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This Week's Citation Classic

Hesketh J D & Moss D N. Variation in the response of photosynthesis to light. *Crop Sci.* **3**:107-10, 1963.

A comparative study between two C-4 (maize and sugarcane) and 11 C-3 plants buried the accepted dogma for 'light saturation' of photosynthesis of leaves at *V full sunlight and for 20 mg CO_2 $dm^{-2}hr^{-1}$ as the maximum crop leaf photosyn-thetic rate. One C-3 plant, sunflower, performed similar to the C-4 plants. [The *SCI*® indicates that this paper has been cited over 125 times since 1963.]**

John D. Hesketh
AR-SEA-USDA
University of Illinois
Urbana, IL 61801

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"This paper was one of several we published in the early 1960s[1] establishing that C-4 plants, in which CO_2 is first fixed into a C-4 acid before cycling through the photosynthetic 'Calvin-Benson' or C-3 pathway, (1) have rapid leaf photosynthetic rates in intense light, (2) do not respire (or photorespire) in light and in CO_2-free air, and (3) respond to light increments up to full sunlight and apparently beyond. Our research, with the biochemical C-4 work of Kortschak, Hartt, and Burr[2] in Hawaii and the oxygen-photorespiration work of Forrester, Krotkov, and Nelson[3] in Canada, defined by the mid-1960s most aspects of the photosynthetic C-4:C-3 phenomenon in higher plants.

"Differences in leaf anatomy and water use efficiency between the two types of plants had been established long before the photosynthetic phenomenon was recognized. In the 1970s, genera were found with species exhibiting either C-4 or C-3 behavior and F_1 hybrids and segregating subsequent generations have been bred from C-4 and C-3 parents.[4]

"In comparing our results with those of the Canadians, Zelitch,[5] in Connecticut, quickly saw the similarity between responses of photorespiration and glycolic acid metabolism to the environment. USDA researchers at Urbana (Bowes and Ogren[6]) linked activities of glycolic acid metabolism and photorespiration with competition between O_2 and CO_2 for the C-3 carboxylating enzyme during CO_2 fixation, explaining the Canadians' results.

"In our early work, we carefully cooled our leaf chambers to maintain leaf temperatures comparable to those in nature. High temperatures in uncooled leaf chambers had been associated with the midday depression in photosynthesis. In our zeal to disprove once again the midday depression hypothesis, we maintained leaf temperatures far below those optimal for photosynthesis in C-4 and in many C-3 plants. Subsequent research by myself[7] and others in warmer climates resulted in maximal photosynthetic rates two-fold greater than those reported earlier for both classes of plants.

"Previous work had been with C-3 plants grown in greenhouses that were poorly lit because of the season or artificial shading. We now know that such plants acclimate to low light conditions and have low photosynthetic rates.

"The C-4:C-3 phenomenon has generated considerable interest in recent years. A re cent review has been prepared by T.B. Ray and C.C. Black.[8] Many other related papers have already been denoted as *Citation Classics.*[2,9] The significance of our paper was related to this subsequent interest in C-4:C-3 research. In the early 1960s this research was considered to be somewhat controversial. D.N. Moss is now at Oregon State University, Corvallis."

1. **Hesketh J D & Musgrave R B.** *Crop Sci.* **2**:311-15, 1962.
2. **Kortschak H P, Hartt C E & Burr G O.** Carbon dioxide fixation in sugarcane leaves. *Plant Physiol.* **40**:209-13, 1965.
   [Citation Classic. *Current Contents/Agriculture. Biology & Environmental Sciences* (4):16, 26 January 1981.]
3. **Forrester M L, Krotkov K G & Nelson C D.** *Plant Physiol.* **41**:422-31, 1966.
4. **Nobs M A, Bjorkman O & Pearcy R W.** *Carnegie Institute of Washington Yearbook* **69**:625-9, 1971.
5. **Zelitch I.** *Annu. Rev. Plant Physiol.* **15**:121-42, 1964.
6. **Ogren W L & Bowes C.** *Nature New Biol.* **230**:159-60, 1971.
7. **Hesketh J D & Baker D N.** *J. Ariz. Acad. Sci.* **5**:216-21, 1969.
8. **Ray T B & Black C C.** The C_4 and crassulacean acid metabolism pathways. 6. The C_4 pathway and its regulation. (Gibbs M & Latzo E, eds.) *Photosynthesis II. Photosynthetic carbon metabolism and related processes.* New York: Springer-Verlag, 1979. p. 77-101.
9. **Hatch M D & Slack C R.** Photosynthetic CO_2-fixation pathways. *Annu. Rev. Plant Physiol.* 21:141-62, 1970.
   [Citation Classic. *Current Contents/Agriculture. Biology & Environmental Sciences* (51):18, 22 December 1980.]