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Population density of insect pests associated with watermelon (*Citrullus lanatus* Thumb) in southern guinea savanna zone, Ogbomoso

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Abstract
Identification and determination of insect pests are key components of integrated pest management. This experiment was conducted at Teaching and Research farm, Ladoke Akintola University of Technology (LAUTECH) during early and late planting seasons of 2011 and 2012. The experiment was arranged and demarcated in a randomized complete block design.
Eight insects were observed – *Phyllotreta cruciferae*, *Monolepta spp*, *Zonocerus variegatus*, *Aulacophora africana*, *Diabrotica undecimpunctata*, *Dacus cucurbitae*, *Copa occidentalis*, and *Coccinella septempunctata*. The studied insects attacked mostly the leaves except *D. cucurbitae*. *D. cucurbitae* had highest infestation at flowering and fruiting stages in both planting seasons whereas 52.8% infestation was recorded by *P. cruciferae* at seedling stage in the early season but *D. undecimpunctata* had highest population density (50.1%) during the late planting season. Infestation by the observed insects commenced two weeks after planting and peak activity was at 7 week after planting**.** Therefore, management of these insects should be initiated two weeks after planting.

Keywords: Population density, Watermelon, Insect pests, Agroecological zone, *Phyllotreta cruciferae*

1. Introduction
Watermelon (*Citrullus lanatus* Thumb) belongs to the Cucurbitaceae family which includes about 118 genera and 825 species [1]. It originated from Kalahari and Sahara deserts in Africa [9] and now found in Tropical and Subtropical climates worldwide. However, this crop has been reportedly cultivated for a long time in Africa and in the Middle East and Egypt [5, 4].
According to [8], the fruit reportedly contains 95% of water, Carbohydrate 5 mg, Calcium 8 mg, vitamins 0.64g, Phosphorous 9 mg and ascorbic acid 8 mg per 100g of edible portion. It has highest lycopene, content among fresh fruits and vegetables, containing 60% more lycopene than tomato. Lycopene has been reported to have prevented heart attack and certain cancers [7]. Rind of watermelon contains an important natural compound called Citrulline, an amino acid that is required by human body. Citrulline is found in high concentration in liver and is involved with athletic ability and functioning of immune system [7]. Also, it is a good source of fiber which is important for keeping digestive tract operating properly by preventing constipation, hemorrhoids and diverticular disease
In spite of aforementioned numerous benefits of this crop, its production in Nigeria especially in southern part of this country is at subsistence level because farmers rarely cultivate more than one acre of land. There is a ready local market for this crop which supposes to be an incentive for increased production. However, insect pest infestation such as *Phyllotreta cruciferae*, *Zonocerus variegatus*, *Aulacophora africana*, *Dacus cucurbitae* etc. is a major constrain in the cultivation of watermelon. Meanwhile, different insect pests have been reported from various agro ecological zones as insect pests of watermelon. This is an indication that geographical locations contribute immensely to the infestation rate of watermelon. In addition, agro climatic condition influences the distribution and population density of insect pests.
In view of this, adequate information is very important on population density of insect pests associated with watermelon in southern guinea savanna agro ecological zone, Ogbomoso. This information will go a long way in forecasting the insect infestation level of this crop in a particular planting season or plant growth stages which will assist in the proper implementation of pest management programme of watermelon.

Therefore, this experiment was conducted to identify different insect pests of watermelon, infestation rate and their distribution along the plant growth stages.

2. Materials and Methods

2.1 Survey of insect pests: This experiment was carried out during the early and late planting seasons of 2011 and 2012. Watermelon seeds (Sugar baby) were deliberately planted in those selected plots. 3 to 4 seeds were dropped per hole which was later thinned to 1 plant per stand. 15 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. However, 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 with a view to study the fluctuation of pest populations. Visual sampling of the insects was done early in the morning per plot when they were relatively inactive and each insect was counted visually per plot. Different insect species collected were taken to Environmental Biology Department, University Ibadan, Oyo state for identification.

2.2 Data Analysis: Data collected were subjected to analysis of variance and significant difference was separated with Duncan Multiple Range Test at 5% probability level.

3. Result

3.1 Effect of seasonal variation on insect pests associated with watermelon

The data presented in table 1 suggest that *P. cruciferae* beetle constituted major economic damage to the leaves at vegetative stage during early season when compared with other insects but there was no significant difference ($P<0.05$) in the infestation rate by *P. cruciferae* and *Monolepta* spp during the late season. However, *Monolepta* spp and Lady beetle significantly attacked the leaves when compared with other insects except *P. cruciferae* in the early season. This result also shows that *Z. variegatus* and *D. undecimpunctata* had the same significant infestation rate on leaves. Similar trend was observed between *A. africana* and *C. occidentalis*. Meanwhile, *D. cucurbitae* was not observed on leaves in both seasons. During the late season, the results show that *D. undecimpunctata* had the highest significant infestation (50.1%) which was followed by *P. cruciferae* (34.4%). No significant difference was detected between *A. africana* and *C. occidentalis* likewise Lady beetle and *Z. variegatus*. This clearly suggests that planting season also dictates the level of insect infestations.

