DAMAGE BY YAM BEETLE *HETEROLIGUS MELES (COLEOPTERA: DYNASTIDAE)* UNDER DIFFERENT POPULATIONS IN YAM CROPPING SYSTEM

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Abstract

Yam beetles are one of the most damaging soil insect pests to yam and have caused considerable set back to yam farmers in the yam growing area of Niger Delta. A one year study to determine the potential threshold level of *Heteroligus meles* damage on yam farm was conducted at the Faculty of Agriculture Teaching and Research Farm, Delta State University, Anwai, Asaba Campus, Delta State, Nigeria in 2004. The variety of yam used was *Dioscorea rotundata* (white yam) cv. Adaka. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The treatments used were: 1, 2, 3, 4 and 5 beetles per stand respectively. No beetle was in the control plot. Beetles were artificially introduced into yam planted in nylon net cages/bags six weeks after sprouting and vine establishment. Results showed that plots infested with various populations of *H. meles* had more number of feeding holes, depth, diameter and size than uninfested control plots. Severity of beetle damage was highest at 4 and 5 beetles/ yam stand and was significantly different ($p<0.05$) from other treatments. Damage scoring ranged from mild to severe damage in beetle infested treatments while no symptom was recorded in the control. Tuber yield was highest in the uninfested control plots which were significantly different ($p<0.05$) from the beetle infested plots. Percentage yield reduction over control was dependent on beetle population while the yield index and multiplication ratio had best results on control plots. The result therefore suggests that the economic threshold level of the insect may be lower than one adult beetle per yam heap under field condition considering the degree of damage.

Keywords: Yam, Yam beetle, damage severity, feeding holes, populations, yield index.

Introduction

Yams belong to the genus *Dioscorea* of the family *Dioscoreaceae* serving as a major staple food for an estimated sixty million people in the production area (Nweke, *et al*, 1991). The production areas include Nigeria, Republic of Benin, Togo, Ghana, Cameroon, Cote d'Ivoire and part of Central Africa The global yam output was estimated at 32.9 million metric tonnes in which Nigeria alone produces 23.9 million metric tonnes, equivalent to about 71% of the world production (FAOSTAT, 1997; FAO, 1998; IITA, 1995). Yam is important as a food security crop and a major source of energy in the diet of most tropical people. It commands high prices as a result of its socio-cultural values (Chukwu and Ikwelle, 2000; Chukwu and Chukwu, 2002; Agbaje, *et al.* 2002).

The greatest constraint to increasing the production of this well appreciated staple food in Nigeria apart from high costs of labour and seed yam (planting materials) is the incidence of diseases and insect pests infestation reported to cause an estimated average yield loss of 25% annually (Arene, 1987; Ezeh, 1998; FAO, 2001). One major insect pest constraint to optimal yam production in yam growing zones is the damage inflicted on yams by the yam beetles *Heteroligus* species (Taylor, 1964; Onwueme, 1978; Tobih and Emosairue, 2006; Tobih, *et al.,* 2007). Species of *Heteroligus* reportedly found in the southern parts of Nigeria include, Greater yam tuber beetle, *Heteroligus meles* Billb, and Lesser yam beetle *H. appius* Burm (Taylor, 1964; 1971; Tobih, *et al,* 2006). *H. meles* is a serious insect pest of yam in the riverine areas particularly in the forest zones, up to the Savannah regions along the Benue- Niger Rivers and their tributaries, (Acholo, *et al*, 1997).

Adult *H. meles* is about 23-33mm in length while *H. appius* is about 21-25mm long. Both are brown to black colour, short -distance fliers, and they usually oviposit in moist and damp site (Taylor, 1964). These beetles cause untold losses and drastic reduction in the yields and market values of yams. Adults feed on yam tubers making large hemi-semi hemispherical holes (1-2.5cm) on the tuber prior to harvest resulting in low market values and predisposition to fungal and bacterial attacks during storage (Morse *et al.,* 2000; Wood *et al.,* 1980; Tobih, *et at.,* 2007). Yam beetles are highly monophagous and host-specific on yam causing considerable damages wherever yams are grown particularly in the all season riverine areas which are usually close to their breeding sites (Taylor, 1964; PANS, 1978; Onwueme, 1978; Morse, *et al.,* 2000).

In order to consider using economically feasible control measures against any pests, reliable information is needed on yield losses as a result of pest attack (Kumar, 1984). A good knowledge and understanding of threshold level of the adult beetles in the infested ecologies is very useful in designing and deciding the need and type of control measure to be used. The aim of this study therefore, is to determine the potential threshold level of yam tuber beetle *Heteroligus meles* on-farm in a yam cropping system.

Materials and Methods

The study was conducted in 2004 planting season at the Faculty of Agriculture Teaching and Research Farm Anwai, Delta State University, Asaba Campus. Experimental site was cleared, ploughed and harrowed before mapping into plots Total land areas used for the study measured 26m X 12m and was demarcated into 18 plots each measuring 4m x 3m separated by one meter path.

