# NITROGEN IN SUGARCANE AND THE FECUNDITY OF *NUMICIA VIRIDIS* MUIR

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### Introduction

It was found in Jamaica that the fecundity of the West Indian canefly *(Saccharosydne saccharivora* (Westw.) Hom: Delphacidae) was raised by an increase in the nitrogen status of sugarcane leaves (Metcalfe, 1965).

With most insects, a number of amino acids are indispensable for oogenesis. In some insects there is also a relationship between the haemolymph protein and the hormonal control of ovarian development. Nutrition therefore not only supplies the materials needed for yolk synthesis but also exerts a fundamental effect on the control mechanism (Beament *et al.*, 1966).

If the fecundity of *Numica viridis,* Muir (Hom: Tropiduchidae) were to increase with higher nitrogen application to the sugarcane plant, this would aid in explaining (as it did in the case of the canefly) why *N. viridis* is a pest under certain conditions and only in certain areas. An insectary investigation of *N. viridis* fecundity and nitrogen level of its food material was therefore initiated.

### Method and Materials

Single bud setts of the cane variety N:Co.310 were pregerminated over a period of eight days. Setts bearing buds of equal size and development were selected and planted nine to a tray in each of sixteen trays. The trays, which were made of polythene, measured 32.5 cm long, 21.5 cm wide and 6.5 cm deep. Each tray held 5 kg. of air-dried Clansthal sand (red structureless loamy sand).

At planting, equal quantities of a potassium hydrogen phosphate solution were added to each tray. The amount added was equivalent to 200 lb. K and 160 lb. P per acre. Four levels of nitrogen were established in each of four replicates. The lowest of these was the control, to which no nitrogen was added. The other three levels received added nitrogen in the form of an ammonium sulphate solution, low-, medium- and high-level treatments being the equivalents of 75 lb., 150 lb. and 300 lb. N per acre.

The soil in the trays was maintained at approximately 50 per cent water-holding capacity. This was achieved by weighing the trays regularly and adding distilled water to bring them back to their original weight. Sixty-six days after planting, third leaf samples from one replicate were taken for total nitrogen analyses by the Kjeldahl method. Results are shown in Table VI.

In the course of the experiment two cages were urgently and unexpectedly required to house a consignment of insects imported from Mauritius; this necessitated discarding one low and one medium treatment from a single replicate.

### Experimental Design

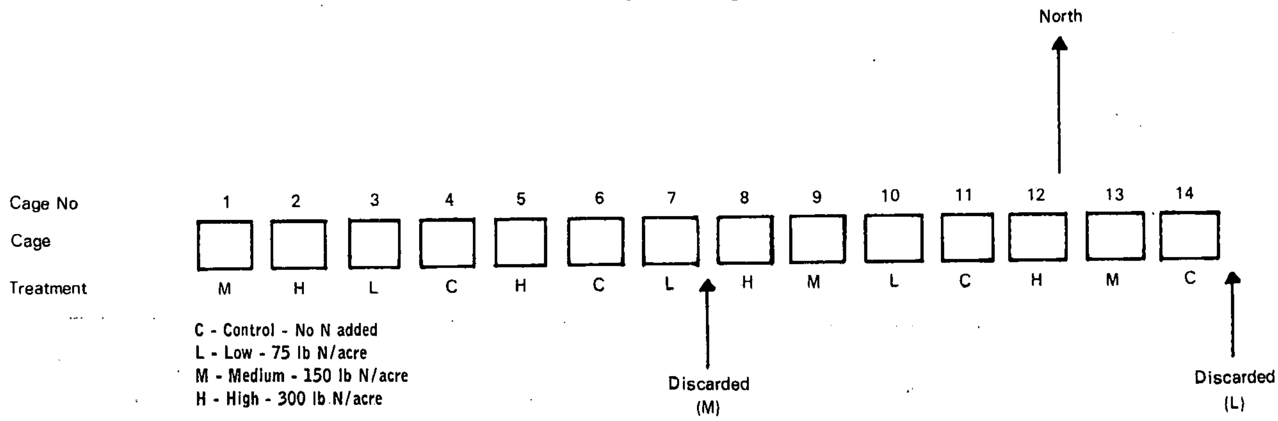
The design was a randomized block comprising four replications of four treatments each. The replicated treatments were set out as in Fig. 1.