In respect to flowering stage, *D. cucurbitae* had highest infestation (15.8%) in both planting seasons but in the early planting season *P. cruciferae* was ranked next to *D. cucurbitae* (22.8%) whereas *Monolepta* spp and *C. occidentalis* were observed to have caused significant damage to the flowers, based on this it was ranked as the second major insect during the late planting season. The least population density of *Z. variegatus* was recorded during the early planting season and no infestation was observed by this insect in the late planting season. However, infestation rate by *Monolepta* spp and *D. undecimpunctata* was significantly the same in the early season but in the late season, *D. undecimpunctata* had significant lower infestation than *Monolepta* spp during the early planting season

Table 1: Percentage occurrence of insects on watermelon (*Citrullus lanatus* Thumb) plant parts

	Insects	Leaves (%)	Flowers (%)	Fruits (%)
Early Season	*P. crucifera*	52.8^{a}	22.8^{b}	45.6^{b}
	Monolepta spp	50.6^{ab}	16.0^{d}	2.2^{d}
	Lady beetle	45.4^{b}	7.8^{f}	0.0^{d}
	Z. variegatus	37.5^{c}	4.1^{g}	0.0^{d}
	D. undecimpunctata	36.6^{c}	16.8^{d}	6.0^{dc}
	A. africana	30.6^{d}	19.8^{c}	0.0^{d}
	C. occidentalis	30.0^{d}	10.7^{e}	10.8^{c}
	B. cucurbitae	0.0^{e}	25.8^{a}	55.0^{a}
Late Season	*P. crucifera*	34.4^{b}	7.3^{d}	1.6^{de}
	Monolepta spp	32.0^{b}	13.4^{b}	2.5^{d}
	Lady beetle	24.9^{c}	2.0^{e}	0.0^{e}
	Z. variegatus	28.1^{c}	0.0^{f}	0.0^{e}
	D. undecimpunctata	50.1^{a}	10.9^{c}	8.5^{b}
	A. africana	33.5^{b}	7.3^{d}	6.7^{c}
	C. occidentalis	33.5^{b}	14.6^{ab}	6.9^{cb}
	B. cucurbitae	0.0^{d}	15.8^{a}	49.6^{a}

Means with the same alphabet(s) along the column are not significantly different at 5% probability using DMRT.

Similarly, *D. cucurbitae* had highest infestation at fruiting stage. Meanwhile, *P. cruciferae* which was ranked next to *D. cucurbitae* attacked freshly emerged young fruits in the early season.

The data also suggest that the roots and stems were not attacked by the studied insects.

Comparatively, that the population density of insects reportedly observed during early season was relatively higher than that of late season meaning that more damage would be done to this crop in the early season due to the fact that rate of insect infestation has direct effect on the kind of damage being done to the crop. And also, more insects were found on leaves than other plant parts in both seasons.

3.2 Distribution of insect pests in respect to week after planting

Z. variegatus infestation commenced at 3rd week after planting (WAP) during early season whereas in the late planting season *Z. variegatus* infestation started at 5th WAP. Meanwhile, infestation of *P. crucifera* started at seedling stage in both seasons. It was also observed that *P. cruciferae* infestation increased as the week after planting increased but there was a

decrease in the infestation level as the number of flowers increased.

D. undecimpunctata was not observed at 3rdand 11th WAP during early planting season whereas M*onolepta spp* commenced the infestation of this crop at 3rd WAP in the early season but it was not observed at this period in the late season. However, the peak activity of these insects was detected at 7th WAP in throughout the study period.

During the early season, there was no significant difference in the infestation of *C. occidentalis* starting from 5th and 9th WAP but in the late season, infestation was significantly higher at 7 and 9th WAP. No infestation was observed at 3rd and 11th WAP.

During early season, Lady beetle infestation reached its peak at 7th and 9th WAP but in the late season the peak was observed at 7th WAP. However, *A. africana* population density was considerably high at 5th and 7th WAP in both seasons. Meanwhile, *B. cucurbitae* was not observed at 3rd and 5th WAP.

