days after spraying

At ten day after spraying, *Beauveria bassiana* @ 1 g / lt was found effective in controlling larval population (0.96 larvae / plant), followed by NSKE @ 5% (1.42 larvae / plant). Next best treatment were azadirachtin 10,000 ppm @ 2 ml / lt (1.84 larvae / plant) and garlic extract 2% (1.88 larvae / plant) which were on par with each other. *Lecanicillium lecanii* @ 1 g / lt was found least effective in controlling larval population per plant (2.56).

Standard check malathion 50 EC @ 2 ml / lt recorded significantly lowest larval population of 0.84 larvae / plant. The highest mean number of larval population was noticed in untreated control (3.60 larvae / plant).

3.1.6 Per cent reduction

Among the organic molecules evaluated, highest per cent reduction of cut worm population was recorded in *Beauveria bassiana* @ 1 g / lt (64.92). This may be due to the potentiality of *Beauveria bassiana* to control insect pests which belong to Lepidopteran order. Fungal infection could affect the growth, development, longevity and fecundity of *S. litura* which ultimately reduced the population build up in the next generation and so also *S. litura* was naturally infested by NPV virus, this is also one of the reasons for the control of the pest.

These research findings are in the line with the findings of [3] who conducted a laboratory experiment by using *Beauveria bassiana* on *Spodoptera litura* and reported that spore density of 10^9 spores / ml caused 100% larval mortality. These results are also in close agreement with [4] who observed the bio-efficacy of entomopathogenic fungi *viz.*, *Beauveria bassiana* against pests of cotton under laboratory condition and reported 86.7% larval mortality in *Spodoptera litura* at 0.25 per cent of liquid formulation. [2] who reported the potentiality of *B. bassiana* against *S. litura*. They reported that 56.32% and 63.26% larval mortality was observed at 10^7 and 10^8 spores / ml, here the mortality of *S. litura* larvae increased with increase in conidial concentrations, followed by NSKE 5% with 53.04% reduction. These results are also in close agreement with the results of [9] who reported the efficacy of neem products *viz*., neem oil, NSKE, neem cake extract, neem leaf extract against *S. litura*. Among these botanical insecticides, NSKE 5% recorded highest larval mortality of 40 per cent.

3.1.7 Leaf yield and cost-benefit ratio of Amaranthus

Out of the organic molecules evaluated, the cost-benefit (C: B) ratio was highest in case of NSKE 5%, *i.e*. 1: 2.45 due to higher leaf yield of 14.54 t / ha, followed by azadirachtin 10,000 ppm @ 2 ml / lt which recorded C: B ratio of 1: 2.16 with leaf yield of 13.14 t / ha, *Beauveria bassiana* 1×10^9spores which recorded C: B ratio of 1: 2.12 with leaf yield of 12.72 t/ ha, *Lecanicillium lecanii* 1×10^9spores which recorded C: B ratio of 1: 1.88 with leaf yield of 11.30 t / ha, Pongamia oil 5% which recorded C: B ratio of 1: 1.76 with leaf yield of 10.62 t / ha and Garlic extract 2% which recorded C: B ratio of 1: 1.71 with leaf yield of 10.24 t / ha. The present results are in close association with the findings of [5] reported cost benefits of insecticides and botanicals against defoliators on Amaranthus, wherein treatments, NSKE 5% and azadirachtin gave leaf yield of 12.22 t / ha and 13.89 t / ha coupled with 22.00 and 14.28 incremental benefit-cost ratio, respectively. However, standard check, malathion 50 EC @ 2 ml / lt recorded highest C: B ratio (1: 3.07) as compared to all other organic insecticides with leaf yield of 18.60 t / ha.

