Preliminary Notes

Ribonucleic acid as an index of the metabolic activity of pea leaves

In studies of metabolic changes in developing pea leaves (*Pisum sativum* var. Laxton's Progress), it was observed that the levels of certain energy-producing mechanisms changed considerably as the leaves aged. Thus chloroplasts isolated from pea leaves of different chronological ages showed marked differences in their capacity for photosynthetic phosphorylation. Similar changes occurred in the capacity of isolated leaf mitochondria for oxidative phosphorylation.

Leaves were selected from 6- to 16-day-old pea plants grown in a greenhouse on soil contained in flats. The measurements of photosynthetic phosphorylation and oxidative phosphorylation were based on the methods of ARNON *et al.*[1] and SMILLIE[2] respectively.

Table I shows that when photosynthetic phosphorylation was expressed per leaf, the activity increased until the 9th day of the plant age and then declined. In these leaves, chlorophyll synthesis was usually completed by the 8th day and leaf expansion by the 9th–11th day. Similar developmental changes were also observed for oxidative phosphorylation by pea-leaf mitochondria. Such a rise and fall in both the photosynthetic and oxidative phosphorylation activities was observed when the results were expressed not only per leaf, but also as per leaf fresh weight, leaf dry weight, cell count, DNA or chlorophyll content.

TABLE I

PHOTOSYNTHETIC PHOSPHORYLATION ACTIVITIES OF PEA LEAVES OF DIFFERENT AGES

Age of pea plants (days)	*Total photosynthetic phosphorylation activity of leaf chloroplasts (μg P/h/leaf)*
6	2.0
7	43.0
9	93.0
12	67.6
16	28.6

The pattern of the rise and fall, and the stage in the leaf development when maximum activity was reached, varied according to the basis on which the activities were expressed. For instance, when expressed on a leaf fresh-weight basis, the photosynthetic phosphorylation activity of the leaf chloroplasts rose during greening to a level which was maintained for 2–3 days. It then rapidly decreased. If expressed on a chlorophyll basis, the peak of activity was reached sooner and the ensuing decline in activity began almost immediately.

When the photosynthetic phosphorylation activities were expressed on a RNA basis, there was an initial increase in the activity during greening to a level which

Abbreviations: RNA, ribonucleic acid; DNA, deoxyribonucleic acid.

was more or less maintained throughout the subsequent development of the leaf (Table II). Oxidative phosphorylation, when expressed on the RNA basis, showed a similar trend. There was an increase during the very early stages of leaf development, during which intense protein synthesis was probably taking place. Thereafter the leaf capacity for oxidative phosphorylation approximately followed the RNA level. Except for the very early stage of the leaf development, the RNA content of the leaf was indicative of the activities of the major photosynthetic and respiratory energy-producing mechanisms of the leaf. In a number of plant tissues these energy mechanisms have been related to the levels of other physiological activities such as photosynthesis[3], respiration[4,5], protein synthesis[6] and cell division[7]. Hence the leaf RNA appears to be a reasonable indication of the level of metabolic activity of leaves at different stages of development. A correspondence between RNA and metabolic activity has been observed for tissues from a wide range of organisms[8].

TABLE II

PHOTOSYNTHETIC AND OXIDATIVE PHOSPHORYLATION ACTIVITIES OF PEA LEAVES AS A FUNCTION OF THE LEAF RIBONUCLEIC ACID

Age of pea plants (days)	*Photosynthetic phosphorylation activity (μg P/h/μg RNA-P)*	*Age of pea plants (days)*	*Oxidative phosphorylation activity (μg P/h/μg RNA-P)*
6	0.8	5–6	0.8
7–8	5.8	7	2.6
9	11.2	8	2.8
10	11.8	9	2.7
12	11.6	12	3.0
13	11.8		
16	12.8		

The observed lack of correlation between photosynthetic phosphorylation activity and chlorophyll content is noteworthy. Since it is customary to express rates of photosynthetic phosphorylation by isolated chloroplasts on a unit chlorophyll basis[1], it is important to define the approximate physiological state of the leaf material used in such experiments.

Details of this study will be published later.

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Department of Biology, Queen's University, Kingston, Ontario (Canada)

R. M. SMILLIE*
G. KROTKOV

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* Holder of a National Research Council of Canada Studentship.