ANATOMY OF SUGARCANE STALK AS INFLUENCED BY TOP BORER (*SCIRPOPHAGA NIVELLA* F.) ATTACK

By K. L. Khanna, F.A.Sc., and S. L. Sharma, M.Sc.
(*Central Sugarcane Research Station, Pusa, Bihar*)

Received May 26, 1947

I. Introduction

The reaction of the tissues of sugarcane stem to mechanical injury sustained as a result of an attack by top borer (*Scirpophaga nivella* F.) and their subsequent structural variations, so far as the authors are aware, have not been reported anywhere. Pemberton (1925) and Stewart and Hansson (1928) reported injury to roots by centipedes and nematodes and there are passing references by Ferret (1927) and Lyon (1927), about the formation of galls in sugarcane stem, the internal structure of which has not been paid the attention it deserves. Morbid anatomy induced by various pathogens and insect pests explains the behaviour of the host to a great extent.

II. Material and Methods

Four to five shoots attacked by top borer of Co 205, Co 210, Co 213, Co 299, Co 313 and Co 331 were collected before the secondary invasion by other organisms took place. The affected portion of the stalk was cut into internodes at various stages of growth. Hand sections were stained with Safranin and mounted in Canada balsam, in the usual way.

III. Observations

The examination of slides showed that the reaction of sugarcane tissues to the attack of top borer was confined to the neighbourhood of the actual damage, and the maturer the tissue, the less the area involved; and so also, the less the deviation from normal structure. Both the parenchymatous matrix and vascular bundles were more or less equally affected. The derangement of the tissues manifested itself mainly by the changes in size and shape of cells and the staining quality of their walls.

In very young top-most internodes, two or three layers of parenchymatous cells adjacent to the tunnel usually grew into long palisade-like tissue (Plate I, Fig. 1) deep into the cavity which became irregular in outline, some times their distal ends forming knobs. The outgrowths brought about by the rapid increase in the size of newly formed cells, in the absence of proper tissue tension all round them, narrowed the borer tunnel to a mere slit in some internodes. Safranin stained the walls of the morbid

cells much more deeply than those of the healthy ones. In partially mature internodes, where the growth rate had slowed down, these cells could not acquire their normal size though there was not much difference between a healthy and an affected cell as regards their shape (Plate I, Fig. 2). In very young internodes also this type of reaction by parenchymatous tissue situated between the palisade-like and healthy tissue was sometimes met with. The staining quality of the cell wall also changed as stated above. In fully mature internodes, the reaction to the attack and the presence of a larva was confined to about half a dozen layers of cells all round the cavity. The cell walls became thick and highly lignified (Plate I, Fig. 3) with the result that the healthy tissue was cut off from the cavity and its contents. A prototype of this lignified ring between the healthy tissue and the morbid growth was often met with in younger internodes also. Sometimes the cells outside the sanitary cordon, lost their rounded shape and became polygonal (Plate I, Fig. 4) thus obliterating the intercellular spaces, which appeared to be a further attempt at the segregation of healthy tissues. Excepting the radial elongation of a few cells isolated or in groups, there was no change in the shape or size of the parenchymatous cells surrounding the borer tunnel in fully developed internodes (Plate I, Fig. 4).

Disruption in the case of vascular bundles was equally extensive. There were no vascular bundles in the deranged parenchymatous matrix, due to the complete disorganisation of the primordia of vascular bundles (Plate I, Figs. 1 and 2). Their frequency and structure slowly moved towards the normal as one receded from the cavity. Elongation of xylem end of the vascular sheaths towards the tunnel, the suppression of protoxylem vessels, and distortion of one or both of the metaxylem vessels or their complete absence were among the most common deformities (Plate I, Fig. 5). Phloem was not so easily affected as xylem. Sometimes its place was found to have been occupied by thick-walled cells probably intruders from the adjoining vascular sheath. The sclerenchymatous cells forming the sheath which were so characteristically polygonal in outline when healthy, became diamond-shaped in cross-section with their longer axis towards the cavity. Their walls could not acquire the usual thickness and were comparatively poorly lignified. Vascular bundles far removed from the centre of disturbance in the growing internodes were found to be quite normal in all respects (Plate I, Fig. 5). But in mature internodes even those abutting the cavity did not show any structural change (Plate I, Figs. 3 and 4). Very often their xylem components, less so the phloem, were found to have been choked with a dark, darkish brown or chocolate coloured substance which was insoluble in water, various grades of alcohol and xylol. Sometimes this

substance filled a few of the parenchymatous cells adjacent to the cavity. But in the case of the vascular bundles, it was found to be present at considerable distance from the cavity (Plate I, Fig. 6).

No marked difference in the behaviour of tissues of the varieties studied, was noticeable except that the choking of vascular bundles appeared to be more common in Co 210 than in others.

IV. Summary

1. The stage of growth at which the tissues were attacked determined the affected area and the changes in the size and shape of cells forming them.

2. Lignification of cell walls was greater and less respectively in affected parenchyma and sclerenchyma than in the healthy ones.

3. No marked varietal differences in the behaviour of tissues were discernible.

V. Acknowledgements

The work was carried out as part of the Sugarcane Research Scheme in Bihar being financed jointly by the Bihar Government and the Indian Central Sugarcane Committee to whom grateful thanks are due.

References

1. Ferret, J. H. .. "Notes on yield and stem gall occurrence of some Uba Quarter Breeds at Mukiki," *Hawaii, Pl. Rec.*, 1927, **31**, 273–75.
2. Lyon, H. L. .. "Further notes on stem galls of Sugarcane," *Ibid.*, 1927, **31**, 249–72.
3. Pemberton, C. E. .. "Cane root injury by Centipede, Mecistocephalus Maxillaris," *Ibid.*, 1925, **29**, 3–7.
4. Stewart, G. R., and Hansson, F. .. "A study of the effect of nematodes upon cane roots in sterilised soil," *Ibid.*, 1928, **32**, 3–8.

Explanation of Plate

Microphotographs of Transverse Sections showing Reactions of Stem Tissues at Various Stages of Plant Growth

(Magnification × 50 for all)

Fig. 1. Young internode showing abnormally elongated cells of the parenchymatous matrix without any vascular bundle.

Fig. 2. Partially mature internode. The tunnel is surrounded by a few layers of parenchymatous cells smaller than the healthy ones. (*a*) a partially developed vascular bundle with protoxylem suppressed, metaxylem not fully formed, and poorly lignified vascular sheath.

Fig. 3. Mature internode, showing a highly lignified ring of cells cutting off the tunnel from healthy tissue.

Fig. 4. Mature internode. The parenchymatous cells become polygonal. A few of those abutting the cavity become elongated; vascular bundles normal.

Fig. 5. Immature internode showing common deformities of vascular bundles, such as elongation of xylem-end of vascular sheath, suppression of protoxylem and distortion or suppression of metaxylem.

Fig. 6. Mature internode. Vascular bundles normal but choked with a blackish substance,