S. litura infesting in field | *S. litura* larvae | NPV affected *S. litura*

Fig 1: Spodoptera litura infestation on Amaranthus

Table 1: Efficacy of organic molecules against tobacco cut worm, *Spodoptera litura* on Amaranthus during *Kharif*, 2019-20

Treatment details	Mean number of larvae per plant					Overall mean	Per cent reduction over control
	1DBS	3DAS	5DAS	7DAS	10DAS		
T1-NSKE 5%	3.06 (1.88)	2.06 (1.60)^{bcd}	1.74 (1.49)^{cd}	1.26 (1.32)^{d}	1.42 (1.38)^{cd}	1.62	53.04
T2-Azadirachtin 10,000 ppm @ 2ml/lt	3.00 (1.87)	2.00 (1.58)^{cd}	1.86 (1.53)^{bcd}	1.52 (1.42)^{cd}	1.84 (1.52)^{bc}	1.80	47.68
T3-Pongamia oil 5%	2.93 (1.85)	2.48 (1.76)^{abc}	2.14 (1.62)^{bc}	2.08 (1.60)^{bc}	2.36 (1.69)^{b}	2.26	34.34
T4- *Beauveria bassiana* 1×10^{9}spores @1g / lt	3.13 (1.90)	1.88 (1.54)^{cd}	1.26 (1.32)^{de}	0.74 (1.11)^{e}	0.96 (1.20)^{d}	1.21	64.92
T5- Garlic extract 2%	3.13 (1.90)	2.36 (1.69)^{bc}	2.20 (1.64)^{bc}	1.86 (1.53)^{bcd}	1.88 (1.54)^{bc}	2.07	39.85
T6- *Lecanicillium lecanii* 1×10^{9}spores @1g / lt	2.93 (1.85)	2.78 (1.81)^{ab}	2.56 (1.74)^{ab}	2.42 (1.70)^{b}	2.56 (1.74)^{ab}	2.58	25.21
T7- Malathion 50 EC @ 2ml/lt	2.90 (1.84)	1.62 (1.45)^{d}	0.98 (1.21)^{e}	0.62 (1.05)^{e}	0.84 (1.15)^{d}	1.01	70.05
T8- Control	3.06 (1.88)	3.20 (1.923)^{a}	3.40 (1.974)^{a}	3.60 (2.024)^{a}	3.60 (2.024)^{a}	3.45	
SEm±	0.060	0.079	0.086	0.077	0.098		
CD@(P=0.05)	0.182	0.238	0.259	0.232	0.294		
CV (%)	NS	9.024	10.621	10.377	12.442		

Figures in parentheses are √x+0.5 transformed values;
Means in the columns followed by the same alphabet do not differ significantly by DMRT (P = 0.05);
DBS- Day Before Spray
DAS- Days After Spray

Table 2: Yield and cost benefit ratio of Amaranthus

Tr. No	Treatments	Cost of production (Rs/ha)	Cost of plant protection (Rs/ha)	Total cost of cultivation (Rs/ha)	Leaf Yield (t/ha)	Yield increment over control (%)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B: C ratio
1	NSKE 5%	53,367	413	53,780	14.54	37.35	1,31,877.8	78,097.8	1: 2.45
2	Azadirachtin 10,000ppm @ 2ml/lt	53,367	1790	55,157	13.14	30.59	1,19,179.8	64,022.8	1: 2.16
3	Pongamia oil 5%	53,367	1200	54,567	10.62	14.12	96,323.4	41,756.4	1: 1.76
4	*Beauveria bassiana* 1×10^{9}spores @1g / lt	53,367	1000	54,367	12.72	28.30	1,15,370.4	61,003.4	1: 2.12
5	Garlic extract 2%	53,367	840	54,207	10.24	10.98	92,876.8	38,699.8	1: 1.71
6	*Lecanicillium lecanii* 1×10^{9}spores @1g / lt	53,367	1000	54,367	11.30	19.29	1,02,491	48,124	1: 1.88
7	Malathion 50 EC @ 2ml / lt	53,367	1520	54,887	18.60	50.96	1,68,702	1,13,815	1: 3.07
8	Control	53,367	-	53,367	9.12	-	82,718.4	29,351.4	1: 1.54

