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BRIEF COMMUNICATION

Radiant energy utilized in photosynthesis

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Abstract

On the basis of values from literature it was established that photosynthetically used radiation (PUR) amounts to 6 % of absorbed radiant energy in cabbage (producer of high yields), 3.5 % in sugar beet leaves, and 2.6 % in tobacco leaves. PUR of these species did not depend on irradiance in a wide range from 22 to 287 W m^{-2}.

Additional key words: *Beta*; *Brassica*; cabbage; *Nicotiana*; irradiance; photosynthetic rate; sugar beet; tobacco.

Gaastra (1959) established that photosynthetically active radiation (PAR) refers to radiant energy of the wavelengths from 400 to 700 nm, but the main absorption bands of chlorophyll in blue and red regions are narrow. Plants use only a small part of PAR. Bacławska-Krzemińska (1973) gives a convenient basis for such calculations because it covers a wide irradiance area with a well defined point of saturation of photosynthetic system with PAR. She studied the effect of water deficit on photosynthetic rate (*P*) in cabbage seedlings within a wide range of irradiances from 36 to 360 W m^{-2}. Plants were grown in 5 kg pots with sand and naturally irradiated. *P* was measured by the isotopic method (Strebeyko 1967). The production of 1 mol of oxygen in photosynthesis requires an input of 1 760 kJ. If this energy is divided by the Avogadro number, then 2.92 aJ fall to one molecule of the produced oxygen. It can be assumed that the energy necessary to assimilate 1 atom (2×10^{-26} kg) of carbon amounts to about 3 aJ and in that way the power required in the process was calculated (Table 1).

In this broad range of irradiances each increase in irradiance elicited a proportional increase of *P* reaching the maximum of 100 μg(C) m^{-2} s^{-1}. With the irradiance of 287 W m^{-2} the photosynthetic system was saturated with PAR. Cabbage belongs to cultivated plants that utilize PAR well and give very high yields. The calculated PUR slightly varied with irradiance and reached a mean value of 5.2 %.

However, not all plant species use PAR as efficiently as cabbage. This was shown by similar experiments with sugar beet (Jarecka 1973) and tobacco (Wróblewska

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Table 1. Dependence of photosynthetic rate, *P* [μg(C) m^{-2} s^{-1}], power requirement [W m^{-2}], and photosynthetically used radiation, PUR [%] on irradiance [W m^{-2}] in three plant species.

	Irradiance 22	36	72	108	144	216	287	324
Brassica oleracea L. var. *capitata alba* Ditmarska								
P		13	29	46	61	76	100	100
Power requirement		1.95	4.35	6.90	9.10	11.40	15.00	15.00
PUR		5.40	6.00	6.40	6.30	5.30	5.20	4.90
Beta vulgaris L. var. *saccharifera*								
P	5				33	50	58	58
Power requirement	0.75				5.00	7.50	8.70	
PUR	3.47				3.47	3:47	3.03	
Nicotiana rustica L.								
P			12.5		25	44	58	50
Power requirement			1.87		3.74	6.60	7.50	
PUR			2.60		2.60	3.05	2.61	

1973). The PUR values of 3.47 % (for sugar beet) and 2.60 % (for tobacco) had an exactness rarely observed in biological experiments (Table 1).

The way the radiant energy is utilized by different plant species suggests that their photosynthetic pigments have a different absorbance or that they differently utilize the already absorbed energy. PUR as a genetic trait can be of a great significance in crop breeding.

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