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): 979-982

Received: 08-07-2020
Accepted: 13-08-2020

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Population density of insect pests associated with eggplant varieties (*Solanum* species) in Ogbomoso, Nigeria

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Abstract
Insect pest infestation has become a major threat in the cultivation of crop which results into low yield. This experiment was conducted at Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Oyo State, Teaching and Research Farm during 2016/2017 planting season. To determine the level of insect pest infestation associated with three variety of garden egg namely (*Solanum depressum, S. escullantum* and *S. sapienium*). The experiment was arranged randomized complete block design and the variety was replicated four times. Attention was focused on insect pests of the three growth stages (Vegetative, Flowering and Fruiting stages). The result showed that there are four major insect pests of eggplant (*Z. variegattus, S. litoralis, L. ornabolis*). It was observed that *Z. variegatus* and *Epilachna spp* defoliate the leaf of the target crop but these insects were not found that the fruiting stage meanwhile *S. litoralis* and *L. ornabolis* heavily attacked the flowers and fruits of the target crop about 70% of fruit were destroyed before the harvesting stage except *S. serpientium*. However, infestation of by S. litoralis and L. ornabolis commenced five weeks after planting. Therefore, the management of insect pests of eggplant should be initiated four weeks after planting.

Keywords: Eggplant, *Spodopteral litoralis, Leicinodes ornabolis, Epilacna spp* and *Zonocerus variegatus*

1. Introduction
Eggplant, *Solanum* species, which is also known as garden egg, belongs to the family Solanacaea. It is widely grown either as a sole crop or with other vegetables such as okra, pepper, tomato, potato [1, 2]. (Baidoo *et al*., 2018; Zakka *et al*., 2018). Some of the countries with high production capacity are China, India, Egypt, Turkey, Algeria, Iran, Indonesia [3] (FAOSTAT, 2018). The fruit is rich in essential nutrients [4] (Shirley, 2000) and it is composed of 92% water, 6% carbohydrate, 1% protein and negligible fat [5] (San Jose *et al* 2014). Higher yield and longer fruiting period have been observed to have attracted our local farmers in Nigeria to eggplant production. Aside from soil fertility, insect pest infestation has become a major threat in the cultivation of eggplant in Nigeria [6] (Ghimire and Khatiwa, 2001). This factor has resulted into reduction and low fruit yield of eggplant.
In Nigeria, all the tribes especially Igbos offers the eggplant fruits to visitors to demonstrate their rich hospitality value. The fruits are eaten fresh as food or used in salad preparation. In most parts of the world, eggplant fruits are eaten as a vegetable, fried or incorporated instead.
However, cultivation of eggplant is mostly affected by pests, diseases and unfavorable climatic conditions which often lead to low yield [7] (Emeasor and Uwalaka, 2018). Among the insect pests, *L. ornabolis* (Lepidoptera pyralidae) has been implicated as the most destructive insects [8] (Olaniran, *et al*; 2016). This pest is widely spread in Africa Countries such as Burundi, Cameroun, Congo, Ethiopia, Ghana, Kenya etc. meanwhile, estimated yield loss by Lepidoptera insects vary from one region to another. *S. litoralis* is one of the major insect pests of this crop which attacks different growth stages. The larvae bore into the tender shoots of seedling and other plants which inadvertently leads to wiping and death of the tips. These activities lead to yield loss and poor market value [8] (Olaniran *et al*; 2016). There is an indication that the research should be conducted to determine when to initiate the control of these insect pests in other to have effective control of these destructive insects. Therefore, this research was conducted to investigate on the level of insect pests attack and the critical stage of insect pest infestation.

2. Materials and Methods

2.1 Survey of insects

This experiment was carried out during the early and late planting season of 2016/2017. Eggplant seeds were planted in the selected plots. About 3 to 4 seeds were dropped per hole and were later thinned to 1 plant per stand. A total of 45 plots were arranged and demarcated in a randomized complete block design. Each plot had four plants rows out of which the two middle plant rows were tagged for insect sampling. The activities of the insects were closely monitored from 2 weeks after planting. Serious attention was paid to the abundance of insects at vegetative, flowering, and fruiting stage of the plant. Throughout the experimental trial, the use of insecticide was avoided. Sampling of the insect was done at two week interval in order to study the fluctuation of pest populations and their relation with prevailing weather conditions.

