COLORADO FLOWER GROWERS ASSOCIATION, INC.

IN COOPERATION WITH COLORADO STATE UNIVERSITY
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Photosynthesis in Roses III. The Nature of Rose Water Stress and Its Effect on CO_2 Uptake

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Information from studies of photosynthesis in 'Forever Yours' roses as affected by light intensity and leaf age have been presented (CFGA Bulls. 289 & 290). Internal plant water levels also influence photosynthesis, although perhaps not as great as its effect on stem growth. It has been found in corn, sunflower and cotton that as internal water levels decline, elongation is first retarded, followed by a decline in photosynthetic rates. The mechanism by which water stress causes this decrease in CO_2 uptake is primarily by restricting the size of the leaf stomates, restricting the flow of carbon dioxide into the leaf.

The Nature of Rose Internal Water Status

Four stem developmental stages were examined. Stage 1 was a young, tender shoot with no mature leaves, and the neck of the bud had not elongated. Stage 2 was more advanced with some of the lower leaves mature. Stage 3 was when the calyx had begun to peel back and expose color, and all leaves had matured. Stage 4 was mature blind growth. The amount of water stress as it commonly occurs in each stage on a clear day was tested.

Fig. 1 shows the results of these tests. Plant water status is expressed in bars (1 bar = 14.7 psi pressure). Maximum water is zero bars. As water loss increases during the daylight hours, water inside the plant comes under a tension (or negative pressure). Hence, all these measurements are negative.

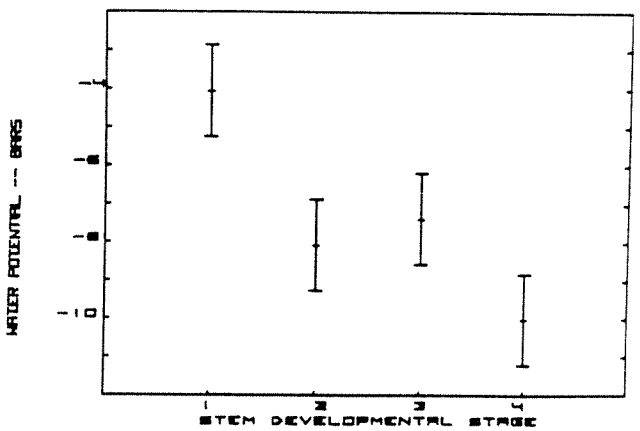

Figure 1. Water potentials of the four stem developmental stages.

Stage 1. Young, tender shoot, no mature leaves.
Stage 2. Lower leaves mature, pea-sized bud.
Stage 3. All leaves mature, calyx exposing color.
Stage 4. Mature blind growth.

[1] *W. J. Aikin was a graduate research assistant and has completed his work on photosynthesis in roses, supported by the Joseph H. Hill Foundation and Roses, Inc.*

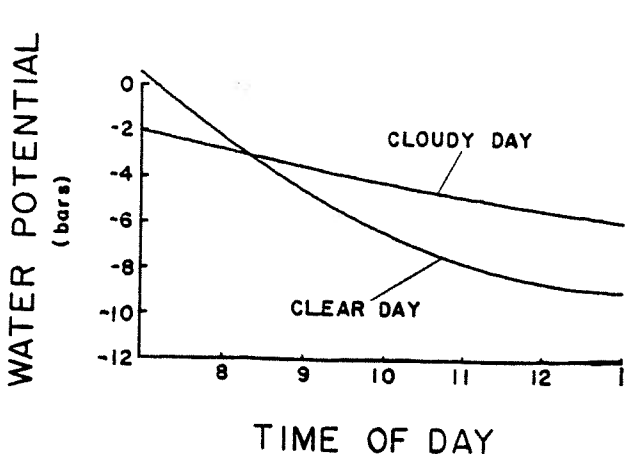

Figure 2. Common water potentials as they vary with time of day in 'Forever Yours' roses under cloudy and clear days.

The "tails" about a mean which do not overlap the "tails" of another mean show the two means to be statistically different from each other.

Fig. 1 shows that internal water levels vary according to the stage of stem development. This may be related to the amount of woodiness, the younger, less woody tissues maintaining higher levels than those more mature. This has been confirmed in peas.

