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Effect of the grape chrome-mosaic and grape fanleaf yellow-mosaic virus-infection on the photosynthetical carbon dioxide fixation in vine-leaves

by

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After discovering the virus-disease called grape fanleaf yellow-mosaic (GFYM) in the Hungarian vineyards (LEHOCZKY 1965, SÁROSPATAKI 1965) it became evident that there exists another virus disease, similar to the former, the grape chrome-mosaic (GCM), previously called "Hungarian yellow mosaic" (MARTELLI 1965, MARTELLI *et al.* 1965, 1969). This was caused by a serotype of the tomato-black-ring-virus (TBRV) and not by the yellow-mosaic-strain of the grape fanleaf-virus (GFYM) (MARTELLI *et al.* 1968, HEWITT 1968). At the beginning of summer the symptoms of the GCM are similar to those of the GFYM (Fig. 1) but later they become different in that the symptoms of GCM are not marked, in fact one part of the leaves turns completely white (Fig. 2). The GCM is a more serious disease than the GFYM because the diseased vines can perish 5—6 years after the GCM infection.



Fig. 1

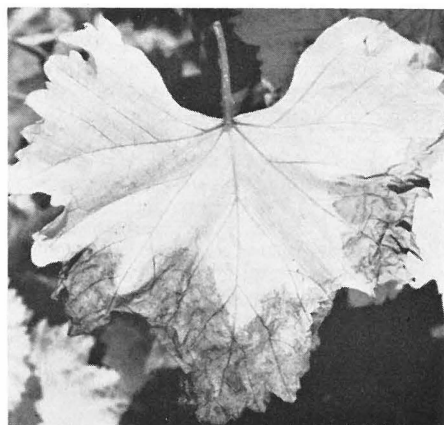


Fig. 2

Fig. 1: Symptoms of chrome mosaic on leaf of Red Veltliner grape variety.

Fig. 2: Severe symptoms of chrome mosaic on leaf of Red Veltliner grape variety.

Examinations were conducted earlier on the nitrogenous metabolism of GCM-diseased vines (JÁKÓ *et al.* 1966) to determine the changes occurring in the pigment and sugar content (JÁKÓ *et al.* 1968). Considering that the photosynthetical activity may vary independently of the decrease of the chlorophyll content (ROBERTS *et al.* 1952; SPIKES and STOUT 1955), GCM and GFYM diseased vines were investigated on their chlorophyll content and on the intensity of their photosynthetical carbon dioxide fixation.

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Materials and Methods

The leaves were collected at different times during summer. The GCM-diseased leaves originated from slightly and seriously diseased and from completely healthy vine stocks of the Red Veltliner variety, grown in Badacsony (near the Balaton lake). The slightly diseased and the healthy leaves of Sultana white were gathered in Budapest (Variety-Collection of the Research Institute for Viticulture and Enology).

The intensity of carbon dioxide fixation was measured by incorporation of radioactive carbon- ^{14}C released from $\text{Ba}^{14}\text{CO}_3$, using the method of ARNON (1961). An amount of 130 mCi/g of bariumcarbonate of specific activity of 120 μCi was used in an exsiccator of 5 litres, which was prepared especially for this purpose. Carrying out the carbon dioxide fixation in the presence of light, bulbs of 400 W were employed to illuminate the leaf-discs. The exposition time for the fixation of CO_2 was 15 minutes, with or without illumination. After exposure, the radioactive carbon dioxide was drawn by means of a vacuum pump, from the exsiccator within 3 minutes into a solution of $\text{Ba}(\text{OH})_2$ containing BaCl_2 ; afterwards leaf-discs were killed directly by ethanol. The radioactivity of the tissues was determined utilizing the liquid-scintillation method using Packard-tricarb apparatus.

As to GCM-diseased leaves the CO_2 -fixation was repeated four times, as to GFYM diseased leaves three times, using 5 parallels each and calculating the results on 100 mg leaf-tissues (fresh-weight). Besides the intensity values of the CO_2 -fixation, the mean errors of the mean values are given too.

The chlorophyll content of the leaf-tissues was extracted with 2 ml of 80% methanol after washing the dish with 2 + 1 ml of methanol, the substance being combined in a centrifuge tube. After centrifuging which lasted 10 minutes (rpm = 4000), the supernatant was poured out of the tube, the residual was suspended in 4 ml of methanol and centrifuged. The remainder was then washed with a mixture of 1 : 1 ether and methanol and was combined with the supernatant and completed to 10 ml by adding methanol. The optical density of this solution was measured using a spectrophotometer system Hilger, wave length = 665 nm. In Table 1 the data of extinction are given calculated on the concentration base.