Note: Market price of Amaranthus leaves was Rs 10 / kg Garlic bulb: Rs 120 / Kg
Cost of insecticide: Neem Seed Kernal Extract: 55 Rs / Kg seeds *Beauveria bassiana* 500 g: 125Rs
Azadirachtin 10,000 ppm lRs 895 / 500 ml *Lecanicillium lecanii* 500 g: 125Rs
Pongamia oil 5%: Rs 80 / lt Labour cost- 250 Rs Malathion 50 EC 1 lt: 380

4. Conclusion

Among the organic molecules evaluated, *Beauveria bassiana* 1×10^{9}spores @1g / lt was found superior with respect to the percent reduction over control (64.92%). However, with respect to the cost benefit ratio, NSKE 5% was found superior which recorded highest cost-benefit ratio (C:B ratio) of 1: 2.45 with higher leaf yield of 14.54 t / ha, followed by azadirachtin 10,000 ppm @ 2 ml / lt with C: B ratio of 1: 2.16 with leaf yield of 13.14 t / ha, *Beauveria bassiana* 1×10^{9}spores which recorded C: B ratio of 1: 2.12 with leaf yield of 12.72 t/ ha. Hence, to manage the tobacco cut worm, *Spodoptera litura* on Amaranthus effectively, NSKE 5% can be recommended.

5. Acknowledgement

Special thanks to Department of Entomology, University of Agricultural and Horticultural Sciences, Shivamogga for the necessary facilities that were made available to carry out the research work.

6. References

1. Akubugwo IE, Obasi NA, Chinyere GC, Ugbogu AE. Nutritional and chemical value of *Amaranthus hybridus* L. leaves from Afikpo, Nigeria. African Journal of Biotechnology 2007;6(24):2833-2839.
2. Asi MR, Bashir MH, Afzal M, Zia K, Akram M. Potential of entomopathogenic fungi for biocontrol of *Spodoptera litura* F. (Lepidoptera: Noctuidae). The Journal of Animal and Plant Sciences 2013;23(3):913-918.
3. Joseph I, Edwin CD, Singh AJAR. Studies on the influence of *Beauveria bassiana* on survival and gut flora of groundnut caterpillar, *Spodoptera litura* Fab. Journal of Biopesticides 2010;3(3):553-555.
4. Karthikeyan A, Selvanarayanan V. *In vitro* efficacy of *Beauveria bassiana* (Bals.) Vuill. and *Verticillium lecanii* (Zimm.) viegas against selected insect pests of cotton. Recent Research in Science and Technology 2011;3(2):142-143.
5. Manjula KN, Kotikal YK, Patil HB, Biradar IB. Studies on insect fauna, their natural enemies and pollinators in fenugreek. Karnataka Journal of Agricultural Sciences 2015;28(2):279-281.
6. Martirosyan DM, Lidia AM, Svetlana NK, Pogojeva AV, Zoloedov VA. Amaranth oil application for coronary heart disease and hypertension. Lipids in health and disease 2007;6(1):1-12.
7. Mureithi DM, Fiabof KKM, Ekesi S, Meyhofer R. Important arthropod pests on leafy Amaranth (*Amaranthus viridis, A. tricolor* and *A. blitum*) and broad-leafed African nightshade (*Solanum scabrum*) with a special focus on host plant ranges. African Journal of Horticultural Science 2017;11: 1-17.
8. Prakash A, Rao J, Nandagopal V. Future of botanical pesticides in rice, wheat, pulses and vegetables pest management. Journal of Biopesticides 2008;1(2):154-169.
9. Razak AT, Santhakumar T, Maheswari K, Santhi S. Studies on efficacy of certain neem products against *Spodoptera litura* (Fab). Journal of Biopesticides 2014;7:160-163.