Table 2: Distribution of insect pests associated with watermelon in respect to week after planting

	Weeks	*Z. variegatus*	*P. cruciferae*	*D. Undecimpunctata*	*Monolepta* spp.	*C. occidentalis*	Lady Beetle.	*A. africana*	*B. cucurbitae*
Early Season	3	1.00^{cd}	2.67^{c}	0.00^{c}	2.00^{c}	0.00^{b}	0.00^{d}	0.33^{d}	0.00^{d}
	5	2.33^{b}	5.00^{b}	3.33^{b}	4.00^{b}	2.00^{a}	2.67^{b}	3.33^{b}	0.00^{d}
	7	4.00^{a}	6.67^{a}	5.00^{a}	6.00^{a}	2.00^{a}	4.00^{a}	5.00^{a}	7.00^{a}
	9	1.33^{bc}	2.67^{c}	2.67^{b}	1.67^{c}	2.00^{a}	4.00^{a}	2.33^{c}	5.67^{b}
	11	0.00^{d}	0.00^{d}	0.00^{c}	0.00^{d}	0.67^{b}	1.33^{c}	0.00^{d}	4.00^{c}
Late Season	3	0.00^{b}	1.00^{bc}	2.33^{b}	0.00^{c}	0.00^{c}	0.00^{d}	0.00^{c}	0.00^{c}
	5	1.00^{ab}	1.67^{b}	4.00^{b}	1.67^{b}	1.00^{b}	3.33^{b}	2.67^{a}	0.00^{c}
	7	2.00^{a}	3.33^{a}	6.67^{a}	2.67^{a}	2.00^{a}	5.00^{a}	2.00^{ab}	5.33^{a}
	9	1.00^{ab}	0.33^{c}	2.67^{b}	1.33^{b}	2.33^{a}	2.67^{b}	1.33^{b}	6.67^{a}
	11	0.00^{b}	0.00^{c}	0.00^{c}	0.00^{c}	0.00^{c}	1.33^{c}	0.00^{c}	3.33^{b}

Means with the same alphabet(s) along the column are not significantly different at 5% probability using DMRT.

4. Discussion

Insect pests have been described as the major factor militating against the cultivation of crops. Therefore, it has become necessary to study the level of insect infestation in the cultivation of watermelon and this give an insight to when the control programme would be established. Throughout the course of this study, different insects were observed on the field but eight insects were considered as the major insects of this target crop such as Flea beetle (*P. cruciferae*); Grasshopper (*Z. variegatus*); spotted beetle (*D. undecimpunctata*); Lady beetle (*C. septempunctata*); Red pumpkin beetle (*A. africana*); melon fruit fly (*D. cucurbitae*); *C. occidentalis* and *Monolepta* spp. All the observed insects are leaf-feeding insects except *D. cucurbitae*, they defoliated the cotyledons of the leaves however, their defoliating potential decreased as the leaf canopy increased. This is an indication that the observed insects preferred feeding on the newly emerged leaves. This observation agrees with Indra and Kamini [6] who reported that adult flea beetles feed on the cotyledons and leaves of young plants which resulted into a short-hole effect. However, during the flowering stage, majority of these insects such as *P. cruciferae*, *D. undecimpunctata*, *Monolepta*, *A. africana* and *C. occidentalis* abandoned the matured leaves and started feeding on the flowers leading to defoliation thereby prevented the pollination of the flowers by the honeybees. In addition to this, they were also found on young emerged fruits especially *P. cruciferae* and *D. undecimpunctata* though serious damage was not done to the flowers and fruits compared with the leaves. This observation is in line with Yamaguchi [11] who reported that *Aulacophora foveicophora* caused 35-75% damage to all cucurbits at seedling stage. According to Dent [2] the larvae of *P. cruciferae* live in the soil and feed on the roots of the host plants but this observation was not detected throughout the studied period. Among the observed insects, *D. cucurbitae* is being considered as the most destructive insect due to the fact that it attacked the economic parts of this crop i.e. flowering and fruiting stages. Destructive activity of this insect can be described as indirect effect because this insect oviposit on flowers, young and matured fruits of this crop and the activity led to the flower abortion, young fruits and matured fruits and the larvae stage of this insect feed on the stated parts of this plant. The previous research work by Dhillion [3] has shown that melon flies caused damage to the crops through oviposition in fruit and soft tissues of vegetative parts of hosts and the larval tunnels provide entry points for bacteria and fungi thereby cause the fruit to rot. Weems and Heppner [10] also support the fact that the eggs are laid on unopened flowers and the larvae successfully develop in the tap roots, stems and leaf stalks.

Throughout the experimental trial, it was observed that insect infestation commenced at 3rd WAP and the infestation was relatively low at 11th WAP meanwhile the infestation was discovered to be relatively higher at 7th WAP. Variation in the level of infestation can be attributed to the availability of feeds for the observed insects. Therefore management of these insects must take its effect from the 3rd WAP in order to have the effective control of both pre-flowering and post-flowering insect pests of this crop.

Comparatively, the observation shows that the population density of these insects abnormally higher in the early season than late season meaning that more damage would be done to this crop in the former because there is direct relationship between the insect infestation and damage [2]. And also, more insects were found on the leaves than other parts of the plant in both planting seasons.

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