Methods of insecticide application to control yam tuber beetles (heteroligus spp; coleoptera: dynastidae) in yam monocrop system in Delta State, Nigeria

Tobih FO

Department of Agronomy, Delta State University, Asaba Campus, Delta State, Nigeria

Author E-mail: tobih002@yahoo.com

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Abstract

A study to evaluate the application methods of an insecticide (Chlorpyriphos E.C) to control yam beetles in yam monocrop system in 2010 and 2011 seasons was investigated. The trials were laid out in randomized complete block design with three application methods, namely, treated yam setts, treated planting holes, application at tuber initiation (10 WAS) and the control, replicated three times. Results obtained indicated the superiority of application at tuberization and treated setts over treated planting holes and the control. The two methods had higher tuber yield, less beetle feeding holes, percentage tuber attacked which were significantly different (P≤ 0.05) from the treated hole and control. Yield increase due to the application methods ranged from 13% to 61% in both cropping seasons. The study therefore recommends the use of either setts treatment or application of insecticide at tuberization periods to manage yam beetle decimation.

Keywords: Yam beetle, insecticide, chlorpyriphos, damage scoring, yam sett, methods.

INTRODUCTION

Yams (Dioscorea spp.) are important in household food security and income generation particularly in developing economy like Nigeria. The socio-economic and cultural importance of this crop in West and Central Africa where most of the World production occurs has been well reported (Okwor, 1998; Ekpe et al., 2005). The economic importance of this important staple crop is largely due to its tuberous underground stem which may weigh 15 – 20 kg (Timothy and Bassey, 2009; Ukpabi and Okoli, 2002). About 1.5 – 2.0 million hectares of land was reportedly put in yam production annually with bulk of this production emanating from the southern Nigeria, the largest producer (31.5 million metric tonnes, annually), (Enwesor et al., 1989; CBN, 2003) and at the same time the largest consumer of the produce (Ezulike et al., 2006).

However, there are numerous factors militating against optimum yam production; which include expensive planting materials (seed yams/setts) labour, staking, weed menace, diseases and insect pests. The major culprit in this regard is the decimation by the yam tuber beetles Heteroligus species (Taylor 1964; Tobih et al., 2007). This monophagous and voracious beetle are very serious insect pest of yam in riverine areas particularly in the rainforest zones up to savanna regions along major rivers such as Benue and Niger Rivers and their tributaries (McNamara and Acholo, 1995). Serious losses and drastic reduction in tuber yield and market value as a result of the beetle damage has been reported by (Wood et al., 1980; Tobih et al., 2009).

Adult beetles feed on the tubers making large hemi-semi spherical holes (1 -2cm) on the tuber resulting in low market value and a predisposition to other microbial attack in storage. The beetle attack rates vary from one region to another and season to season. Up to 40 – 60% attack rate has been reported in yam cropping system (Taylor, 1964; Tobih et al., 2007) and various control strategies to control the beetle menace has been well documented (Taylor, 1964; Tobih et al., 2009; Emeazor, 1998). To adequately and maximally achieve good results from yam production in an endemic yam...
beetle infested areas, accurate identification, good knowledge of attack/infestation periods associated with any pest species, and degree of damage/infestation in the field determined by proper monitoring and sampling are key to any insect pest management. This study was undertaken to determine the best methods of insecticide application for the control of yam beetle devastation in yam cropping system in Delta State, Nigeria.

**MATERIALS AND METHODS**

The study was carried out at the Faculty of Agriculture Teaching and Research Farm, Delta State University, Asaba Campus in 2010 and 2011 cropping seasons. The study area is located at Latitude 6º, 14’ N and Longitude 6º 49’ E of the equator with a hot humid climate and bi-modal pattern of rainfall. The mean annual rainfall is about 1,500mm – 2,000mm which usually lasts between April and October with June and September as the peak. Relative humidity is 77.2%, temperature 37.3°C, soil temperature at 100cm depth is 28.3°C while the monthly sunshine stands at 4.8 bars (Federal Ministry of Aviation, Asaba Inspectorate Office Bulletin, 2009).

**Land preparation and treatments**

The study site which was left fallowed for about 5 years, was cleared using local implements (hoe, cutlass, spade, garden fork) and yam mounds were made with Abakaliki traditional hoe (Ikeorgu and Igwilo, 2002). Due to the long fallow period, there was natural soil fertility as a result of copious decayed vegetation covers resulting in good organic matter contents with full biological agents activities in the soil. No inorganic fertilizer was applied. Twelve plots each 4m long by 3m wide were demarcated and three insecticide application methods as treatments and untreated control were assigned to them in a randomized complete block design replicated three times.