2.2 Data Analysis

Data were collected on insect population densities early in the morning by visual observation from the two middle plant rows. The agronomic data were collected based on plant height, percentage defoliated leaves per plant, and number of fruit damaged per plot. The yield was calculated in kilogramme per hectare.

3. Results

As presented in Table 1, *Epilachna spp* were not observed at 2 week after planting (WAT) on all the tested varieties. Meanwhile *S. litoralis* and *L. ornabolis* were not observed throughout experimental trial on *S. depressum*. The data collected also showed that *S. litoralis* and L. ornabolis were observed at 8, to 12 WAP on *S. escullantum* and *S. serpentium*. However, the highest *Z. variegatus* infestation was detected on *S. escullantum* and *S. serpentium* at 6 WAP. Among the tested varieties, *S. serpentium* had highest *Epilachna* infestation at 6 WAP (133). Generally, *S. escullantum* and *S. serpentium* were heavily attacked which compared with *S. depressum*.

The result presented on Table 2 showed the level of infestation on three growth stages. Among the observed insects, Z. *variegatus* and *Epilachna spp* had highest infestation on the vegetative stage on eggplant when compared with the level of infestation of *S. litoratis* and *L. ornabolis* in respective to the tested varieties. However, it was observed that *S. depressum* had least *Z. variegatus* and *Epilachna spp* infestation at flowering stage. *S. escullantum* and *S. serpentium* had the highest level of the observed insect pests attacked but the level of *Z. variegatus* and *Epilachna spp* population density was considerably reduced at flowering stage whereas *L. ornabolis* and *S. litoralis* had highest population density at flowering stage. At fruiting stage, the level of *Z. variegatus* and *Epilachna spp* infestation was considerably low when compared with *S. litoralis* and *L. ornabolis*. *S. litoralis* heavily attacked *S. serpentium* when compared with *S. depressum* and *S. escullantum* similar result was observed by *L. ornabolis* infestation. Generally, there was no significance differences in respect to insect attacked *S. escullantum* and *S. serpentium*.

Table 1: Population dynamics of insect pests associated with varieties of eggplant

Varieties	Week	*Z. variegatus*	*Epilachna species*	*S. litoralis*	*L.ornabolis*
V1	2	0.00c	0.00h	0.00d	0.00c
	4	8.67bc	9.33bc	0.00d	0.00c
	6	9.00bc	10.7b	0.00d	0.00c
	8	6.67cd	5.67de	0.00d	0.00c
	10	1.67fg	2.00fhg	0.00d	0.00c
	12	0.67g	0.00h	0.00d	0.00c
V2	2	2.00efg	0.00h	0.00d	0.00c
	4	12.0ab	6.33de	0.00d	0.00c
	6	13.3a	11.0b	0.00d	0.00c
	8	8.33bc	4.33Fe	10.7c	16.7a
	10	6.00cde	4.00feg	18.3a	15.0ab
	12	2.00efg	1.67fhg	12.7bc	11.7b
V3	2	3.67efg	0.00h	0.00d	0.00c
	4	15.0a	8.00bcd	0.00d	0.00c
	6	15.0a	15.3a	0.00d	0.00c
	8	8.33bc	5.00efg	13.7b	13.3ab
	10	4.00defg	3.33fhg	16.7a	16.7a
	12	2.00efg	0.67gh	18.3a	15.0ab
V1		4.44b	4.61a	0.00b	0.00b
V2		6.78a	4.56a	6.94a	7.22a
V3		8.00a	5.39a	8.11a	7.22a
LSD		1.65	1.41	1.21	1.72

Means with the same alphabet(s) are not significantly different at $p<0.05$

V1 *Solanum depressum* V2 *Solanum escullantum* V3 *Solanum serpentium*

Table 2: Distribution of insect pests at three growth stages

Insect pests	Varieties	Vegetative	Flowering	Fruiting stage
Z. Variegatus	V1	35.0d	11.7bc	6.00d
	V2	55.3d	33.0a	15.7c
	V3	68.0a	30.7a	10.0d
Epilachna species	V1	27.7e	15.3b	6.33d
	V2	45.3c	35.0a	10.7cd
	V3	55.0b	31.3a	6.00d

