



FIG. 2. Effect of variations in cation concentration of phosphate buffer solutions of pH 6.2 on the cytochrome oxidase activity of sunflower leaf tissues. Values are expressed as the velocity constant for a first-order reaction ( $K \text{ sec}^{-1}$ ).

rectly, the optimum buffer concentration was approximately 0.05 M phosphate which would correspond to a cation concentration of about 0.1 M. This concentration falls in the vicinity of the optimum cation concentration found by us. However, there is some difference in pH optima found which may be due to their use of a manometric instead of a spectrophotometric method.

It appears from the work reported that a combination of a pH of about 6.0 and a cation concentration of the phosphate buffer of about 0.130 M is probably the most favorable one for the determination of cytochrome oxidase activity in plant tissues by the spectrophotometric method employed.

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## THE EFFECT OF CARBON MONOXIDE ON RESPIRATION IN HIGHER PLANTS<sup>1</sup>

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Current studies (1, 2, 5) have indicated that a cytochrome oxidase is found in most of the tissues of higher plants. The widespread distribution of this enzyme has raised the possibility of its general participation in plant respiration in a manner similar to that in animals, yeast, and aerobic bacteria. Unquestionable proof of the participation of cytochrome oxidase in plant respiration is very difficult, but the relative importance of cytochrome oxidase and tyrosinase (or other copper containing enzymes) in respiration may be estimated by use of the carbon monoxide inhibition techniques of Warburg (4). It is well established (3, 4, 5) that the carbon monoxide

inhibition of cytochrome oxidase activity is eliminated by light while the carbon monoxide inhibition of tyrosinase is insensitive to light. This difference in properties provides a means of differentiating between the activities of these oxidases in plant respiration.

In connection with some previously reported studies (5) on the occurrence of cytochrome oxidase in plants, the author had occasion to examine the effect of carbon monoxide and light on the respiration of a number of plant tissues. The respiration of root (1 cm sections) or other tissue (0.5 mm slices) in 0.05 M potassium phosphate buffer (pH 7.1) was measured at 25° C by standard manometric tech-

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niques in various ratios of carbon monoxide or nitrogen to oxygen. The results reported here were obtained with 95% CO and 5% O<sub>2</sub>. As is evident from table I, the respiration of all eleven tissues studied was strongly inhibited by carbon monoxide. In ten of the eleven cases examined the inhibition

was largely or completely eliminated by irradiation of the tissue with light.

The one exception, apple fruit tissue, has consistently failed to show any reversal of carbon monoxide inhibition even at far higher light intensities than those necessary to completely reverse inhibitions in the other tissues studied. It is of interest to note that apple fruit is one of the few tissues that failed to show any significant cytochrome oxidase activity in a previous study (5). It seems possible that we are dealing here with a respiration that is either not cytochrome linked or that is altered in such a way that it is not possible to demonstrate the occurrence of the cytochrome oxidase.

Despite the results with apple, the far more important fact remains that in ten of the eleven tissues examined the evidence fairly well precludes the participation of a tyrosinase and definitely supports the participation of a cytochrome oxidase in respiration. The results obtained here, therefore, provide further evidence for the general importance of cytochrome oxidase in plant respiration.

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TABLE I

EFFECT OF CARBON MONOXIDE AND LIGHT ON THE RESPIRATION OF NON-PHOTOSYNTHETIC TISSUES OF SOME HIGHER PLANTS

PLANT AND TISSUE	PERCENT INHIBITION OF RESPIRATION WITH 95% CO AND 5% O <sub>2</sub> *	
	<i>In the dark</i>	<i>In the light**</i>
	<i>Fagopyrum esculentum</i> L. (buckwheat)—root	65
<i>Delphinium Ajacis</i> L. (larkspur)—root	51	6
<i>Raphanus sativus</i> L. (radish)—root	38	19
<i>Pyrus Malus</i> L. (apple)—fruit	45	45
<i>Beta vulgaris</i> L. (beet)—root	43	9
<i>Phaseolus vulgaris</i> L. (bean)—root	61	6
<i>Phaseolus limensis</i> L. (lima bean)—root	63	0
<i>Medicago pratense</i> L. (alfalfa)—root	56	0
<i>Nicotiana Tabacum</i> L. (tobacco)—root	43	7
<i>Cucumis sativus</i> L. (cucumber)—fruit	54	10
<i>Helianthus annuus</i> L. (sunflower)—root	55	0

\* Percent inhibition as compared with a 95% N<sub>2</sub> and 5% O<sub>2</sub> control.

\*\* White light of about 300 fc incident on the vessel.

#### NOMENCLATURE OF CHEMICAL PLANT REGULATORS—A CRITICISM

In the May, 1954, issue of *Plant Physiology* there appears a report of a committee of the American Society of Plant Physiologists on the nomenclature of Chemical Plant Regulators. The undersigned was a member of that committee, but did not sign that report, as he was opposed to various points in the set of definitions proposed by the majority of the committee.

**REGULATOR:** The word Regulator has a status in Biology as a term for a substance by which living organisms maintain the harmony and balance of their various physiological processes in spite of the action of external factors. To regulate, according to Webster's Dictionary, means "to adjust so as to work accurately and regularly." 2,4-D and several other synthetic growth substances do not do this. 2,4-D, therefore, is not a regulator; and **REGULATOR** should not be used as a broad term including substances, influencing a variety of physiological processes, another term is needed, **ERCON** might serve this purpose; but within the field of growth processes the term **GROWTH SUBSTANCE** is sufficient.—Further, the

assignment of the Committee is "to consider and propose a uniform nomenclature on growth substances."

The Minority, therefore, proposes the following set of definitions.

#### PROPOSED DEFINITIONS

**GROWTH SUBSTANCES** are organic compounds which at low concentrations promote, inhibit, or qualitatively modify growth. Their effect does not depend on their caloric value or their content of essential elements.

*Comment:* On account of the ambiguity of the word "nutrient" (cf. proposal by the Majority), particularly when both autotrophic and heterotrophic organisms are considered, this term should be avoided, and is unnecessary.

**GROWTH HORMONES** are growth substances which regulate growth and are produced by the organism itself. They usually move within the organism from a site of production to a site of action.

*Comment:* For the meaning of "regulate," see above.