The insecticide applied was chlorpyriphos, an organophosphate with contact, stomach and fumigant action. It is non phytotoxic, easily degraded in the soil between (60 – 120 days residual activity), moderately hazardous (LD$_{50}$ oral 150mg/kg; World Health Organisation Class II), (Schoubroeck et al., 1992). Two hundred grammes (200g) yam setts weights were planted per mound spaced 1m x 1m on April 15 – 16$^{th}$, 2010 and April 18 – 19$^{th}$, 2011. The rate of insecticide applied (chlorpyriphos EC) was 1.92 L chlorpyriphos per 2 tonnes yam setts.

**Treatment application**

*Dioscorea rotunda cv Adaka* was the cultivar used. The setts were dipped in the specified concentration of the insecticide solution for about 2 – 5 minutes and allowed to dry before planting for treated setts. For the treated planting holes, the already marked and prepared yam mounds planting holes were treated (sprayed) with same concentration of the insecticide solution with knapsack sprayer CP15 before the setts were planted 15 minutes thereafter in each designated treated holes. At tuber initiation periods 10 - 12 weeks after sprouting (Njoku et al., 1973; Okezie et al., 1981) each yam stands were treated with the same quantity and concentration of the insecticide solution with knapsack sprayer while the untreated plots served as the control treatment.

The yams were staked using 2.5m Indian bamboo stakes after sprouting and vine establishment while plots were kept need-free manually by hoeing at 3, 8 and 12 weeks after planting. Tubers were harvested in November when all the aerial parts were completely senescence.

**DATA COLLECTION AND ANALYSIS**

**Tuber Weight**

Freshly harvested tubers were properly cleaned to remove sand and other foreign materials before using top-loading scale balance and each tuber weights were recorded.

**Feeding Hole Number**

Harvested tubers were physically examined for yam beetle feeding and each identified holes were counted with the aid of black-ink marker and recorded.
Percentage Tuber Attacked

This was calculated by subtracting all tubers with beetles feeding holes from the total tubers harvested. This was further divided by total number of tuber harvested per treatment and multiplied by 100.

Multiplication Ratio

Total weight of yam setts planted divided by the final weight of tuber harvested.

Yield Index

Total weight of yam setts planted subtracted from the final total tuber yield.

Percentage Yield Increase

This was computed by subtracting the treatment yield value from the control value while the difference is further subdivided by the control value and multiplied by 100.

Severity Scoring/Damage

This was based on Agbaje, et al, (2002) damage ratings with some modification by Tobih et al, (2011). All data collected were subjected to Analysis of Variance (ANOVA) and significant means were separated by Fisher’s Least Significant Difference (F-LSD) at 5% probability level.

RESULTS

The effects of method of insecticide application to control yam beetle damage and its impact on tuber yield in 2010 and 2011 cropping seasons are presented on tables 1. Results obtained indicated significantly higher tuber yields in all insecticide treated plots than the control. Highest yield was recorded at tuber initiation (16 t/ha) followed by treated setts, (15.9 t/ha) and treated planting holes (13.60 t/ha), which were all significantly (P≤ 0.05) higher than the control plots (9.90 t/ha) in 2010. Feeding holes as a result of the beetles attack was highest in the untreated plots (15.84), followed by treated holes (5.35) while the least were in the plots treated at tuber initiation (0.15) table 1.

Damaged severity was visibly high in control plots with damage scoring of 4.66 (very severe damage). Yield index was highest at tuber initiation treatment (13.50) closely followed by treated setts (13.40) with no significant difference at 5% probability. These were however significantly higher than treated holes and control plots.

In 2011 cropping season, the results obtained in all the parameters evaluated such as tuber yield, feeding holes, percentage tuber attacked, yield index, damage scoring and percentage yield increase over control showed the superiority of treated yam setts and treatment at tuber initiation than treated planting holes and the unprotected plots (Table 2). Generally, the results obtained indicated similar trends as was obtained in 2010 cropping season. There were varied significant differences between the insecticide – treated plots and untreated plots at 5% probability. The coefficient of variation percentage in all the parameters evaluated showed relatively low values indicating reliability or near reliability of the results obtained in the study.

Table 1. Effect of Insecticide application methods on yam beetle damage and tuber yield in 2010

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Tuber yield t/ha</th>
<th>Feeding hole number</th>
<th>Yield index</th>
<th>Damage scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated yam setts</td>
<td>15.90</td>
<td>3.15</td>
<td>13.40</td>
<td>1.33</td>
</tr>
<tr>
<td>Treated planting hole</td>
<td>13.60</td>
<td>5.35</td>
<td>11.10</td>
<td>2.66</td>
</tr>
<tr>
<td>*Treatment at tuber initiation</td>
<td>16.00</td>
<td>0.15</td>
<td>13.50</td>
<td>1.33</td>
</tr>
<tr>
<td>Control</td>
<td>09.90</td>
<td>15.84</td>
<td>07.40</td>
<td>4.66</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>3.77</td>
<td>1.95</td>
<td>1.50</td>
<td>1.20</td>
</tr>
<tr>
<td>CV (%)</td>
<td>13.30</td>
<td>18.95</td>
<td>19.30</td>
<td>24.03</td>
</tr>
<tr>
<td>SE (±)</td>
<td>3.57</td>
<td>0.82</td>
<td>0.78</td>
<td>0.36</td>
</tr>
</tbody>
</table>

