though tetrazolium was widely used in biology, very little was known about its reducing mechanisms, and consequently the results obtained with the substance were bound to be empirical in character. The inconsistent results obtained with some varieties do not necessarily mean that such canes do not respond to the test. It would appear that so many factors are involved that not only should the reaction be carried out under carefully controlled experimental conditions, but also further work is necessary in order to determine the particular conditions under which different varieties should be tested.

REFERENCES


GIBBERELLIN STIMULATES GROWTH OF SUGAR CANE PLANTS AFFECTED WITH FIJI DISEASE

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Claims that certain forms of cadang-cadang disease of coconut (Cocos nucifera L.) have been cured with gibberelin prompted the testing of the chemical on abacá (Musa textilis Nee) infected with bunchy-top caused by Marmor abacá Holmes, and sugar cane infested with Fiji disease caused by Galla fijiensis Holmes, two virus diseases which severely stunt their hosts.

Maramorosch of the Rockefeller Institute for Medical Research used 100 p.p.m. solution of gibberellic acid to spray China aster severely stunted with aster yellows, hybrid corn infected with corn stunt, and crimson clover with wound tumor, 6 weeks after the plants were inoculated. The gibberellic acid was reapplied twice at weekly intervals, and was found to influence significantly the growth of the virus-stunted plants. He also found that although stunting could be overcome by gibberellic acid, the signs of virus infection were retained by the diseased plants.

For our tests, "Gibrel" was kindly provided by Merck, Sharp and Dohme (Philippines) Inc., and Gibberellin "Kyowa" by C. Itoh & Co., Ltd. Small amounts of the gibberellic in 1000 p.p.m. solution were introduced with a medicine dropper into the furled young leaves of bunchy-topped abacá in the 5-leaf stage. A week after application, an increase in height was noted. The same amounts of gibberellic solution were applied 2 weeks after the first application. A week after the second application, the treated diseased abacá plants were 15.75" longer than the untreated diseased plants. The clearing of the veins, the most reliable diagnostic symptom of bunchy-top, was still very distinct in the treated diseased abacá plants.

The buds on the nodes of several stalks of sugar cane infected with Fiji disease were numbered consecutively from the base to the top, and 1-node cuttings prepared from them. The odd-numbered buds were used as checks. The shoots from the even-

References p. 1046.
numbered eyes were divided into 4 lots for spraying: the first with 25 p.p.m., the second with 50 p.p.m., the third with 75 p.p.m., and the fourth with 100 p.p.m. solutions of gibberellin. The solutions were applied every 2 weeks, starting when the shoots were 20 days old. The shoots from the odd-numbered eyes used as checks were sprayed with distilled water.

The results showed a conspicuous increase in the length of the leaves of the treated plants 2 weeks after the first application of gibberellin. The response to the gibberellin by the experimental plants consisted of longer leaves than those of the control, and in many cases, the leaves were lighter in colour. There was always a difference in the growth of the leaves of the treated plants over those of the controls. The plants sprayed with 50 and 75 p.p.m. gibberellin solutions continued to make greater growth than the leaves of the control. In some cases, the experimental plants had fewer and smaller galls and, in other cases, the treated plants had more and larger galls. In all cases, however, galls, the most reliable diagnostic symptom of Fiji disease infection of sugar cane, were present in both the experimental and the control plants. The presence of the galls indicates that both the gibberellin-treated and the untreated canes have Fiji disease virus.

In bunchy-topped abacá, the overlapping leaf sheaths and the leaves showed the effects of the gibberellin, but the true stem underground did not. In the Fiji-infected sugar cane, observations have been made on the leaves and leaf sheaths. It remains to be shown by experiments now under way what effect gibberellin has on the length and girth of the internodes.

REFERENCES


DISCUSSIONS

P. E. Robinson (Australia): The same phenomenon occurred when chlorotic streak diseased plants were treated with 100 p.p.m. of gibberellin. However, in order to obtain continued growth, it was necessary to repeat the treatment at least at weekly intervals.

