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# Preferential feeding and damage to cultivars of Nigerian cassava by the variegated grasshopper (*Zonocerus variegatus*)

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# Preferential feeding and damage to cultivars of Nigerian cassava by the variegated grasshopper (*Zonocerus variegatus*)

BY E. R. TERRY,* G. A. SCHAEFERS† AND M. J. GARBER*
* *International Institute of Tropical Agriculture, PMB* 5320, *Ibadan, Nigeria*
† *New York State Agriculture Experiment Station, Geneva, New York* 14456, *USA*

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SUMMARY

Large populations of *Zonocerus variegatus* invaded a cassava crop established during the dry season. The resultant damage was severe, certain cultivars being totally destroyed. The grasshoppers exhibited a statistically significant preference for certain cultivars the defoliation of which shifted attacks to less preferred ones. On a particular variety (Isunikankiyan), populations increased and persisted even after defoliation, probably due to acceptability of the bark by the grasshoppers.

## INTRODUCTION

The grasshopper *Zonocerus variegatus* L. feeds on a wide variety of crops in Nigeria including cassava, cocoa, yams and cowpeas (Golding, 1946; Libby, 1968; Toye, 1971, 1972; Youdeowei, 1974) and although not generally regarded as a major pest may cause serious damage on some of these crops (Golding, 1946).

In southern Nigeria, *Z. variegatus* has two annual generations (Anya, 1973). One generation, commonly called the 'dry season population', exists from October to March–April. Oviposition occurs in April but hatching is delayed until the following October. Meanwhile, another generation, the 'wet season population', hatches in February–March and matures in July–August. The latter generation is of low density and of little concern (Anon. 1974).

In Nigeria, cassava is usually planted at the beginning of the rains (March–April). Short-duration cultivars are, however, sometimes planted at the beginning of the wet season and long duration ones later, but generally, cuttings are planted whenever parent plants are harvested (Jennings, 1970). As cassava is particularly valued because of its drought tolerance some are planted in the dry season in the southern states of the country.

This paper reports studies of (1) population levels and (2) the extent of damage by *Z. variegatus* to cassava planted during the active period of the 'dry season population'. Additional investigations include the preferential feeding responses of the grasshopper to Nigerian cassava cultivars.

## MATERIALS AND METHODS

Test cultivars used were 53101 and 60444 (Improved Nigerian) and Isunikankiyan (Nigerian local). The three cultivars were laid out in eight $3 \times 3$ Latin squares. Each of the nine plots within a square contained fifteen plants arranged in three rows with five plants per row. Uniform cuttings 25 cm long were planted in each plot; the within row and between row spacings were 1 m. The eight squares were arranged in two rows of four squares each running north–south. The experimental plot was bounded on the south, east and west by primary bush and on the north by an access road and an area free of bush. Cuttings were planted on 30 October 1974 and the plots were kept weed-free during the investigation.

Grasshopper counts were made between 21 November 1974 and 18 February 1975 on the centre plant of each five-plant row. The counts were made during the morning when the insects were less active and care was taken to minimize disturbance of the insects.

Defoliation of each cultivar was assessed on six dates starting 17 January 1975 and ending 3 February 1975. Individual plants were considered defoliated when more than 90% of the foliage was consumed.

For analysis of variance, the following transformations were made:

(*a*) grasshopper counts: where $X$ = number of grasshoppers per plant, $y = \sqrt{X}$;

(*b*) degree of defoliation: where $X$ = proportion defoliation, $y = \sin^{-1} \sqrt{X}$; $y$ is measured in radians (Snedecor & Cochran, 1967).

## RESULTS

Grasshopper counts were generally low during the period from 21 November to 10 January (Fig. 1). Young nymphs were present at this time, but fed primarily on wild leguminous plants surrounding the planting. Density on the cassava averaged less than three grasshoppers per plant. However, on 21 November, there were significantly fewer grasshoppers on cv. 53101 than on Isunikankiyan and 60444 (mean numbers: 0·4, 2·1, 3·7, respectively). On the first four sample dates fewest grasshoppers were found on 53101 while most were found on cv. 60444 (Table 1). The insect invasion originated from the 'open' or 'cleared' north end of the planting and counts on 2 January showed a definite decreasing trend in hopper numbers in the north–south direction for all three cultivars.

