DIFFERENCES IN PHYSIOLOGICAL AND MORPHOLOGICAL PARAMETERS OF TWO POTATO CULTIVARS DIFFERING IN TOLERANCE TO SOIL DROUGHT

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Introduction:

Global climate change in the form of extreme heat and drought poses a major challenge to sustainable crop production by negatively affecting plant performance and crop yield. Potatoes require a cool growing season with an average daily temperature of 15–18◦C temperatures above 21◦C have adverse effects on growth. The optimal tuber yield for most commercial potato varieties is produced when potato plants are grown at average day temperatures between 14 and 22 ◦C. The susceptibility of potato crops to high temperatures largely depends on the genotype, development stage, and stress duration; tuber initiation and bulking are the most critical stages. In potato plants, the minimum night temperature plays a crucial role during tuberization, which is reduced at the night temperatures above 20◦C with complete inhibition above 25◦C.

Matherial and methods:

The experiment involved analysis of selected morphological, physiological and anatomical parameters related to the photosynthetic efficiency of plants in order to assess the level of tolerance to stress: drought and high temperature in the tested potato genotypes. The study was conducted on 2 potato varieties with extreme tolerance to soil drought. Denar –resistant genotype to soil drought and Lenka – sensitive genotype to water shortages. After growing in optimal conditions during the tuberization period, the plants were subjected to soil drought and high temperature stress in 4 experimental variants: (1) watered plants, growing in optimal temperature conditions (21°C, control), (2) unwatered plants, growing in optimal temperature conditions (21°C, drought), (3) watered plants and subjected to high temperature (38°C) and (4) unwatered plants and subjected to high temperature (38°C, drought).

Among the morphological and physiological parameters: the ratio of leaves to stems, the assimilation area, the mass of leaves, the mass of stems, the greenness of leaves SPAD, the rate of wilting was assessed. The parameters of the quantity and quality of the yield were also assessed.

The analysis of the anatomical structure concerned 4 parameters such as: leaf thickness, the epiderma thickness, the palisade and spongy mesophyll thickness. In order to prepare microscopic preparations with cross-sections of leaves, the "freezing" technique and a cryostat type device were used. Microscopic observations were carried out in a light microscope (Olympus).

Results:

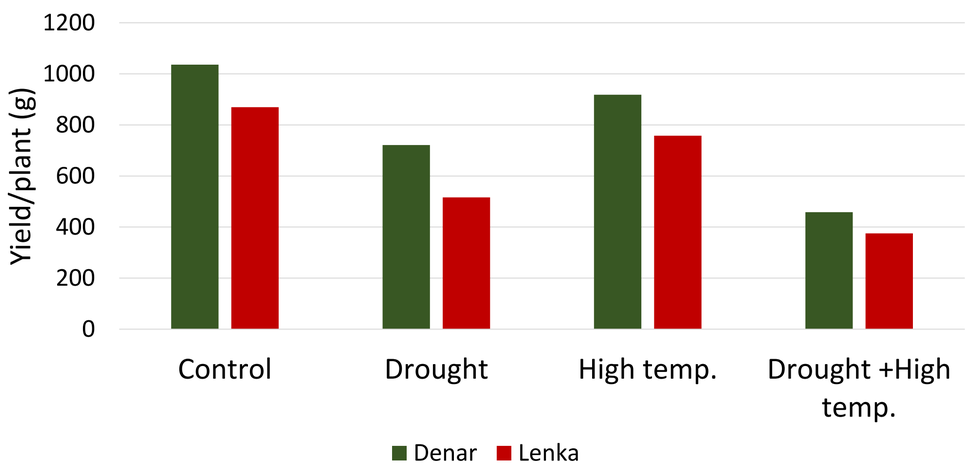


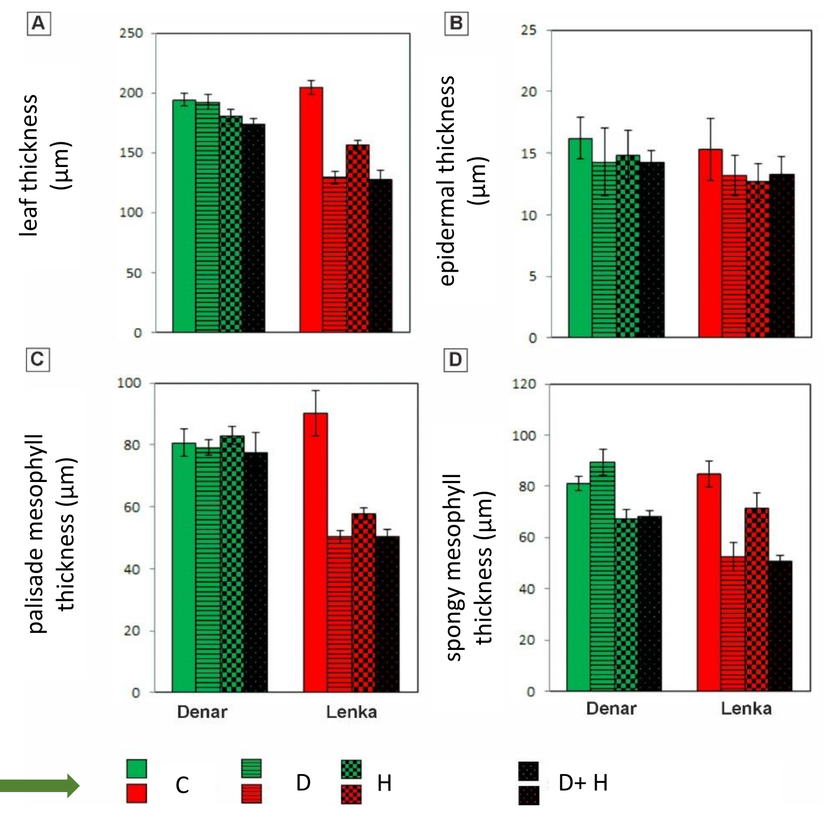
Fig. 1. Changes of potato yield (g/plant) of cultivars growing under optimal conditions (C), soil drought (D), high temperature (H), and combine soil drought and high temperature conditions (D+H).

Cultivar	treatment	RWC	LAI	Fv/fm	PI_{ABS}
Denr	Control	88,2	0,66	0,82	7,11
	Drought	56,3	0,44	0,82	5,17
	High temp.	88,8	1,00	0,74	2,5
	Drought and High temp.	45,9	0,39	0,69	0,31
Lenka	Control	85,9	2,67	0,82	4,2
	Drought	48,0	0,66	0,78	3,0
	High temp.	84,0	0,89	0,77	1,8
	Drought and High temp.	45,2	0,39	0,75	1,0

Fig. 2. Changes of morphological and physiological parameters (Relative Water Content – RWC; Leaf Area Index – LAI, chlorophyl fluorescence parameters: Fv/Fm; PI_{ABS}) of potato cultivars growing under optimal conditions (C), soil drought (D), high temperature (H), and combine soil drought and high temperature conditions (D+H).

The observed changes in anatomical structure and physiological parameters confirm the varied level of tolerance to drought and high temperature stress in the tested potato varieties.

Fig.3. Changes in anatomical parameters: leaf thickness (A), epidermal thickness (B), palisade (C) and spongy mesophyll thickness (D) in leaves of two potato cultivars: Denar (resistant) and Lenka (sensitive) under conditions of soil drought and high temperature (38 °C).



Optimal conditions (C), soil drought (D), high temperature (H), and combine soil drought and high temperature conditions (D+H)

Denar

Lenka

Potato plants after two weeks of drought

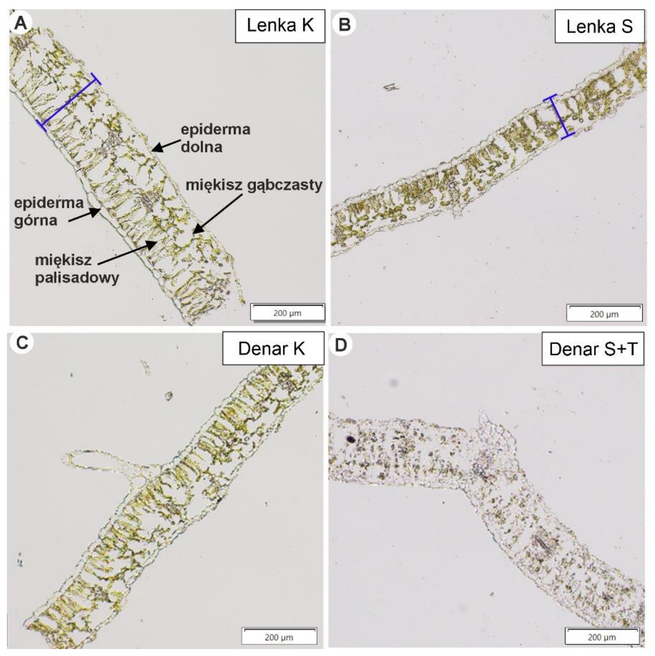


Fig. 4. Analysis of the anatomical structure of potato leaves under drought and high temperature conditions