Results and Discussion

Table 1 shows the measure of chlorophyll defectiveness of GCM and GFYM diseased leaves and the decrease of the intensity of photosynthesical CO_2 -fixation. The fixation measured in light and in darkness was reduced already at the first phase with a great efficiency by the virus infection. In the GFYM diseased leaves there was a characteristic low intensity of CO_2 -fixation accompanied by a decrease of the chlorophyll level. In GCM infected leaves this decrease was much more pronounced at the beginning of the infection, accompanied by a decrease of intensity of photosynthesical CO_2 -fixation.

The specific activity referring to the photosynthesical CO_2 -fixation decreased to a much smaller extent compared to the chlorophyll content, on the influence of virus infection. This suggests that the photochemical activity of chlorophyll was presumably gradually increased, probably due to the better absorption of light by the tissues.

The data of Table 1 demonstrate the striking decrease of the chlorophyll-level above all in the GCM diseased leaves. The specific activity of the photosynthesical

T a b l e 1
CO₂-fixation and chlorophyll content in healthy and in GCM or GFL-YM diseased leaves

| Material | Fixation of ¹⁴ CO ₂ in cpm | | | | Chlorophyll content | | | Specific activity of fixation of CO ₂ | |
|---|--|---------|----------------|---------------------|------------------------|---------------------|--|--|---------------------|
| | In light | In dark | Photosynthetic | | mg/100 mg fresh weight | Referred to control | cpm/100 m fresh weight /mg chlorophyll | Referred to control | Referred to control |
| | | | cpm | Referred to control | | | | | |
| Red Veltliner | | | | | | | | | |
| Healthy leaves | 21 084 | 147 | 20 937 | 100 | 0.350 | 100 | 60 240 | 100 | 100 |
| GCM diseased leaves with slight symptoms | 4 682 | 52 | 4 630 | 22 | 0.167 | 47 | 28 035 | 46 | 46 |
| GCM diseased leaves with severe symptoms | 916 | 31 | 885 | 4 | 0.021 | 6 | 43 619 | 72 | 72 |
| Sultana white | | | | | | | | | |
| Healthy leaves | 14 719 | 172 | 14 547 | 100 | 0.130 | 100 | 113 223 | 100 | 100 |
| GFL-YM diseased leaves with slight symptoms | 8 220 | 50 | 8 170 | 56 | 0.117 | 90 | 70 256 | 62 | 62 |

CO₂-fixation remained the same at the first phase of infection, but it was characteristically increased in the more serious state of the disease. At the same time, the specific activity of the CO₂-fixation decreased to a great extent in leaves of vines suffering from GFYM infection but at this phase, the decrease of the chlorophyll-level was very small. The relative photochemical activity of chlorophyll is reduced in case of both diseases on the effect of virusinfection but the CO₂-fixation referring to the fresh weight, was generally increased in a later, typical phase of the infection.

A decrease in the chlorophyll level by 10—94% in GCM infected leaves was found while photochemical activity of chlorophyll was reduced only by 28—54%. Damages occurring in proteins were presumably indirectly connected with photochemical activity, as reported in a former publication (POZSÁR 1967). The decomposition of proteins caused by virus-infection, has an inhibiting effect on the intensity of photosynthesical CO₂-fixation by destruction of the chlorophyll-protein-complexe.

Summary

The intensity of photosynthesical CO₂-fixation in red Veltliner leaves, strongly or slightly infected with GCM, was compared with leaves of healthy individuals. Leaves of white Sultana, slightly infected with GFYM virus were also compared with leaves of healthy plants. The photosynthetic activity was calculated by measuring the CO₂-fixation in dark and in light and the data thus obtained were compared with the content of chlorophyll. In GCM infected leaves with slight symptoms the chlorophyll level and the intensity of photosynthesical CO₂-fixation gradually decreased; in leaves with severe symptoms, the specific activity (CO₂-fixation/mg chlorophyll) was relatively higher, presumably due to the increased transparency of the tissues. After GFYM infection the photosynthesical CO₂-fixation decreased strikingly, independently of the strength of leaf symptoms. It is supposed that the destruction of the chlorophyll-protein-complexe caused by the virus infection asserts an inhibiting effect on the photosynthetic activity.

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Eingegangen am 13. 3. 1969

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