A massive invasion of the test planting occurred during mid-January and by 17 January (Table 2) the population averaged 27·2, 92·0 and 19·6 on the west side and 73·2, 57·2 and 32·9 on the east side on Isunikankiyan, 60444 and 53101 respectively, with single plant counts as high as 274. On the west side of the planting there were significantly higher numbers on 60444 than on the other cultivars while on the east side of the planting Isunikankiyan had significantly more hoppers than 53101. Defoliation on cv. 60444 was as high as 25% on 17 January, compared to 2 and 3% respectively for the other two cultivars (Fig. 2). Analysis of variance showed that there was a significant interaction for defoliation between cultivar and latitudinal orientation (Table 3).

On 21 January, there was a highly significant difference in the level of defoliation in cv. 60444 (52·0%) compared to Isunikankiyan and 53101 (13·3 and 12·5%, respectively). There was a definite decreasing trend in defoliation in the north–south direction for all three cultivars. Grasshopper numbers were evenly distributed among the three cultivars on 20 January (Table 1). The relative decrease on 60444 and the increase on 53101 resulted when the grasshoppers deserted the almost defoliated

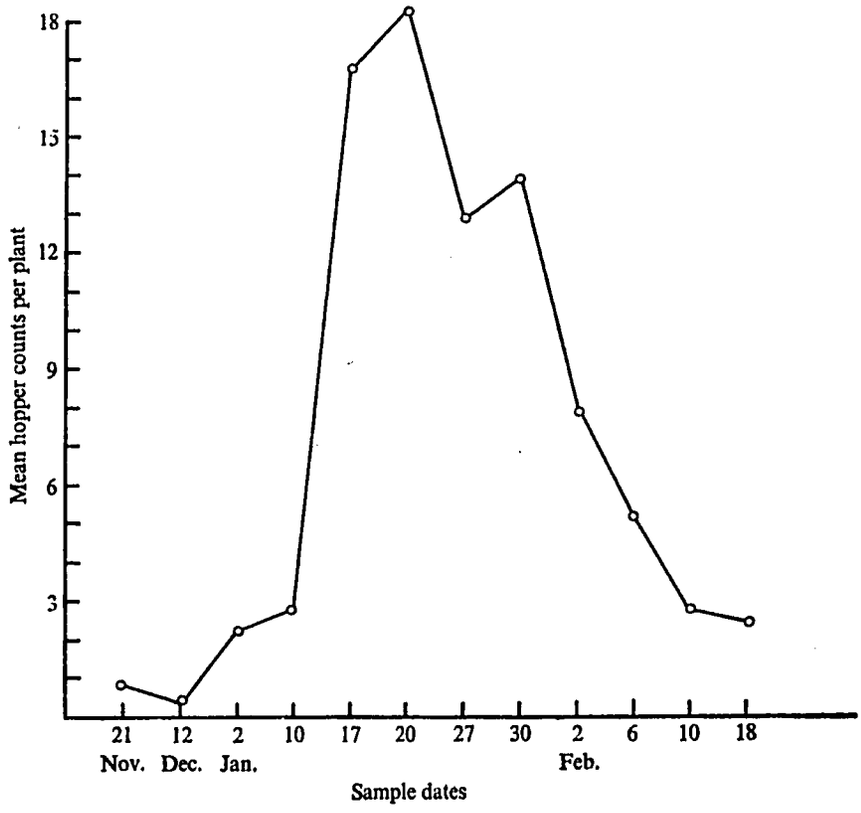


Fig. 1. Population levels of *Zonocerus variegatus* on 216 cassava plants, November 1974–February 1975.

60444 plants at the north end of the trial. By 25 January there were significant differences in defoliation between 60444 (71·2%), Isunikankiyan (45·0% and 53101 27·5%).

On 27 January, cv. 60444 was significantly more defoliated than 53101 on the west side of the experiment. Because of the near total defoliation of 60444 at that time, significantly more grasshoppers were found on Isunikankiyan than on 60444 or the apparently least preferred 53101. Along the east side of the planting, significant differences in defoliation occurred among all three cultivars (Table 3). On the same side of the planting, cv. 60444 was almost totally defoliated and, as expected, had significantly fewer grasshoppers than the remaining two cultivars. The trend towards

decreasing defoliation in the north–south direction continued to be significant during this evaluation period.