R. Stein (U.S.A.): Dr. Coleman of Houma found the same thing when he used gibberellin on cane. It was necessary to continue using the material in order to keep the treated plants ahead of the check plants. As I understand it, it was healthy cane.

E. V. Abbott (U.S.A.): In both the greenhouse and field, Dr. Coleman found it necessary to continue the applications if the growth stimulation were to continue. He made rather extensive field trials with the idea of determining whether we might get increased tonnage, but that did not prove to be the case. The total length of stalk was greater, but the total weight of the treated plants was no greater than for the untreated; the stalks were much more slender.

J. P. Martin (Hawaii): It is interesting to note that with downy mildew we have jump-ups which are much higher than the healthy cane. It is possible that the causal organism may produce some growth-promoting substance similar to gibberellic acid.

TWO UNRECORDED LEAF DISORDERS OF SUGAR CANE IN HAWAII*

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Sugarcane plants from the Waipio and Kailua Substations, Experiment Station, HSPA, manifesting symptoms of "leaf stipple" and "ring mosaic", were submitted in

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1948 and 1949, respectively, by the geneticists to the pathologists for identification; these disorders, while under investigation, were provisionally so designated. A description, accompanied with illustrations of each disorder, follows.

Leaf Stipple

Cuttings from the original stalk of the commercial variety 37-1933 were planted at the Pathology Plot. The resulting growth was greatly retarded and the leaves showed a leaf mottling similar to that of the original specimen. Repeated plantings demonstrated that the poor growth and leaf symptoms were transmitted with cuttings.

The youngest leaves are pale green with very fine chlorotic markings which occur between the vascular bundles, oftentimes resulting in a minute pin-striping effect. The symptoms become more distinct on the middle aged leaves, and are most pronounced on the oldest leaves; necrotic areas frequently appear in the striping on the latter (Fig. 1). The chlorotic markings on the oldest leaves are from 1 to 3 mm in length and from .5 to 1 mm in width, with the long axes parallel to the veins of the leaf. All leaves are chlorotic and become progressively more so with leaf age. The symptoms have not been observed on the stalks or on the leaf sheaths.

The leaf symptoms differ from those of mosaic disease in that they are less pronounced on the younger leaves than on the older ones.

Attempts to transmit this type of stipple to the varieties 37-1933 and Lahaina by the pin-prick method, used for transmitting certain virus diseases, were unsuccessful.
In 1949 and 1951, a few leaves on affected plants showed definite stripes of uniform width (5 to 15 mm) and of normal green tissue extending from the midrib to the leaf’s edge; the development of these stripes or chimeras have been recorded several times since. Leaf and stalk variegations resulting from somatic mutations frequently appear in sugar cane, and some varieties are normally variegated.

In 1958, stalks of normal growth and leaf color developed in one concrete pot where abnormal plants were being maintained (Fig. 2) for study. Further plantings from “recovered stalks” have been made to study the type of growth produced.

The development of normal green stripes in affected leaves and the failure to transmit the disorder, indicate that this type of leaf stipple is genetical in origin.

**Ring Mosaic**

The elongated chlorotic leaf markings first observed on a 1949 seedling ranged from minute up to 36 mm in length and 6 mm in width. The markings usually exhibit centers of light green surrounded with chlorotic tissue, and occasionally chlorotic centers surrounded with light green tissue; frequently they show an elongated, concentric ring effect, resulting from the pale green and chlorotic bands (Fig. 3). The small lesions are similar in shape and color to the large ones. The markings are present on the leaves not yet unrolled and most numerous on the lower surfaces of the midribs and adjacent areas. At times, irregular chlorotic leaf areas develop where the markings coalesce, this being especially true on the midribs.
Cuttings from the material were planted at the Pathology Plot. The resulting growth exhibited leaf symptoms identical to those on the original specimens. Repeated plantings demonstrated that the leaf markings are transmitted with cuttings. No transmission of the symptoms resulted when: 1) juice, expressed from affected, macerated leaves under 15,000 lbs. pressure, was inoculated hypodermically into the young spindles of healthy H. 109 and Lahaina plants, or 2) when the expressed juice was poured into the spindle of healthy H. 109 plants and inoculated into the young leaves by numerous pin pricks through the juice into the youngest leaves (spindle).

