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Action of UV-B on *Crepis capillaris* (L.) Wallr. plants in controlled environmental conditions

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30-day-old *Crepis capillaris* plants were irradiated with physiologically realistic UV-B doses in the range of 0–9 kJ m^{-2} d^{-1} for 5 days in growth chambers of two different places.

Unexpectedly, a significant effect on plant growth (expressed in fresh and dry plant weight, leaf area), superoxide dismutase (SOD) activity and protein content in the leaves was exerted by irradiation with even the lowest (1 kJ m^{-2} d^{-1}) UV-B dose, but there was no effect on plant pigments (carotinoids, chlorophyll a and b). The higher doses, 5 kJ m^{-2} d^{-1} and more, showed an inhibitory effect on plant growth, protein content in leaves, but increased SOD activity per protein mass unit. The observed effects depended to various extent on the conditions in the growth chambers in which the plants were irradiated.

Conclusion: even realistic physiological UV-B doses act not on a single but on many quantitative genes, and UV-B effects depend on the conditions of irradiation in the growth chambers.

Key words: UV-B, realistic physiological doses, different conditions, SOD activity, effect on growth, protein content, plant pigments

INTRODUCTION

The action of solar UV-B (280–320 nm) on plant genome and physiological functions is of high interest and actuality [1–3]. However, local weather conditions, solar zenith angle and latitude, as well as reflectivity (*i.e.* clouds and aerosol) show a very strong effect on the doses actually received by plants [4]. Results depend also on a model system used for investigation. Solar UV-B reduces the growth and biomass production of some species. These reductions are typically associated with shorter plants that produce fewer, smaller leaves and have a less total leaf area [5, 6]. A suitable model is the primary leaf of wheat (*Triticum aestivum* L.). If that model was used to examine how an elevated UV-B radiation affects growth, UV-B reduced the proportion of mitotically active cells and increased the time needed for cell division. It decreased also the rate of cell elongation, what was expressed in reduced leaf growth [7]. Cell division and cell expansion both were negatively affected after exposure of 26 populations of white clover (*Trifolium repens* L.) for 18 days to 13.3 kJ m^{-2} d^{-1} UV-B in a controlled environment [8]. Both vegetative and reproductive morphology were altered by UV-B radiation. The crop species (35 crop species published since 1975) exhibited variability in the loss of chlorophyll, changes in biomass/yield [9].

The damage of DNA and disruption of membrane integrity by lipid peroxidation processes are two of the supposed main causes of UV-B induced growth inhibition and genotoxicity in plants [1, 2]. However, results concerning the oxidative stress factors in UV-B induced plant damage are contradictory [10, 11].

For many years in our laboratory the model plant *Crepis capillaris* (L.) Wallr. has been used for investigation of the genotoxicity of solar UV-B alone and in combination with UV-A without or after photoreactivation [12–14]. *C. capillaris* is very suitable for evaluation of the mutagenic agents in the chromosome structure [17], and the mutagenic activity of solar UV-B and UV-A was shown in Vilnius (Lithuania) in natural environmental conditions [12–14]. However, the action of UV-B on *C. capillaris* plant growth and antioxidant systems was not investigated. On the other hand, the action of the environmental conditions has been also shown. It was expressed in variations of the spontaneous and UV-B induced level of chromosome aberrations in different years of *C. capillaris* irradiation [15, 16]. This showed the necessity to examine the action of UV-B on *C. capillaris* in controlled environmental conditions.

Common indices of plant growth (fresh and dry weight, leaf area), concentration of pigments (chlorophyll a and b, carotinoids) are compared with superoxide dismutase (SOD) activity and protein con-

tent in leaves of *C. capillaris* plants preliminary grown for 30 days in the same conditions and then for 5 days brought to different growth chambers in different places: Lithuanian Institute of Horticulture and Vegetables (Babtai, Kaunas district) and Institute of Botany (Vilnius). In both gowth chambers plants were irradiated with physiologically realistic UV-B doses.