### Introduction of Insects

Sixty-one days after planting marked differences in growth between treatments could be seen. Fifty *N. viridis* nymphs, which had emerged sixteen days previously, were caged on the plants in each tray (Plate 1). The cages used measured 76 cm in height, 36 cm in width and 26 cm in depth and were covered with a fine nylon mesh.

The insects used in the experiment were obtained from an insectary-reared population. One nymph died in cage 14 and was replaced by another of the same age. Eighty-one days after hatching, no nymphs could be found and a 100 per cent adult population was assumed.

**FIGURE 1: Layout of experiment**



During the course of the experiment two escaped males were detected outside the cages, but there was no way of determining from which cage they had escaped. The adult insects as they died were removed from the cages, counted and sexed.

When the insects had been caged on the cane for 115 days, the experiment was terminated to prevent the following generation maturing and ovipositing. The remaining adults were taken from the cages, counted and sexed (Table IV). The numbers of eggs per ovary were determined for those females which were in a fit state for dissection. All females examined were capable of further oviposition (Table I).

**TABLE I**

**Egg analysis of ovaries**

| Treatment | Number of ♀s | Total number of eggs | Average number of eggs/♀ |
|---|---|---|---|
| H = High | 55 | 1,226 | 22 |
| M = Medium | 61 | 1,900 | 31 |
| L = Low | 40 | 1,327 | 33 |
| C = Control | 49 | 1,316 | 27 |

### Weight of Plant Material and Egg Analyses

After the insects had been removed from the cages, the plant material was air dried and weighed (Table V). A count was made of all eggs laid in the plant material (Table II).

### Results and Conclusions

The results (Table II) were statistically analysed, allowances being made for the two discarded treatments. The analyses showed that as the nitrogen level was increased there was a significant increase in the number of eggs laid ($P<0.01$. Table III).

**TABLE II**

**Number of eggs laid in each cage and the totals thereof**

| Treatment and Cage No. | Number of eggs laid | Total |
|---|---|---|
| H 2 | 3,969 | |
| H 5 | 5,939 | |
| H 8 | 3,865 | |
| H12 | 3,456 | 17,229 H |
| M 1 | 3,123 | |
| M 9 | 3,900 | |
| M13 | 3,698 | 10,721 M |
| L 3 | 2,780 | |
| L 7 | 2,502 | |
| L10 | 2,655 | 7,937 L |
| C 4 | 1,952 | |
| C 6 | 1,046 | |
| C11 | 1,364 | |
| C14 | 1,331 | 5,693 C |

**TABLE III**

**Summarized results of analyses of variance**

| Treatment | Mean log. count | Detransformed egg counts |
|---|---|---|
| Control | 3.187 | 1,660 |
| Low N | 3.333 | 2,323 |
| Medium N | 3.470 | 3,184 |
| High N | 3.622 | 4,519 |

Approx. S.E. of treatment mean=0.081 C.V.=5.2%

In Fig. 2, where the log. of the total egg numbers is plotted against lb. N per acre, there seemed to be no reason to expect any marked deviation from a linear increase in egg numbers with nitrogen level.

Table IV shows the numbers of male and female insects recovered, during and at the termination of the experiment. In no instance were all fifty insects