Fig. 5. Depressed growth from cuttings affected with ring mosaic (center) in contrast to that from healthy cuttings of P.O.J. 2878 (left and right). Cheribon Sub-Experiment Station, Java.

In September 1955, cuttings from diseased plants were treated in water maintained at 50° C for $\frac{1}{4}$, 1, $1\frac{1}{4}$, 2 and 2½ hours; a number of cuttings received no treatment. The heat treatments failed to control the disease.

The leaf marking has been of no economic importance in Hawaii, since it has been recorded only on 1 or 2 seedlings; its cause has not been established from the preliminary studies carried out to date.

Leaf Stipple and Ring Mosaic in Java

While attending the 1929 Congress, I.S.S.C.T., in Java, the senior author, with other pathologists, studied 2 new cane diseases which were discussed and exhibited by G. Wilbrink, Director and Pathologist of the Java Experiment Station at Cheribon; these were ring mosaic and leaf stipple on the variety P.O.J. 2878. DR. Wilbrink pointed out that both diseases were transmitted by cuttings and it is believed that they were caused by viruses. The symptoms of ring mosaic occurred on both the leaf blades and the stalks. The leaf lesions were large, irregular rings, of a brownish color; they seldom developed on the very youngest leaves but were usually confined to the more mature leaves (Fig. 4, right). The ring pattern on the stalks was not as definite as that on the leaf blades. Cane growth of affected cuttings was considerably depressed when compared to that of healthy cuttings (Fig. 5). DR. Wilbrink pointed out that this type of ring mosaic could cause lower yields if affected cuttings were used for planting material.
According to Dr. Wilbrink, stipple disease (Fig. 4, left) was observed on P.O.J. 2878 and a few other varieties. It is recognized by small chlorotic and, in some instances, reddish spots which cover the leaves uniformly. The small leaf markings usually occur between the vascular bundles; they frequently coalesce and cause irregular chlorotic areas. Plants so affected are depressed in growth. The growth of O.C. 16 (a seedling) was greatly retarded when it is grown from cuttings taken from affected plants as compared to growth from healthy cuttings.

DISCUSSIONS

E. V. Abbott (U.S.A.): In seedling nurseries we do find a number of leaf markings similar to stipple. I think of stipple as being more of a flecking. In some respects it is more like mosaic. Do you have other things that you call stipple?

J. P. Martin (Hawaii): We do in Hawaii.

Dr. Abbott: We frequently find both of these conditions in our seedling nurseries. In 1933, a plant was noted in a commercial field of Co. 290 in Louisiana showing a condition which I thought was identical with Wilbrink’s ring mosaic in Java, as he described and illustrated it in the Proceedings of the Fourth Congress. The symptoms were not like the ring mosaic described by Mr. Martin. It gives the impression of being a bacterial infection rather than a water-soaked leaf marking with a concentric pattern. Affected plants showed a marked growth depression and they lost their rigidity and were rubbery. We found only that 1 plant and were never able to transmit the disease by any manner of inoculations or eliminate it by any heat treatment; it is transmitted with cuttings. I still have a specimen in my greenhouse of that plant that I carried for 25 years. I have never encountered it since, but it does seem to be rather similar to Wilbrink’s ring mosaic.

P. E. Robinson (Australia): Have any studies been conducted on these mosaics or stipple with the electron microscope?

Dr. Abbott: Not to my knowledge.

Mr. Martin: If a plant is affected with mosaic, the virus particles occur in all cells of the plant and the leaf symptoms are manifested by the mottling as indicated by the light and the dark green tissues. Has anyone observed a mosaic-infested plant showing a leaf-variegation with normal tissue? As soon as we noted this leaf condition it was evident that the cause was genetical.