MATERIALS AND METHODS

Plant material and growth conditions. Seeds of *Crepis capillaris* (L.) Wallr. were harvested in our laboratory (in conditions of Vilnius). Two separate experiments were made with UV-B irradiation, but for both of them plants had been preliminary grown for 30 days in the same growth chamber at Laboratory of Cell Engineering of the Institute of Botany in controled conditions, thus, conditions for preliminary preparation of plants were the same in both experiments with a 12 /12 h dark cycle (21 °C) in pots filled with soil and irrigated daily with tap water to maintain moist soil. In each pot five plants were grown. For illumination, lamps OSRAM L36/77 Fluora (PAR 53 μm m^{-2} s^{-1}) were used.

UV-B irradiation conditions. For the first experiment, the preliminary grown plants were transferred to the chamber of the Lithuanian Institute of Horticulture and Vegetables (Babtai, Kaunas district, these plants are called LIHV-plants). For the second experiment, plants were left and irradiated with UV-B in the same growth chamber of the Institute of Botany (all conditions of plant growing were the same as for the preminary planting described upper; these plants are called IB-plants). Illumination conditions in Babtai were different from conditions in Vilnius: lamps SON-T Agro, (PAR 100 μm m^{-2} s^{-1}) were used. UV-B irradiation conditions in both growth chambers were about the same. The duration of irradiation was 5 days from noon during the photoperiod with lamps TL 40W/ 12 RS (Philips) in Babtai or TL 40W/ 12 RS (Philips) in Vilnius. The UV-B doses were 0, 1, 3, 5, 7, 9 kJ m^{-2} d^{-1} measured with a VLX-3 radiometer (Vilber-Lourmat, France) equippedd with a 312 nm probe. The beginning of the experiment for Babtai (including preliminary plant growing) was 2 March 2005 and for Vilnius 11 April 2005. Both experiments were made in three repeats. The position of pots was randomised. Plants were examined the next day after UV-B irradiation.

Plant growth measurerements. Leaf area was measured from three plants taken from different places of the pot in each sample. Leaves were scanned and analysed with the Sigma Scan Pro. The same plants were used for the determination of fresh and dry weight.

Concentration of chlorophylls and carotenoids. The concentration of carotinoids and chlorophylls a and b was determined in100% acetone by the method of Wettstein [18] with a spectrophotometer at 662, 644 and 440.5 nm for chlorophyll a, chlorophyll b and carotenoids, respectively.

SOD activity and protein content in leaves. For superoxide dismutase (SOD, EC 1.15. 1.1) activity determination, leaf material (1 g) was grounded with an extraction buffer (2 ml) consisting of 1mM EDTA, 0.1% Triton X-100 in 0.05M Na-K phosphate buffer pH 7.8, with a mortar and pestle at 4 °C. The homogenates were centrifuged for 15 min at 12,000 × g (4 °C), and the supernatants were used as a crude extract for SOD assays and for soluble protein quantification according to Bradford [19] with bovine serum albumin as the standard.

Total SOD activity was assayed by the inhibition of the photochemical reduction of nitro blue tetrazolium (NBT) according to a modified method of Fridovich [20]. The reaction mixture consisted of 50 mM (Na–K) phosphate (pH 7.8), 13 mM methionine, 2 μM riboflavin, 75 μM NBT, 100 nM EDTA and 20 μl of enzyme extract. Each extract was assayed twice and measured with a spectrophotometer at 560 nm. The SOD activity was defined as the amount of enzyme that inhibits NBT and expressed in nM min^{-1} mg^{-1} of protein or in nM min^{-1} g^{-1} f. wt.

Statistical analysis. The position of pots was randomized, and the results are the means of three replications. All determinations made at least in two independent measurements. The statistical data analysis was carried out employing the package of statistical analysis tools of MS Excel 2002 (Microsoft Corporation) program. We considered treatment effects at the $P = 0.05$ level.

RESULTS AND DISCUSSION

In critical reviews and several research works on the genotoxical and physiological action of UV-B on plants it is emphasized that in many works the relative significance of UV-B on growth inhibition and different types of the molecular damage has not been established in experiments carried out under realistic physiological conditions, *i.e.* the UV-B doses used were significantly higher than those affecting plants in natural outdoor conditions [3, 9, 11].

We examined the UV-B effect on 30-day-old *Crepis capillaris* plants in the range of doses 0–9 kJ m^{-2} d^{-1}, and the duration of UV-B action was only 5 days. This range of doses includes the realistic intensity of UV-B irradiation in the outdoor conditions.