Preparation of Nylon Net Cages/Bags

A ¼ (one-fingered nylon fish net) strong, durable and elastic nylon net meshes procured from fish market in Onitsha, Anambra State, Nigeria were carefully measured and cut into 80cm long by 110cm wide. These were neatly joined together to form a bag with posterior end completely sealed off while the anterior end remained open. Pre-marked yam stand spots measuring 1m x 1m were dug to a depth of 80cm, and 60cm wide. The bags filled with top soil were lowered into the empty holes earlier dug and completely buried into the ground Yam setts averaged 300g in weights were each planted with *Dioscorea rotundata* (cv Adaka) being the cultivar used Plants were spaced 1 m x 1m both inter and intra rows given a population density of 10, 000 plants per hectare. After sprouting and vine establishment, the yams were staked with 2.5m tall Indian bamboo. The experiment was laid out in a randomized complete block design (RCBD) with three replications and six treatments. Adult yam beetles earlier collected from light traps and quarantined in plastic cages identified as *H meles* when compared with paratypes at the Insect Reference Collection Centre, Department of Crop Protection and Environmental Biology, University of Ibadan, Nigeria. They were then introduced into the cages/bags as treatments, six weeks after planting (6 WAP) as follows: Treatment: 1 beetle/yam stand, 2 beetles/ yam stand, 3 beetles/ yam stand, 4 beetles/ yam stand, 5 beetles/yam stand and control, zero beetle/ yam stand.

Six weeks after sprouting (6 WAS) with well - established yam vines, the test insects (adult yam beetles) were carefully introduced in the cool evening between 4: 30p.m - 6: 30p.m into each bag when the weather condition was conductive. The anterior end of the bag was untied, while a hole of about 2-3 cm deep was made with fingers at the upper parts before the adult beetles were carefully dropped and covered with soil (Umeozor, 1998). The anterior end of the bag now containing both the growing yams and adult beetle were finally tied with nylon twine round the vine/shoot of the yam to prevent possible escape of these artificially introduced beetles and infestation by other soil insects (Inyang, 2004).

Plots were kept weed-free manually with hand hoes at three, eight and twelve weeks after planting respectively. The yams were grown under rain-fed and natural soil fertility condition without application of fertilizer or pesticide. Tubers were harvested in November when all the aerial parts were completely senescence.

Data collected included fresh yield of harvested tubers, numbers of beetle feeding holes on tuber harvested, depth, diameter and size of feeding holes, number of dead beetle seen at the end of the study and the severity scoring for beetle infestation and percentage tuber yield reduction over check. Other data were yield index and computed multiplication ratio based on the final harvested yam tubers. Data were subjected to analysis of variance (ANOVA) and significant means were separated using Fisher's Least Significant Difference (F-LSD). The data collected except the yield parameter were further subjected to square root transformation before analysis of variance.

Results and Discussion

The results of different population of yam beetle (*H. meles)* damage related parameters are presented in Table 1. Results indicated that mean number of beetle feeding holes significantly increased with increase in the beetle population at 5% probability. There were no significant difference among treatment with 3-5 beetles per yam stand but were significantly higher than treatments with 1-2 beetles and the uninfested control. Conversely, for mean depth and diameters of feeding holes, there were no significant differences ($p>0.05$) among treatments with beetles but they were all significantly higher compared with uninfested control. Varied significant differences existed among treatments with beetles regarding mean-size of feeding holes. Meanwhile, it was observed that they were all significantly higher than the control plots. The mean number of dead beetle seen at the end of the experiment varied from approximately 1 to 4 beetles among beetle-infested treatments with significant differences at ($p<0.05$). Severity scoring for beetle damage ranged from severe damage (4.4) to mild damages (2.0) in all infested plots with adult beetles on the severity scoring scale of 1-5, where 1=no damage, 2 - “mild” damage, 3 = moderate damage, 4 = severe damage, 5 = very severe damage (Agbaje *et al.*, 2002). At 4 and 5 beetles, all the plots showed severe damage significantly higher than lower, (1 and 2) beetle populations (Table 1).

Table 1: Yam beetle (H. meles) damage-related parameters of different beetle populations (treatments)

Treatment	Mean no. feeding holes**	Mean feeding Holes (cm)*			Mean dead beetle	Mean damage severity
		Depth	Diameter	Size		
1. Beetle	7.40 (2.74)	1.26(1.32)	1.40(1.59)	1.80(1.97)	0.60(2.16)	2.00(1.22)
2. Beetles	7.60 (2.75)	1.42 (1.37)	1. 78 (1 58)	2.19(1.89)	1.40(1.89)	2.40(1.58)
3. Beetles	17.40 (4.21)	1.52 (1.40)	1.98(1.56)	3.31 (1.88)	2.40(1.68)	3.20(1.91)
4. Beetles	20.40 (4.55)	1.56(1.43)	2.04(1.50)	3.05(1.71)	3.20(1.33)	4.20(2.16)
5. Beetles	21.40(4.63)	1.66(1.46)	2.06 (1.36)	3.45 (1.49)	4.20(1.01)	4.40(2.21)
Control	0.0 (0.70)	0.00 (0.70)	0.00 (0.70)	0 .00 (0.70)	0.00(0.70)	0.00(0.70)
LSD (0.05)	5.41 (0.75)	0.50 (0.19)	0.69 (0.23)	0.48 (0.42)	0.05(0.35)	0.71(0.18)
CV (%)	33.18 (17.36)	31.25(11.25)	34.13 (12.68)	47.57 (20.17)	40.57(19.26)	18.89(7.59)

Means were separated with Fisher's Least Significant Difference (F-LSD) at 5% probability.
*Data transformed to square root transformation V x + 0.5 (values in parenthesis)
** The untransformed actual values.