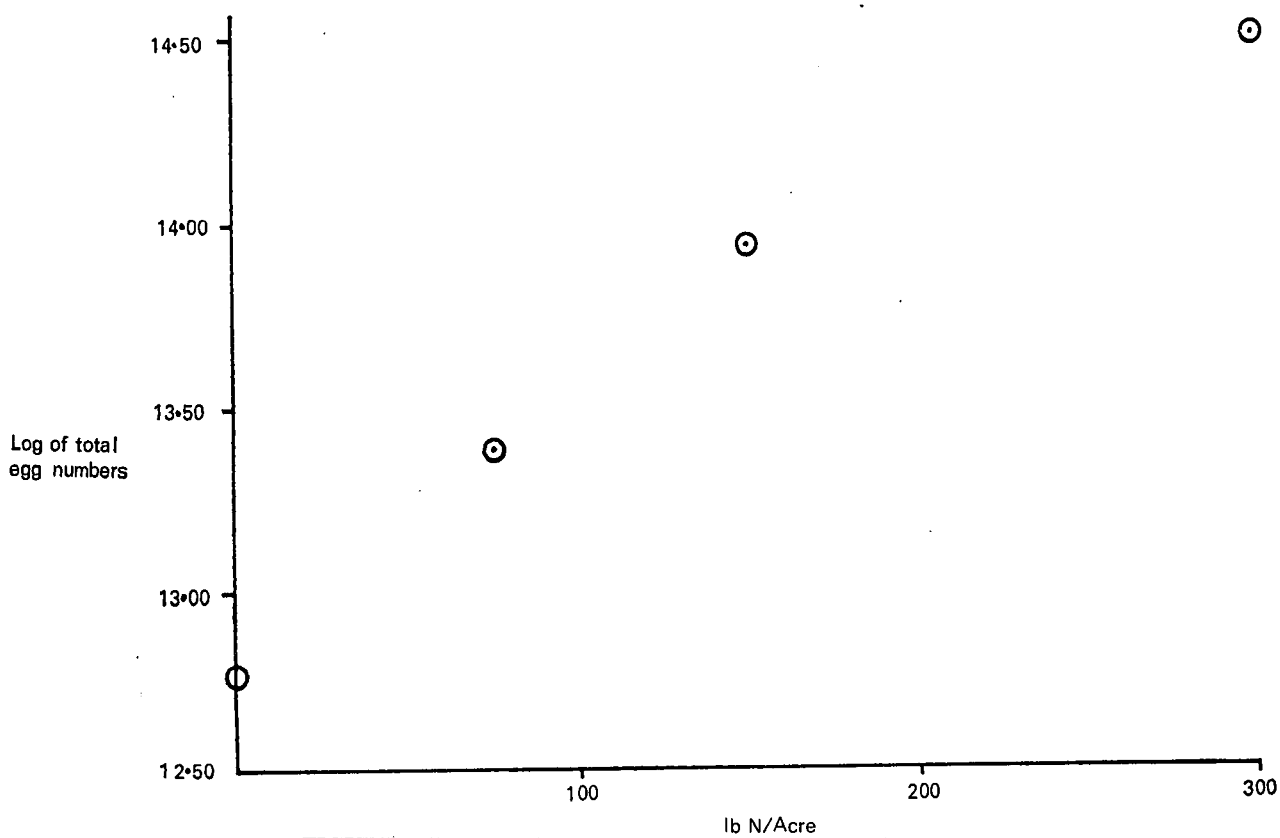
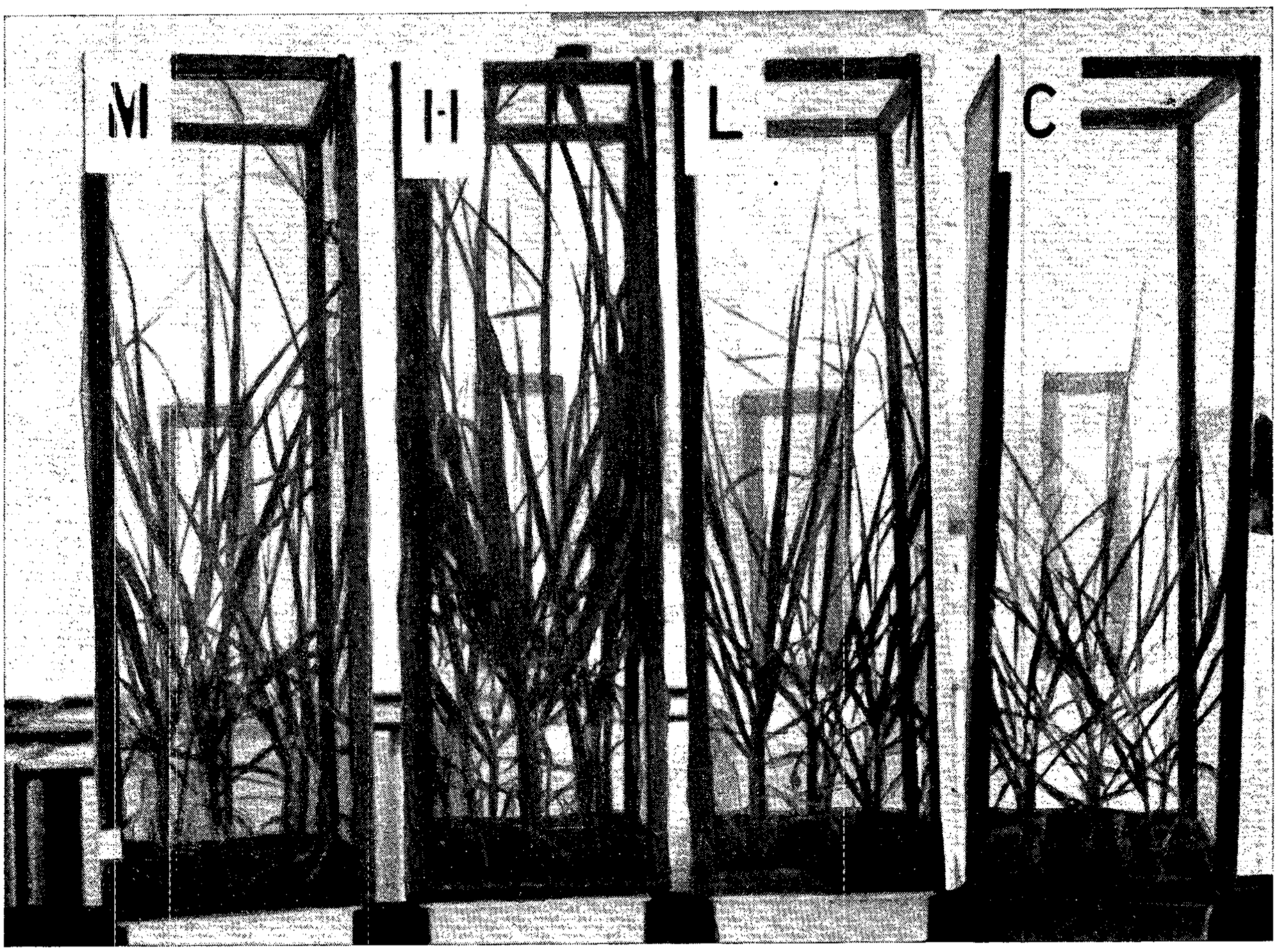