Unexpectedly, a strong inhibition of plant growth, expressed in a decrease of fresh or dry plant weight, was observed even after irradiation with the lowest, 1 kJ m^{-2} d^{-1} UV-B, dose (Fig. 1A). This dose falls in the interval of realistic physiological conditions [11].

In the range of UV-B doses 5–9 kJ m^{-2} d^{-1}, another phenomenon, desiccation of plant mass, was observed. It was expressed in a relative increase of the dry weight : fresh weight ratio (Fig. 1B). Plant mass desiccation

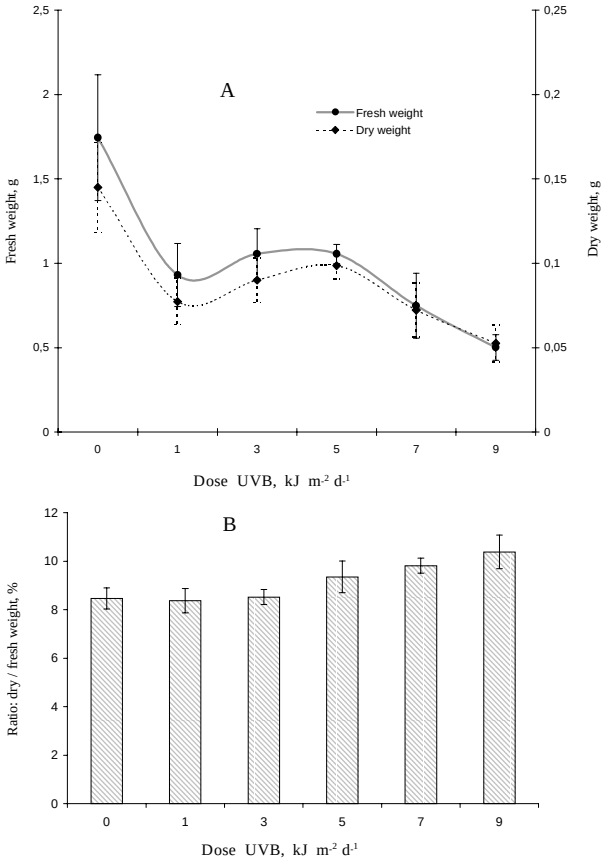

Fig. 1. Action of different UV-B doses on leaf area of *Crepis capillaris* plants:

Exp. 1– at the Lithuanian Institute of Horticulture and Vegetables (LIHV, Babtai); Exp. 2 – at the Institute of Botany (IB, Vilnius)

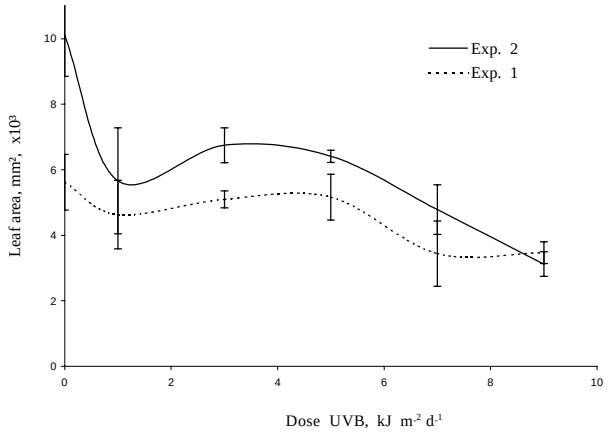

Fig. 2. Fresh and dry weight (A) and ratio: fresh/dry weight (B) of *Crepis capillaris* plants irradiated with different UV-B doses:

UV-B irradiation at the Institute of Botany (IB)

was in agreement with the results of Hofmann et al. [8] who showed that the ecotypes of white clover (*Trifolium repens* L.) adapted to drought also contribute to a decreased UV-B sensititivity to drought. A conclusion is made that the natural adaptation of plants to stress such as drought can provide UV-B tolerance [8]. The opposite relation is also realistic. Adaptation to UV-B can increase resistance to drought, and both responses have a common interrelationship. Drought-induced cross-tolerance to UV-B stress was also shown in transgenic tobacco plants [21].