Spodoptera litoralis	V1	0.00f	8.33c	0.00e
	V2	0.00f	32.3a	46.7b
	V3	0.00f	33.7a	55.0a
Leucinodes ornabalis	V1	0.00f	14.7b	0.00e
	V2	0.00f	33.3a	54.7a
	V3	0.00f	32.3a	54.3a
	V1	15.7f	12.5b	3.08b
	V2	25.2b	33.4a	31.9a
	V3	30.8a	32.0a	31.3a
	LSD	1.33	2.43	2.79

Means with the same alphabet(s) are not signicantly different at $p<0.05$
V1 *Solanum depressum* V2 *Solanum escullantum* V3 *Solanum serpentium*

4. Discussion

Throughout the experimental trials, four major insect pests were observed which caused major economic damage to the eggplant. Those insects caused various degree of damage to the leaves, flowers and fruits. This goes in line with earlier report by [9] Rice and Pedigo (2014) who reported that various insect pests attacked different phenology of crops. *Z. variegatus* and *Epilachna* species were discovered to have attacked the leaves but the level of their infestations decreased as the age of the plants increased this is an indication that the aforementioned insect pests are leave eating insects. This observation agreed with [10]Indra and Kamini, (2012) who reported that adult flea beetles feed on the cotyledons and leaves of young plants and this resulted into a short-hole effect. Although, very few of the adult flea beetles were found at flowering and fruiting stages of the target crop, however, *S. litoralis* and *L. ornabolis* were not detected at vegetative stage in all the tested varieties but the largest population densities were discovered at flowering and fruiting stages of the target crop.

Meanwhile, the adult stages of *S. litoralis* and *L. ornabolis* were not detected at vegetative stage but larvae of the said insects heavily attacked the flowers coupled with fruits. However, S. *litoralis* and *L. ornabolis* cause significant damage to the fruits when compared with the rate of infestations on the flowers.

With respect to the tested varieties, *Z. variegatus* and *Epilachna* species constitute higher economic damage to the leaves of *S. escullantum* and *S. serpientium* while the *S. depressum* had the least leaf defoliated ranging from 27.7-35% damage. For the damage on *S. depressum* and *S. escullantum. Z. variegatus* caused 68% damage to *S. serpientium* while 55.3% damage was recoreded on *S. escullantum.* This showed that *S. depressum* is more resistant to *Z. variegatus* and *Epilachna* species attacked than *S. escullantum* and *S. serpientiium* but *S. serpientium* had highest infestation. Variation occurs in the level of insect infestation within and among the plants of the same family which can be contributed to many mechanisms such as difference in the host nutritional, quality, suitability of the physical environment and abundance of the competitor consumers or natural enemies [11, 12] (Clancy, *et al*., 1988; Olatunji, *et al*., 2014). However, *L. ornabolis* and *S. litoralis* did not attack *S. depressum* this might have been attributed to its hard fruit but *S. escullantum* and *S. serpientium* were heavily attacked this might have been due to the succulent nature of their fruits.

There was significant variation in the level of the observed insect pests along with the growth stages of the eggplant. For instance, the level of *Z. variegatus* infestation at two weeks after planting was significantly low when compared with level of insect infestation at 4 to 8 weeks after planting in all the tested varieties similar result was observed at 10-12 weeks after planting where low *Z. variegatus* infestation was observed, the same thing applicable to *Epilanchna* species infestation. This implies that leave eating beetles should be controlled at four weeks after planting. In respect to the three varieties, *S. litoralis* and *L. ornabolis* infestations were observed on *S. depressum* and *S. escullantum* at 6 WAP to 12 weeks after planting which resuled into heavy defoliation of flowering and boring of the fruits thereby causing considerable economic loss to the fruit which is the economic part of the eggplant. This showed that S. *litoralis* and *L. ornabolis* caused more damaged than *Z. variegatus* and *Epilanchna* species because the former insect pests attack economic part of the crop. The implication of this observation is that it is more economical to initiate the control strategy when the insect infestation have not reached its peak, therefore management of the- flowering and post- flowering insect pests of this crop.

5. Conclusion

Insects attack is a serious threat in the cultivation of eggplant with the peak activity of the observed insect pests fourth week after planting. Based on the data collected, the observed insect pests can be grouped into two categories pre-flowering and post-flowering insect pests. This experiment also shows that level of population density depends on the varieties of eggplant meanwhile *S. esculentum* and *S. sapientum* had the same level of insect pest infestation which was significantly higher than that of *S. depressum* but none of the post flowering insect pests was discovered on *S. depressum*

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