On 30 January, there was significantly more defoliation of Isunikankiyan and 60444 than of 53101 (97·9, 95·5 and 75·4%, respectively, Table 4). The distribution of the

Table 1. *Distribution of* Zonocerus variegatus *on three cassava cultivars, Ibadan, Nigeria*, 1974–5.

| Sample date | Total hopper counts on 216 plants (72/cultivar) | Distribution of hoppers on each cultivar (%) | | |
|---|---|---|---|---|
| | | Isunikankiyan | 60444 | 53101 |
| Nov. 21 | 157 | 35 | 58 | 7 |
| Dec. 12 | 99 | 42 | 42 | 16 |
| Jan. 2 | 491 | 36 | 40 | 24 |
| 10 | 599 | 30 | 50 | 20 |
| 17 | 3616 | 33 | 50 | 17 |
| 20 | 3864 | 33 | 33 | 34 |
| 27 | 2744 | 44 | 22 | 34 |
| 30 | 3006 | 32 | 20 | 48 |
| Feb. 2 | 1710 | 54 | 18 | 28 |
| 6 | 1117 | 50 | 21 | 29 |
| 10 | 568 | 66 | 19 | 15 |
| 18 | 545 | 44 | 36 | 20 |

Table 2. Zonocerus variegatus *counts per plant on three cassava cultivars, 17 January* 1975, *Ibadan, Nigeria*

| Plot ... | West side | | East side | |
|---|---|---|---|---|
| Cultivar | Mean | Transformed | Mean | Transformed |
| Isunikankiyan | $27{\cdot}25_b$* | 4·146 | $73{\cdot}16_a$* | 6·953 |
| 60444 | $92{\cdot}00_a$ | 7·980 | $57{\cdot}25_{ab}$ | 5·967 |
| 53101 | $19{\cdot}58_b$ | 3·467 | $32{\cdot}92_b$ | 4·450 |

* Subscripts refer to within column differences only. Means are significantly different if they do not contain the same subscript.

grasshoppers on this date (Table 1) simply reflects the reduced availability of foliage on 60444. Declining numbers of grasshoppers within the planting in February resulted from both declining availability of foliage on all three cultivars, and possibly from dispersal and reaggregation at oviposition sites. The relatively high percentage of grasshoppers found on the completely defoliated Isunikankiyan cultivar resulted from the greater acceptability of its bark to the grasshopper.

By early March most grasshoppers had emigrated from the test planting. Cvs 60444 and Isunikankiyan were completely dead but more than 60% of cv. 53101 plants exhibited regrowth and, although bushy, could still survive. Most loss in 53101 occurred in the south-west corner of the planting where high populations were stranded without available foliage and consumed the bark on all three cultivars.

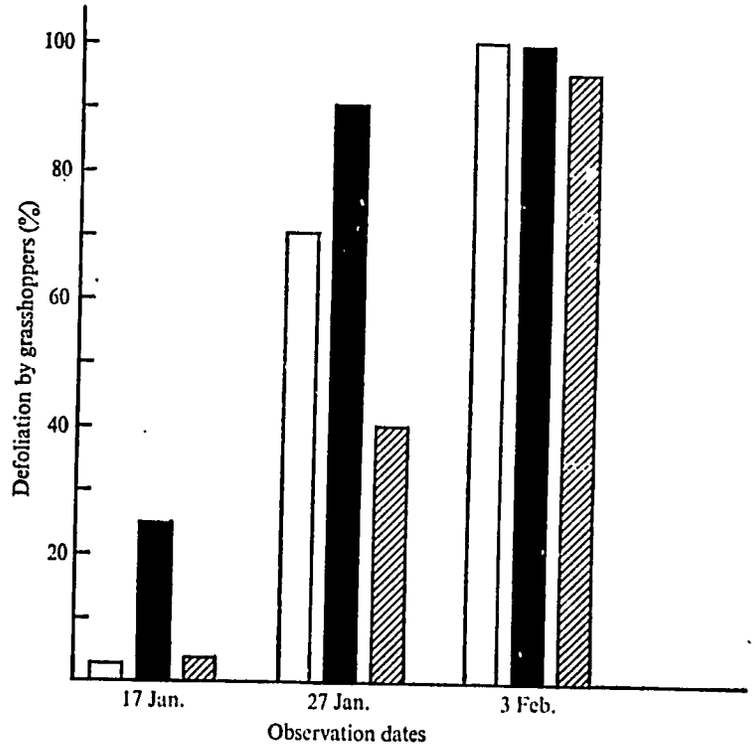


Fig. 2. Defoliation of cassava by *Zonocerus variegatus*. Cultivars: □, Isunikankiyan; ■, 60444; ▨, 53101.