Growth inhibition at the whole plant level is frequently correlated with reduced leaf area expansion, which appears to be more sensitive to UV-B than photosynthesis per unit leaf area or net assimilation rate [10, 11]. This conclusion about the leaf area as well the sign of plant reaction to UV-B was also partly confirmed by results of our investigations (Fig. 2). We did not observe the curling effect, which is regarded as a photomorphogenic response that helps diminish the leaf area exposed to UV, but same effect gives the reduction of leaf area observed in our work and in works of the other investigators [6, 22, 23]. However, the UV-B effect on leaf area and total biomass depends on plant species. Monocots with reduced plant area and specific leaf disposition appear to be generally more resistant to UV-B than dicots [3]. UV-B irradiation in barley causes leaf elongation and tiller production. The effects depend on plant genotype [24]. Increase in branch and tiller production is also one of the plant responses to UV-B [6].

There is another group of plant species, in which the response to UV-B is contrary to that in plant species of the first group. In contrast to the first group of plants, an increase in plant growth and total biomass as well as elongation of leaf area are characteristic of UV-B response of these plant species after irradiation with elevated UV-B doses. The upper leaves of such plants serve as a screen from UV-B rays [25, 26].

Crepis capillaris belongs to the first group, because its leaf area decreased even after UV-B irradiation with the lowest 1 kJ m^{-2} d^{-1} dose (Fig. 2). *C. capillaris* is a very sensitive plant according to that sign, in contrast, for instance, to cotton (*Gossypium hirsutum* L.) whose leaf area of the plants treated with 8 kJ m^{-2} d^{-1} did not differ from that of the control plants. Only plants treated with 16 kJ m^{-2} d^{-1} UV-B had a 47 to 50% smaller leaf area than the control [27].

Dose dependence of UV-B effects on leaf area is in full agreement with the plant growth dependence on UV-B doses (*cf.* Figs. 1 and 2), showing that only the leaf area parameter alone may be used for expression of the UV-B dose–effect relations in *C. capillaris* plants. This conclusion is supported by a comparison of the results of UV-B dose relations in the two different growth chambers – those of the Lithuanian Institute of Horticulture and Vegetables (Babtai, Kaunas district) and of the Institute of Botany (Vilnius). Differences in the results obtained in these growth chambers concerned the absolute leaf area parameters, but not the curve of the UV-B dose relations (Fig. 2). As on plant weight, a strong effect on the leaf area was shown the by lowest 1 kJ m^{-2} d^{-1} UV-B dose. This means that the high effectivity of 1 kJ m^{-2} d^{-1} UV-B dose is not accidental.

Visual symptoms such as chlorotic or necrotic patches on leaves, leaf curling, glazing or bronzing of a whole plant or separate leaves exposed to UV-B are not unique [9, 22, 28–30] but depend on plant species [23]. We did not observe such visual symptoms in a whole plant or leaves in the range of UV-B doses tested. Only plants had longer but narrower leaves after exposure to UV-B doses higher than 5 kJ m^{-2} d^{-1}. This fact has confirmed once more that in our work realistic physiological UV-B doses were used. The doses discussed, *e.g.*, in the review of Kakani et al. [9] were significantly wider, varying within 0–50 kJ m^{-2} d^{-1}. The conclusion regarding the doses used in our work is supported by a direct investigation of plant pigments such as chlorophylls a and b, carotinoids (Fig. 3 and Table).

The concentration of carotinoids in leaves was about the same in the range of all UV-B doses tested in both experiments – at the Institute of Botany (IB) and the Lithuanian Institute of Horticulture and Vegetables (LIHV) (*cf.* A and B parts in Fig. 3).

More significant differences between both experiments have been observed as regards the concentration of chlorophylls a and b separately (Table) or of the sum (a + b) (Fig. 3). Even in leaves of control plants untreated with UV-B, the concentrations of chlorophyl a, b and the sum (a + b) was about 1.7 times higher in leaves of IB (Fig. 3B) than in LIHV (Fig. 3A) experiments.

