DIFFERENCES OF ELECTRIC POTENTIAL IN THE LEAVES OF PLANTS

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Differences of electric potential appear to exist in all living organisms. Physiologists and biophysicists are studying these differences of potential in an attempt to discover their origin, and to determine whether they are, as some investigators think, mere indicators of processes going on in the organism or whether they exert some control over these processes. Knowledge of the factors which influence these differences of potential, not only assists in arriving at a solution of the problem of their origin[1, 2, 3] but also makes it possible in some cases to use them to indicate changes going on within an organism without probing within that organism or injuring it in any way. Since these differences in electric potential in plants and animals are affected by numerous physical conditions, many of which undoubtedly are yet unknown, experiments are difficult to control and it is well to have similar experiments repeated by several investigators. One of the factors most studied has been the influence of light on the potential differences between two points on the leaves of plants.[4, 5] I am presenting data which I have obtained on changes in potential difference produced between a point near the basal end of a leaf and another point near the apical end when an area between these points is irradiated by visible light.

Poinsettia leaves growing on the plant have been used throughout these experiments. The differences of potential are measured by a Compton quadrant electrometer. The electrometer is housed in an earthed electrostatic shield near which is placed another earthed metallic box containing the plant whose leaf is to be used in the experiment. The pot in which the plant is growing is insulated on a paraffined wooden block. The leaf is encased in a transparent plastic box in such a manner that the leaf is supported in a horizontal position on the bottom of the box. L-shaped electrodes of silver wire pass through slots in the sides of the box. One end of each electrode has been chloridinized and dips into a drop of tap water placed upon the leaf. The electrode near the basal end is connected by means of a switch to the insulated quadrants of the electrometer. The metal box which contains the plant is painted black inside. An adjustable opening on top admits light from an incandescent lamp directly above it. A water filter is used to absorb much of the infra-red radiation from the lamp. A

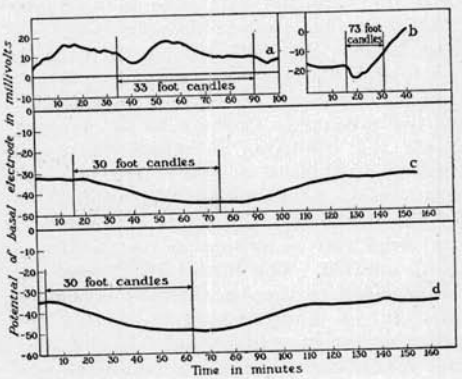

Fig. 1.

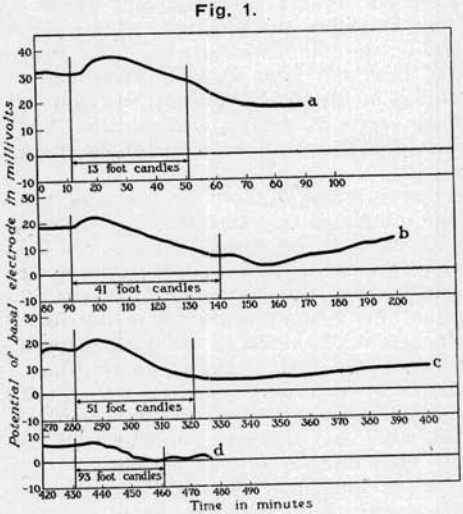

Fig. 2.

piece of heavy black paper with a rectangular opening placed on top of the plastic box is used to admit the light to the desired area between the electrodes. The intensity of the light which falls on the leaf is determined by removing the leaf and putting in its place a thermopile.

The type of response obtained is shown in figs. 1 and 2. The curve gives in each case the variation with time of the potential of the basal electrode with respect to the apical electrode which in turn is earthed. The arrows indicate the intensity of the light used and the duration of the exposure. Curve *a* of fig. 1 represents the condition in which the plant had been kept in a dimly lighted room for several hours before the application of the electrodes. Readings of the potential were started as soon as the electrodes were applied. The initial variations can be ascribed to the disturbance caused by mechanical manipulation in setting the plant up for the experiment. In this case an appreciable change in potential was produced by the illumination. Curve *b* (fig. 1) shows the response of the same leaf on the following morning. The plant had been left over night entirely undisturbed in the light tight box. In both of these sets of determinations the light was allowed to fall over the whole of the plant.

Curves *c* and *d* show the response of a leaf irradiated on two different occasions with light of the same intensity, for the same length of time, and over the same area between the electrodes. An interval of an hour's time during which the plant was left undisturbed in the dark, elapsed between the two series of observations. The two responses were nearly indentical. Fig. 2 shows the effect on the potential difference of successive irradiations of the same area of a leaf by light of increasing intensity. It will be noted that the magnitude of the response in general decreases with the increase in intensity of light, but the response takes place more rapidly. The plants represented by curves *c* and *d* of fig. 1 and by those of fig. 2 were kept over night in the light tight box before observations were started.

The variation in potential difference observed in *Poinsettia* leaves with irradiation by visible light is similar to that obtained by other observers for the same[6] and for different leaves[7] using somewhat different procedures. The results under the conditions represented by fig. 2 are not inconsistent with those of Marsh[8] working with *Valonia*, but many more observations must be made before a definite conclusion can be reached.

It should be remarked that the mangnitude of the response to irradiation varies greatly. Many times it is so small as to make the change indecisive. Keeping the plant in the dark for several hours will often increase the response, but sometimes two days in the dark will not be sufficient to make the response appreciable. Small responses seem to be found more often in summer than in winter. Whether the season, the condition of the plant, its environment, or the conditions under which it was grown are responsible for this lack of change is still to be determined.

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