* Treated with insecticide 10 weeks after sprouting
Table 2. Effect of Insecticide application methods on yam beetle damage and tuber yield in 2011

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Tuber yield t/ha</th>
<th>Feeding hole number</th>
<th>Yield index</th>
<th>Damage scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated yam setts</td>
<td>14.50</td>
<td>0.25</td>
<td>12.00</td>
<td>1.33</td>
</tr>
<tr>
<td>Treated planting hole</td>
<td>11.95</td>
<td>4.83</td>
<td>9.45</td>
<td>2.66</td>
</tr>
<tr>
<td>*Treatment at tuber initiation</td>
<td>16.20</td>
<td>0.07</td>
<td>13.70</td>
<td>1.33</td>
</tr>
<tr>
<td>Control</td>
<td>10.50</td>
<td>13.00</td>
<td>8.00</td>
<td>4.66</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>3.08</td>
<td>1.00</td>
<td>1.35</td>
<td>1.20</td>
</tr>
<tr>
<td>CV (%)</td>
<td>11.28</td>
<td>11.28</td>
<td>17.3</td>
<td>24.03</td>
</tr>
<tr>
<td>SE (±)</td>
<td>2.40</td>
<td>0.25</td>
<td>0.93</td>
<td>0.36</td>
</tr>
</tbody>
</table>

* Treated with insecticide 10 weeks after sprouting

DISCUSSION

Tuber yields in all insecticides treated plots in both 2010 and 2011 cropping seasons were significantly (P≤ 0.05) higher than untreated control plots. The increase in tuber yields in treated plots could be attributed to apparent reduction in the beetle damage. The effects of the insecticides on tuber yield was more visible and pronounced in 2010 cropping season where the yield increase ranged between 61.61% and 37.37% while it was 54.25% and 13.80% in 2011 (Figures 1a and b). Earlier studies by Taylor (1964) and Tobih et al., (2007) reported similar higher tuber yield increases (20 – 77%) and (34 – 68%) respectively. Meanwhile, attack rate of 40 – 60% by the dynastid beetles had been reported by Taylor (1964) and Tobih et al, (2007). The need for control of these beetles was further reinforced by Inoni (2010) who reported yam beetle damage rate of 32.6% in Oshimili North area of Delta State, Nigeria.
The percentage yam tubers attacked were highest in the untreated control plots 86% and 87% followed by treated holes 47.3% and 42% while application at tuberization and treated setts had lower rates of attack 6.33%, 2.66% and 8%, 3.33% which were significant at 5% probability level in both cropping seasons evaluated Figure 1a.

The rate of increase in tuber yields were enhanced significantly by the insecticides applied. However, application at tuberization and treated yam setts gave 61.61%, 60.6%, 54.25% and 38.09% respectively in both seasons unlike the treated planting holes with 37.37% and 13.80% in 2010 and 2011 cropping seasons respectively.

The superiority of application of the insecticide at tuber initiation and treated setts before planting over the treated planting holes could be as a result of some of the active ingredient (toxicant) been leached away before the actual arrival of the beetles to the yam mounds. It must be pointed out also that the practice of soil application is more difficult to standardize and greater difficulty may be experienced in ensuring a uniform distribution of the insecticide between and within the planting holes.

Till date, decimation of yam tuber by yam beetles in major yam producing areas in Nigeria is still a serious concern to yam farmers. Various control methods apart from the use of synthetic pesticides have been evaluated and the results obtained indicated non-effectiveness. The only effective and reliable method is the use of insecticides (Emeazor, 1998; Tobih et al., 2009). Results from this study clearly demonstrated the superiority of application of the insecticide at tuber initiation and treated yam setts before planting for optimum yield and improved market values of the yam tubers. The order of effectiveness of the three method of insecticide application evaluated were tuber initiation > treated yam setts > plant holes. However, due to extra labour required and technicality involved for effective application of the insecticides at tuber initiation, the method of treating yam setts before planting is recommended.

CONCLUSION

The use of available technologies must be effectively utilized to maximize food production to ever increasing human population. The use of up-to-date crop protection methods must be significantly stepped-up if full benefits of capital investments in farm operations inputs such as fertilizer, irrigation, improved varieties, management practices and control measures are to become a total reality. These huge investments may be considered wasted unless the yield potentials of crops can be realized and attained through reduction of losses from crop pests.

References