Table 2: Effect of different populations of H. meles on yam tuber yield and yield related parameters

Treatment	Mean tuber yield t/ha	Yield index	Multiplication ratio	% yield reduction over control
1	38.00	35.00	12.67	28.70
2	37.20	34.20	12.40	30.20
3	31.10	28.10	10.36	41.60
4	31.10	28.10	10.36	41.60
5	25.60	23.60	8.53	51.90
Control	53.30	50.30	17.76	
LSD (0.05)	1.74	2.23	1.93	
CV (%)	36.69	33.92	41.81	

Similar results were obtained when the data were transformed using square root transformation (Vx + 0.5) in all the parameters.

Feeding activities of the yam beetles on the yield of freshly harvested tubers is shown on Table 2. The results indicated that beetle infested plots had least tuber yields which was observed to be significantly ($p<0.05$) different from the uninfested control treatments. The highest yield was observed in the control with mean value of 53.3 t/ha which was significantly higher than plots where 3-5 beetles were used as treatments. Thus, reduction in the yield of tuber may be population dependent i.e. reduction in yield was likely brought about by increase in the severity of infestation. Quantitatively, this translated to tuber yield of 53.3 t/ha under no infestation while 25.6 t/ha was recorded under severe beetle attack. Yield index, multiplication ratio and percentage yield reduction over control followed the same trend table 2. The highest multiplication ratio 7.76 was observed in the control plots while the least 8.53 was found in the highest population of 5 beetles/stand. Percentage yield reduction was equal highest at 5 beetle/plot (51.90%) reductions in yield which was significantly ($P \leq 0.05$) higher than (28.70%) recorded at 1 beetle.

The high tuber yield observed in this study particularly control plots, could be attributed partly to the unconventional way the land was prepared and secondly to the reduced infestation of the beetles on the tubers. Agbaje *et al* (2002) had reported 32.4 t/ha in hybrid yam (TDr89/02665) under sole cropping system in Ibadan, Nigeria. Igwilo, (2001) also reported that increased tuber yield could be maximally achieved if the right variety and seed bed preparation are used. Tuber yield was seriously depressed by increase in the number of beetle per yam heap. For example, the percentage yield reduction over the check (control) was 28.7, 30.2, 41.6 and 51.9 percents for 1, 2, 3, 4 and 5 beetles per heap respectively. The correlation analysis between beetle numbers and severity of infestation gave a correlation coefficient of (r =+ 0.97). This study demonstrated that severity of infestation and yield reduction under infestation of *Heteroligus meles* increase, with increase in population (r= +0.97). This finding is in agreement with that of Tobih and Emosairue (2006) who reported positive correlation between beetle numbers and weight loss in yam tubers i.e. (yield).

The number of dead beetles recovered or found at the end of the experiment was significantly higher at 5 beetle infested plots than 3, 2, and 1 beetle and the control both in the transformed and un-transformed data. The full carcasses of the dead beetles seen was an indication that they fed on the yam tuber since introduction and probably die close to the end of the experiment This may be due to inclement weather conditions such as low moisture, high soil temperature and perhaps low aeration, otherwise the body could have decayed and form part of the soil if they had died earlier

The result obtained from this study confirmed that yam beetle particularly *H. meles* is a very serious insect pest of yam in this area. A Screen House experiment reported weight loss caused by the pest within one month (4 weeks) to range from 0-21 4% under the highest beetle population of 4 per pot (Tobih and Emosairue, 2006).

Beetle infestation in the Old Asaba Province where the current study was carried out was reported to be over 20% attack rate (Taylor, 1964). This was further confirmed by Tobih *et al*, (2006) who reported 31% to 45% and 32% to 51% attack rate in the Oshimili and Aniocha areas of Delta State in 2001 and 2002 respectively. This study seems to suggest that the economic threshold Of this voracious beetle is less than 1 beetle per yam heap considering the feeding rate (damage holes) and duration of stay (3 - 4 months) before embarking on breeding flight back to the swampy or their breeding low land sites (Taylor, 1964).

Conclusion and Recommendation

This study shows that field infestation of yam beetle damages the tuber quantitatively by a comparative reduction of yield potential as well as loss of market values. Similarly, plots with higher beetle populations suffered higher incidence and severity of beetle damages than other treatments. The highest tuber yield was recorded also in un-infested control plots than in all beetle-infested plots. It is recommended that yam setts should be treated with easily - biodegradable insecticides such as endosulfan, carbofuran and chlorpyriphos at recommended dosage rates before planting. Planting could also be delayed till mid- June to avoid peak population of the beetle coinciding with tuberization.

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