**FIGURE 2: Relationship between N level and numbers of eggs laid**

**TABLE IV**
**Total males and females recovered during and at end of experiment**

| Treatment and cage no. | C4 | | C6 | | C11 | | C14 | | L3 | | L7 | | L10 | | M1 | | M9 | | M13 | | H2 | | H5 | | H8 | | H12 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ |
| Dead individuals recovered during experiment | 0 | 3 | 2 | 4 | 3 | 7 | 0 | 2 | 1 | 1 | 0 | 6 | 8 | 2 | 4 | 2 | 3 | 1 | 2 | 4 | 8 | 2 | 5 | 3 | 12 | 6 | 8 | 4 |
| Live individuals recovered at end of experiment | 7 | 13 | 10 | 15 | 22 | 14 | 10 | 10 | 19 | 17 | 16 | 8 | 5 | 9 | 18 | 15 | 21 | 18 | 22 | 17 | 14 | 7 | 20 | 12 | 9 | 8 | 13 | 8 |
| Total | 7 | 16 | 12 | 19 | 25 | 21 | 10 | 12 | 20 | 18 | 16 | 14 | 13 | 11 | 22 | 17 | 24 | 19 | 24 | 21 | 22 | 9 | 25 | 15 | 21 | 14 | 21 | 12 |

**PLATE 1: Photograph of one replicate**




H = High (300 lb. N), M = Medium (150 lb. N), L=Low (75 lb. N), C=Control

recovered from any one cage. The lowest numbers of females were recovered from the control and low treatments, with the exception of control cage 11, where all but four insects were recovered. Although the relatively low numbers recovered from these cages might be attributed to certain individuals having escaped, it is very unlikely that they could have done so without being noticed.

Recovery of insect corpses was effected by means of an adhesive-tipped rod inserted through a small temporary opening in the side of the cage; but not all were recovered, as was evident from the number of chitinous parts found among the soil and plant material when the experiment was dismantled. These decomposed specimens could not be sexed, nor could their numbers be accurately assessed.

It can be seen from Plate 1 and Table V that higher nitrogen applications resulted in more vigorous growth of the sugarcane.