A decrease of chlorophyll concentration in the leaves of plants after UV-B exposure is also a frequent phenomenon for various plant species, but to a different extent. For 35 crop species the decrease was within 10–70% [9]. In the present work, a very slight decrease (about 8%) in chlorophyll sum (a+b) has been observed only if the plants were irradiated with 3 kJ m^{-2} d^{-1} UV-B (Fig. 3B). An opposite effect was observed in both experiments when plants were irradiated with 5 kJ m^{-2} d^{-1} UV-B. The sum of chlorophylls (a + b) was higher in comparison with control plants. That increase was more pronounced in the LIHV-plants (by 60%), while in leaves of the IB-plants it reached only 12–13%. We have supposed the observed increase in chlorophyll a and b content to be one of the initial manifestations of the

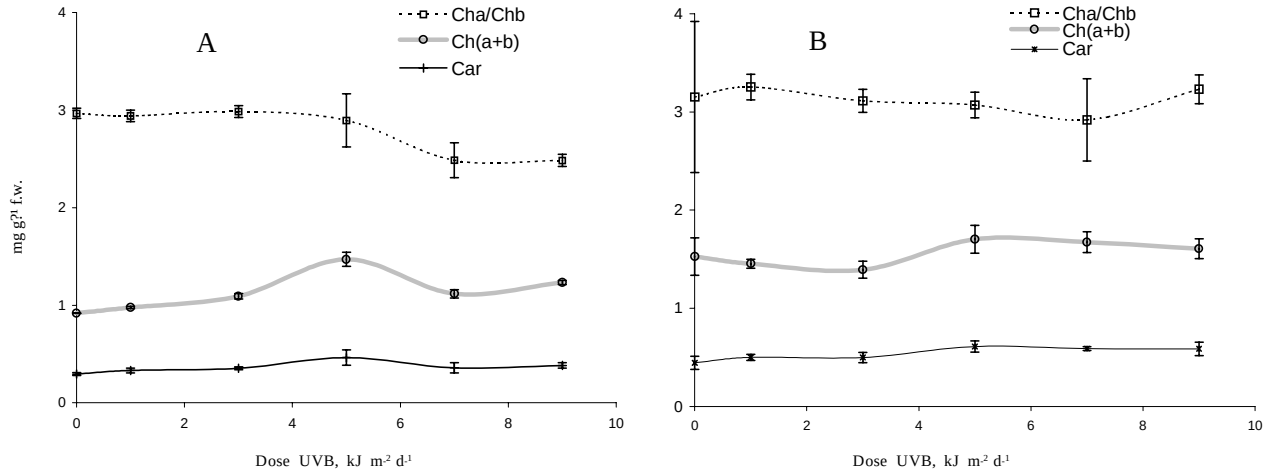

Fig. 3. Carotinoids and chlorophyll sum (a+b) concentrations and chlorophyll a/b ratio in leaves of *Crepis capillaris* plants exposed to diferrent UV-B doses:

A – at the Lithuanian Institute of Horticulture and Vegetables (LIHV, Babtai); B – at the Institute of Botany (IB, Vilnius); Cha/Chb – chlorophyll a / chlorophyll b ratio; Ch (a + b) – sum of chlorophylls (a + b); Car – carotinoids

Table. **Chlorophyll a and b content in leaves of *Crepis capillaris* (L.) Wallr. plants irradiated with different UV-B doses. Comparison of plants irradiated in different growth chambers**

UV-B dose kJ m^{-2} d^{-1}	Chlorophyll a		Chlorophyll b	
	mg/g fresh weight			
	IB[1]	LIHV[2]	IB[1]	LIHV[2]
0	1.137 ± 0.130	0.687 ± 0.203	0.388 ± 0.100	0.231 ± 0.051
1	1.111 ± 0.028	0.729 ± 0.201	0.342 ± 0.019	0.248 ± 0.054
3	1.054 ± 0.074	0.816 ± 0.172	0.338 ± 0.013	0.277 ± 0.034
5	1.285 ± 0.115	1.092 ± 0.067	0.418 ± 0.029	0.378 ± 0.201
7	1.235 ± 0.033	0.799 ± 0.113	0.438 ± 0.079	0.319 ± 0.136
9	1.227 ± 0.090	0.876 ± 0.291	0.379 ± 0.012	0.357 ± 0.069