To illustrate the degrees of water stress which naturally occur in roses, Fig. 2 is a plot of plant water levels of stems in stages 2 or 3 versus time of day. Water levels on cloudy and clear days are presented. Under cloudy conditions, common low values of water stress were around -5 to -6 bars, whereas on a clear day, lows were -8 to -10 bars. For comparison, to illustrate the severity of stress, the wilting point for stems in this developmental stage is about -13 bars. It was also found that, regardless of existing weather conditions, the degree of water stress was very closely associated with light intensity.

How Does Water Stress Affect Photosynthesis?

Fig. 3 is a plot of photosynthesis versus light intensity, and plant water stress was held mathematically at constant values. Determining photosynthetic rates has been previously described (CFGA Bull. 289), and the units presented here for CO_2 uptake are the same as those presented in the previous article.

Fig. 3 presents a relatively clear picture of the intricate, combined effects of plant water stress and light intensity on photosynthesis. As shown earlier, as light intensity increases, CO_2 uptake increases, then past the saturation point (point of maximum uptake rates), CO_2 uptake declines. Fig. 3 shows this decline depends on the amount of water stress.

If light is held constant, increasing water stress (becoming more negative) causes a decrease in the rates of CO_2 uptake. For example, from Fig. 3, at 5000 ft-c light intensity, water stress values and corresponding photosynthesis values were -4 bars (least stressed) and 7.51 mg. CO_2 uptake, -6 and 6.37, -8 and 5.77, and -10 (most stressed) 5.72. Fig. 3 also suggests that at lower light intensities, water stress has little effect on photosynthesis. As light increases, causing increased water loss, water stress begins to have its effect. Light intensities in Colorado greenhouses are commonly above 3500 ft-c most of the year. To conserve internal plant water is to help maximize photosynthesis. This further illustrates the need for adding moisture to the greenhouse air for roses, to help reduce water losses. As mentioned, water stress has an even greater effect upon stem elongation.

Light intensity and plant water stress combined had a greater effect than any single factor alone on CO_2 uptake. This indicated that these two factors are the most critical in regulating photosynthesis.

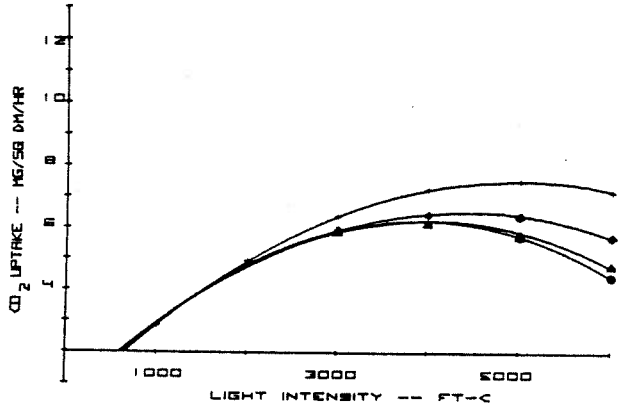

Figure 3. Photosynthesis vs. light intensity at various constant values of plant water stress.
+ — -4 bars = -58.8 psi
⊕ — -6 bars = -88.2 psi
△ — -8 bars = -117.6 psi
⊕ — -10 bars = -147.0 psi

Summary

From the time they originate until they mature, new canes are in their most critical stage for proper internal water levels. Growth, which is controlled mostly by internal water, is most affected at this stage by stress. When canes mature, water does not have as great an effect upon growth, because growth has slowed down for the most part, and tissues have become woody. However, as they mature, water stresses have a marked effect on photosynthetic activity. It has been shown that as water stress increases the photosynthetic rates decrease. Light and internal water combined have the greatest effect on

CO_2 uptake in roses, but light is certainly the main factor because of its influence on water stress. Care must be taken to maintain as high a water level inside the plant as possible to maximize growth and photosynthesis. Growers must live with the fact that water stresses increase with increasing light intensities, and that roses are noted for being sensitive to water stress. Sufficient water should be made available at the roots and in the atmosphere to insure that the internal water levels are not reduced more than necessary. This includes misting, reducing light by shading, and not allowing the soil to dry excessively. The results in this paper and the previous reports (CFGA Bulls. 289 & 290) show that maximum production may be expected in high light regions, combined with greenhouse conditions controlled to reduce water loss to a minimum. Although food production for a rose leaf is only ½ of the maximum rate by the time the flower is cut, those leaves undoubtedly contribute to the parent plant. Every effort should be made to maintain all leaves on the plant.