Table 3. *Mean defoliation percentages of three cassava cultivars by* Zonocerus variegatus, 27 *January* 1975, *Ibadan, Nigeria*

| Cultivar | Plot: West side | Plot: East side |
|---|---|---|
| Isunikankiyan | $85{\cdot}8_{ab}$* | $60{\cdot}00_{a}$* |
| 60444 | $95{\cdot}8_{a}$ | $84{\cdot}1_{b}$ |
| 53101 | $62{\cdot}5_{b}$ | $22{\cdot}5_{b}$ |

* Subscripts refer to within column differences only. Means are significantly different if they do not contain the same subscript.

Table 4. *Mean defoliation percentages of three cassava cultivars by* Zonocerus variegatus, 30 *January* 1975, *Ibadan, Nigeria*

| Cultivar | North–south gradient: 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Isunikankiyan | 96·6 | 100 | 98·3 | 96·6 |
| 60444 | 93·3 | 95·0 | 100 | 100 |
| 53101 | 50·0 | 70·0 | 81·6 | 100 |

## DISCUSSION

Reports of preferential feeding by the variegated grasshopper on different cassava cultivars, to date, have been observational (S. K. Hahn, International Institute of Tropical Agriculture, Ibadan 1975, personal communication). The gregarious nature of the insect limits random distribution and leads to questionable conclusions in a non- or poorly-replicated planting. The present test was designed to overcome these deficiencies and to determine if the grasshopper exhibits statistically significant preferences for certain cassava cultivars.

The results obtained were complicated by several factors. First, an infestation gradient spread from the north-east to the south-west. Thus, early season defoliation of the highly preferred cultivars at the north end of the planting influenced the distribution of the grasshoppers. This effect did not exist at the south end of the planting where such early defoliation did not occur. Secondly, it was found that grasshopper counts were of little value in estimating preference, particularly later in the season when complete defoliation of the preferred cultivars resulted in shifts to the less preferred cultivars. Bernays *et al.* (1975) analysed the survival of *Z. variegatus* on 102 different plant species and showed that more than 50% of the insects survived to the third instar on only eleven of these plants and on a mixture of the five commonest. Nine of the eleven plants on which the insects survived were herbaceous; the others were citrus and cassava. The survival value for the late instars were tested on thirty plants and 50% of the insects were able to mature on only five herbs and cassava. It was also reported by Toye (1972) that, early in the season, grasshoppers on certain cultivars were merely resting and not feeding. In this study, grasshopper counts were also complicated by new attacks following even limited foliar regrowth as well as bark-feeding activity on some cultivars. Thus, while insect counts early in the season gave some indication of preferential feeding, the relative degree of defoliation among the different cultivars appeared to offer more reliable evidence throughout the test.

Between 21 November and 17 January most grasshoppers occurred on cv. 60444, slightly less on Isunikankiyan and fewest on 53101. On 20 January, following the massive migration into the planting, there was an almost equal distribution on all three cultivars. Later the counts on 60444 dropped sharply due to the defoliation of that cultivar. Thereafter the percentage of hoppers on Isunikankiyan increased and persisted even after defoliation because the bark on this cultivar was as acceptable as the foliage. This phenomenon and the extent of damage resulting require additional investigation. The distributional counts on 53101 also increased following defoliation of 60444 and Isunikankiyan, but later declined when it too was defoliated.

Damage by *Z. variegatus* to cassava can be severe and certain cultivars can be totally destroyed. Damage was noticeably more acute on immature plants following dry season planting in October. It was reported (Doku, 1969) that cassava is attacked severely only late in the dry season, possibly because when the habitat dries out the resultant reduction in herbs forces the insect to cassava plants. Bernays *et al.* (1975) reported that herbaceous plants that provide suitable food tend to disappear as the dry season and the development of *Z. variegatus* progress and so the population is forced to cassava by the shortage of food. Although severe defoliation has been

noticed in some mature plantings during January, the plants appeared able to withstand the loss and regained foliage after the grasshoppers left the field.

The marked non-preference of *Z. variegatus* for cv. 53101 was of interest in this test, particularly because the number of hoppers present on this cultivar, even before the insects commenced feeding, was the least among the three test cultivars. It has been suggested that early hopper infestations tend to select tall plants for roosting in preference to shorter ones (K. Leuschner, International Institute of Tropical Agriculture, Ibadan 1976, personal communication). However, in this trial, although data were not collected, there were no obvious differences in height between the three cultivars, but of the three, the foliage of 53101 has the darkest shade of green.

The degree of non-preference and its value in single cultivar plantings is yet to be determined. It is possible that in the present test the preferred cultivar acted as a 'trap crop' and tended to protect the less preferred cultivar through the developmental period of the grasshopper.

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