Irradiation with UV-B: 1 (IB) – at the Institute of Botany (Vilnius); 2 (LIHV) – at the Lithuanian Institute of Horticulture and Vegetables (Babtai, Kaunas distr.).

plant response to elevated doses of UV-B, and the 5 KJ m^{-2} d^{-1} dose means the borderline of that response in our experiments. The differences between the plant species in the response according to plant pigment concentration after UV-B exposure [1, 26, 27, 29–32] allow us to suppose that the borderline of response to UV-B for various plant species is different and must be determined experimentally, but the situation is complicated by the intraspecial differences in the genotypes and environmental conditions [33].

Induction of Reactive Oxygen Species (ROS) is a common feature of many stress-inducing factors. ROS induction has been also observed after UV-B irradiation of plants [1, 2, 21, 22, 32, 34–38]. As a response to elevated ROS concentrations induced by UV-B, the antioxidant systems, including ROS-inactivating enzymes such as catalase, ascorbate peroxidase [32, 35], are activated. However, the effect of UV-B on SOD activity is contradictory [24, 36–41], and there are numerous reasons, such as plant species, doses above the realistic ones *versus* those physiologically realistic, different environmental conditions may determine variations in SOD activity after UV-B exposure.

The effect of UV-B irradiation on SOD activity in plants clearly depends on the UV-B dose used and more slightly on the mode of SOD activity expression. SOD activity in *C. capillaris* leaves has been expressed in two modes (to fresh weight (Fig. 4A) or to protein (Fig. 4B) mass units), and the LIHV- and IB-plants were compared. Similarly to the concentration of pigments, in leaves of the control UV-B untreated IB-plants SOD activity was higher than in leaves of LIHV-plants. However, after irradiation with a 1 kJ m^{-2} d^{-1} UV-B dose this difference between IB- and LIHV-plants disappeared. Indeed, from the point of statistical evaluation the difference between LIHV- and IB-plants was absent in the whole range of UV-B doses used, with one exception – 5 kJ m^{-2} d^{-1}, if SOD activity was expressed to protein mass unit (Fig. 4B). The lower (1–3 kJ m^{-2} d^{-1}) doses decreased SOD activity in IB-plants, while in the LIHV-plants in the range of the same doses a slight increase in SOD activity was observed. Such activation is especially obvious for LIHV-plants in conditions of a more intensive UV-B irradiation (within 5–9 kJ m^{-2} d^{-1}). In leaves of UV-B plants, a significant increase in SOD activity was observed only after irradiation with 5–7 kJ m^{-2} d^{-1} if SOD activity was expressed to a FW unit. SOD activity in leaves of IB-plants was of the same level as in control plants. When SOD activity was expressed to a protein mass unit, the inhibiting effect was observed in leaves of IB-plants after irradiation with 1–3 kJ m^{-2} d^{-1} doses. Only after irradiation with 9 kJ m^{-2} d^{-1} UV-B, the SOD activity in leaves of these plants once more reached the control level, and that phenomenon was observed independently of the SOD activity expression mode – either to FW or to protein mass units (*ef.* Fig. 4A and B).

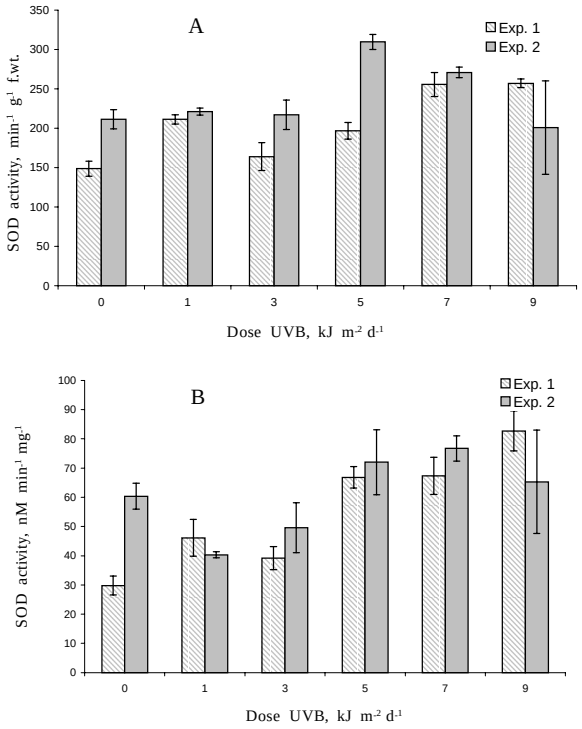

Fig. 4. SOD activity in leaves of *Crepis capillaris* plants exposed to different UV-B doses:

A – activity of SOD expressed in nM to fresh weight; B – activity of SOD expressed in nM to protein; Exp. 1 – at the Lithuanian Institute of Horticulture and Vegetables (LIHV, Babtai); Exp. 2 – at the Institute of Botany (IB, Vilnius)

Our experiments actually show that one of the reasons for the contradictory results regarding SOD activity after UV-B irradiation is a different reaction of the same species plants of nearly identical genotypes to not very significantly but still varying environmental conditions in the different growth chambers. The different interval of UV-B doses used in the discussed works [24, 36–41] had also a decisive role. It was demonstrated also in our work.

The differences between LIHV- and IB-plants were also fixed according to protein content in fresh leaves of UV-B unirradiated plants, but they disappeared after irradiation with UV-B in the interval of 3–9 kJ m^{-2} d^{-1} doses or remained statistically insignificant (Fig. 5).

Protein content in leaves may indirectly show gene activity in response to UV-B irradiation, especially in the case when protein content is increasing. Therefore determination of protein content in leaves of LIHV- and IB-plants had not only an auxiliary role for expression of SOD activity, but also was of decisive significance for comments about response to UV-B in general.

The differences in LIHV- and IB-plants are obvious. Protein content in leaves of LIHV-plants irradiated with all the UV-B doses tested did not reach the level of protein content in leaves of the control

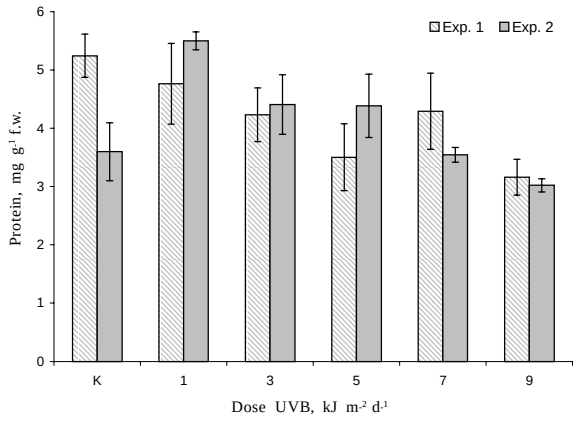

Fig. 5. Protein content in leaves of *Crepis capillaris* plants exposed to different UV-B doses:

Exp. 1. – at the Lithuanian Institute of Horticulture and Vegetables (LIHV, Babtai); Exp. 2. – at the Institute of Botany (IB, Vilnius)

plants. A decrease in protein content is especially obvious after irradiation of LIHV-plants with the highest, 9 kJ m^{-2} d^{-1}, UV-B dose (Fig. 5). However, decrease in protein content (contrary to increase) does not give an unambiguous answer as regards the mechanism of the observed phenomenon. Equally, either inhibition of new protein synthesis or destruction of the already synthesized proteins may take place, or both.

As to IB-plants, an opposite relation has been observed. The low level of protein content in control IB-plants does not allow to show a negative effect of UV-B rays on protein content. Even after irradiation with 9 kJ m^{-2} d^{-1} UV-B, the protein content became equal to its level in level control IB-plants.

At the same time, this situation allows us to show activation of genes in response to UV-B irradiation. It is expressed by an increased protein synthesis. Of course, it is necessary to keep in mind that two opposite and overlapping processes can take place after UV-B irradiation: synthesis of the new proteins as a response to UV-B and, on the other hand, protein destruction caused by the same UV-B dose.

