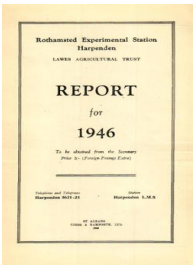
ROTHAMSTED RESEARCH

Rothamsted Report for 1946

Full Table of Content



Crop Physiology Department

D. J. Watson

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SECTION OF CROP PHYSIOLOGY

By D. J. Watson

As in previous years the Section was responsible for the general supervision of the field experiments from the laboratory side. An account of the programme of field experiments is given in a separate report.

The effect of yellows and mosaic virus diseases on the growth of sugar-beet

The Section has cooperated with the Plant Pathology department in designing field experiments, carried out over several years, to measure the loss of yield of sugar beet caused by infection with yellows virus. An account of the results has been published (43).

In 1945 an investigation of the changes in growth induced by infection with yellows virus was begun to determine the physiological causes of the large reduction in the yield of sugar. A field experiment was set up to test the effect of infection at the end of June or in early August of plants sown in mid-April or late in May. In 1946 a comparison was made in another field experiment between the effects of yellows and mosaic infection at two levels of nitrogen supply. On the plots to be infected with yellows infected aphides were placed on each plant, left for about 24 hours and then killed by nicotine fumigation. On the mosaic plots each plant was infected by rubbing one leaf with infected sap. In both years over 2,000 plants were infected in this way. A few plants on the healthy control plots became infected by spread from the infected plots or from outside sources, but the number of accidental infections was too small to affect the results seriously. A sample of about 30 plants was taken from each plot at intervals throughout the period of growth for the determination of fresh and dry weights of lamina, petiole (including the crown) and root, leaf area per plant, leaf number per plant, and the fraction of the total leaf area showing yellowing. The nitrogen content of the different parts of the plant, the sugar content of the root, and, in 1946, the carbohydrate content of the leaf lamina was determined.

In both years yellows infection at the end of June reduced the yield of sugar by nearly 50 per cent., as in the earlier experiments (43). Mosaic infection caused a smaller loss, about 14 per cent. of the yield of healthy plants. The later infection with yellows, in August, 1945, had very little effect. The loss of sugar yield caused by yellows resulted from three distinct effects on growth. The total leaf area of the plant and net assimilation rate were both reduced, and this decreased total dry matter production and hence the yield of roots. The percentage of sugar in the dry matter of the root was also depressed. Mosaic reduced leaf area and net assimilation rate, but did not change the sugar content of the root. Neither disease had any appreciable effect on leaf number; the effects on total leaf area per plant were attributable to a reduction in the size of individual leaves. With both yellows and mosaic the effects on total leaf area were relatively greater than those on net assimilation rate; loss of dry matter yield was mainly the result of the stunting of the leaves. Yellows caused a greater

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reduction in net assimilation rate in 1946 than in 1945; in 1945 the reduction was less, and in 1946 more, than could be accounted for on the assumption that the yellowed areas of the leaves were incapable of photosynthesis. The difference between the two years may be related to weather conditions; there was more rain and less sunshine in 1946 than in 1945.

The total carbohydrate content (sugars and starch) per cent. of dry matter of the leaf laminae infected with yellows was more than double that of healthy leaves, and the increase was mainly in reducing sugars. It was known previously that starch accumulates in leaves infected with yellows to a greater extent than in healthy leaves, and it was assumed that this was caused by restriction of the translocation of carbohydrate from the leaves. This was shown not to be true, for the loss of carbohydrate between sunset and sunrise was at least as great in infected as in healthy leaves. Infection with mosaic had no effect on the carbohydrate content of the leaf.

The two viruses also differed in their effects on nitrogen content; yellows reduced the nitrogen content of the leaf lamina, while mosaic increased it; yellows increased the nitrogen content of the petiole and root, but mosaic had no effect. Both viruses reduced the total nitrogen uptake.

Physiology of leaf growth

A. G. Morton was appointed in November, 1945, to continue the study of leaf growth, which was interrupted by the departure of R. S. de Ropp. Two papers (44, 45) were published on the results of de Ropp's work on the growth of leaves on excised stem-tips of rye in sterile culture.

Experiments were made to determine whether the effects of varying nutrient supply on leaf size are brought about by changes operating during the stage of cell-division, or later in the stage of cell-extension. A rapid method of estimating the total number of cells in a leaf by microscopic examination was worked out. Material was obtained from sugar beet, grown in pot-culture with varying supply of nitrogen, sodium chloride and water, and from field experiments on several crops, including the Classical experiments where the differences in leaf-size induced by varying nutrition are very large.

The examination of the results has not yet been completed. In the sugar-beet experiment it was found that cell number per leaf depended on nitrogen supply, but not on the supply of sodium chloride or water. All three factors affected cell-size. This result is in agreement with many other demonstrations of the importance of nitrogen supply in controlling meristematic activity.

Publications (including Summaries), page 99.

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