**TABLE VI**
**Third leaf nitrogen analyses of all plants in one replicate**

| Treatment and Cage No. | Dry weight of sample in grams | % Nitrogen | mg Nitrogen |
|---|---|---|---|
| C4 | 1.22 | 1.07 | 13.1 |
| L3 | 2.19 | 0.99 | 21.7 |
| M1 | 3.51 | 1.07 | 37.6 |
| H2 | 4.22 | 1.43 | 60.3 |

TABLE V
Weight of air-dried plant material

| Treatment and cage no. | C4 | C6 | C11 | C14 | L3 | L7 | L10 | M1 | M9 | M13 | H2 | H5 | H8 | H12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dry weight of plant material in grams | 33.5 | 37 | 38 | 47 | 47.5 | 48 | 51 | 69.5 | 54.5 | 66.5 | 89 | 77.5 | 83.5 | 81.5 |

In Table VI it can be seen that by the sixty-sixth day after planting differences in the per cent nitrogen of the third leaf were detectable. It was these different levels of leaf nitrogen which were thought to have influenced the fecundity. The mechanism of this response which associates higher levels of nitrogen with higher fecundity is not yet clear; but it seems likely that it is associated with protein metabolism in *N. viridis*.

## Discussion

*Numicia viridis* occurs as a pest chiefly on inland irrigated sugarcane (Carnegie, 1967). Sugarcane in these areas is generally kept at a high nutritive level, and one of the reasons for large numbers of *Numicia viridis* on sugarcane in these areas may be the sustained high nitrogen level. It is also known that populations of *Numicia viridis* decrease in old mature sugarcane, and this may well be as a result of relatively low levels of nitrogen in the leaf. It follows that if, as the evidence suggests, the levels of leaf nitrogen influence fecundity, then an infestation of *Numicia viridis* may be prevented or lessened by avoiding excessive nitrogen application to sugarcane.

## Acknowledgements

Helpful discussion with Mr. R. A. Wood, Chief Chemist, during the preparation of this experiment was much appreciated.

## Summary

An experiment in which the leaf-sucking insect *Numicia viridis* was reared on sugarcane grown at four different levels of nitrogen, is described. The results indicated that the fecundity of *Numicia viridis* increased with increasing rates of nitrogen application to the sugarcane plant.

### References

Beament, J. W. L., Treherne, J. E., Wigglesworth, V. B. (1966). Advances in insect physiology, 3. Academic Press, London and New York.

Carnegie, A. J. M. (1967). Field Populations of *Numicia viridis*, Muir. *Proc. S. Afr. Sug. Technol. Ass., 41*, pp. 178-179.

Metcalfe, J. R. (1965). Nitrogen Status of Sugarcane Leaves and the Fecundity of a Hemipterous Pest. *Nature*, pp. 219-220.

## Discussion

**Dr. Dick:** Although the use of nitrogen cannot be directly employed as a control measure for this pest it is useful to know what factors are associated with the prevalence of an insect.

**Dr. Thompson:** What samples were used for the nitrogen determinations? At 66 days one would expect leaf lamina nitrogen to be in excess of 2% but the maximum here was 1.43.

**Mr. Harris:** These were whole leaf samples, not laminar.

Farmers this year in Swaziland have reported *Numicia* mainly on plant cane. I do not know how this ties in with high nitrogen levels.

**Mr. du Toit** (in the chair): Plant cane is fairly well supplied with nitrogen. There is no doubt about the association of nitrogen level with *Numicia* eggs but is it due to the nitrogen or the lush growth of the plant?

**Mr. Harris:** I personally think it is due to nitrogen.

**Dr. Dick:** During this experiment all the plants were kept at a high level of water.

**Mr. Whellan:** Did the *Numicia* growing on the high nitrogen plants look any different, e.g., healthier, than those on the other plants.

**Mr. Harris:** There was no visual difference but the *Numicia* on the low nitrogen plants appeared to die earlier.

**Mr. K. Armstrong:** Were you able to get an idea of the percentage of nymphs that emerged from the eggs?

**Mr. Harris:** About 50% hatched by the end of the experiment and they were probably 100% fertile.

**Mr. Hansen:** Were analyses done for other nutrients in the leaves?

**Mr. Harris:** Other analyses were not done but we tried to keep the nutrients constant.

**Mr. R. A. Wood:** A basic nutrient solution was applied to all treatments at the time the nitrogen was applied.

**Dr. Brett:** From Table IV it appears that the total number of males recovered stays fairly constant whatever the treatment but there is a big difference in the number of females that survive.

**Mr. Harris:** The longevity of the female does appear to be more affected by high nitrogen than does the male.

**Dr. Dick:** If the nitrogen is being used for egg production the female will obviously require more than the male. The female in the high nitrogen environment will not have to use up its own nitrogen to produce eggs and will therefore live longer.