As for the other features of the plants, our attention was attracted by the action of the lowest, 1 kJ m^{-2} d^{-1}, UV-B dose on protein content in leaves of IB-plants. That UV-B dose yet attracted our attention by the unexpectedly significant decrease in plant weight (Fig. 1) and leaf area (Fig. 2). These effects were observed in both groups of plants, but in distinct extent. On the other hand, despite of the strong effect of the 1 kJ m^{-2} d^{-1} UV-B on plant growth, that UV-B dose did not have any effect on concentrations of carotinoids or chlorophylls a and b (Fig. 3 and Table). Why to SOD activity, the action of 1 kJ m^{-2} d^{-1} UV-B was contradictory. It depended on the growth chamber conditions under which the plants were irradiated with UV-B and on the mode of SOD activity expression. In the leaves of LIHV-plants SOD was activated, while in the IB-plants SOD activity was unaltered if its activity was expressed to a FW unit or decreased if expressed to a protein mass unit (Fig. 4). The opposite conclusion was made about protein content in leaves of *C. capillaris* plants irradiated with a 1 kJ m^{-2} d^{-1} UV-B dose. Protein content increased significantly in the IB-plants, while in the LIHV-plants it was of the same level as in leaves of the control, UV-B unirradiated, plants (Fig. 5).

This 1 kJ m^{-2} d^{-1} UV-B dose attracted so much attention because it has clearly shown that even very low UV-B doses can have a significant effect on gene expression. Increase in protein content undoubtedly shows an activation of gene expression and protein synthesis after exposure to that low UV-B dose. Our results are in agreement with the conclusion of A-H-Mackerness et al. [42] about the regulatory role of UV-B in gene expression.

On the other hand, it may also explain the contradictory results observed in diferrent plants on their growth and especially on SOD activity. In several works, a decrease in SOD activity was observed after UV-B irradiation [24, 36] even in cases when activity of the other protective antioxidant enzymes such as catalase, glutathione dehydrogenase and guaiacol peroxidase increased [36]. Supplementary UV-B caused a decrease of mRNA in chloroplastic Cu/Zn-SOD [41]. Analysis of the action of the 1 kJ m^{-2} d^{-1} UV-B dose shows why conclusions depend on the environmental conditions of plant irradiation.

Our results show the relative nature of the general conclusions regarding UV-B action on plants on the whole. They depend on plant species, genotype and varying environmental conditions, especially of plant UV-B irradiation, even in controlled conditions of the growth chambers which in various works have different characteristics. Close to our conclusion are the results of Zu et al. [40] who showed a different reaction of 20 soybean cultivars to enhanced UV-B radiation according to SOD activity: its activity in ten cultivars was significantly increased, while in six other cultivars it was, also significantly, decreased. This situation could be resolved by standardization of UV-B irradiation conditions [3, 43].

The other general conclusion which can be made from our work is that even realistic physiological UV-B doses act as environmental regulators of gene expression, and they regulate not a single gene or gene group, but numerous genes determining different quantitative traits. This conclusion is in agreement with the view of A-H-Mackerness et al. [42] and Brosche and Strid [44] that exposure of plants to UV-B radiation (280–320 nm) results in changes in the expression of a large number of genes.

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UV-B POVEIKIS *CREPIS CAPILLARIS* (L.) WALLR. KONTROLIUOJAMOMIS SÀLYGOMIS

Santrauka

Mënesio amþiaus þalioji kreisvë (*C. capillaris*) apðvitinta realiai fiziologinëmis UV-B dozëmis – tarp 0 ir 9 kJ m^{-2} d^{-1}. Atlikti du eksperimentai, kuriø metu augalai ðvitinti skirtinguose fitotronuose – Lietuvos sodininkystës ir darþininkystës instituto bei Botanikos instituto. Iðtirtas UV-B poveikis augalø þaliajai ir sausajai biomasei, lapø plotui, pigmentø (karotinoidø, chlorofilø a ir b) kiekiui, superoksido dismutazës (SOD) aktyvumui ir baltymø kiekiui augalø lapuose.

Nustatyta, kad net nedidelës UV-B dozës, kaip antai 1 kJ m^{-2} d^{-1}, labai paveikia augalø augimà, SOD aktyvumà ir baltymø kieká lapuose, taip pat genø, lemianèiø kiekybinius poþymius, raiðkà. Rezultatams turi átakos ir augalø apðvitos UV-B spinduliais sàlygos skirtinguose fitotronuose.