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Leaf Physiological Properties of Pepper and Potato Crops

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Abstract: This study examines the physiological properties of pepper and potato leaves, including leaf thickness and number of stomata per 1 mm². Soil temperature at depths of 10 and 20 cm, air temperature and mean values of transpiration (*Tr*) for the period 5 July 2008 – 15 September 2008 were also monitored.

The obtained results suggest the following:

Leaf thickness was far greater in potato (171.82 μm) than in pepper (140.0 μm). The number of stomata per 1 mm² was also considerably greater in potato (241.6) than in pepper (184.1).

The highest mean daily transpiration rates of 10.92 mg g⁻¹ min⁻¹ in pepper and 11.23 mg g⁻¹ min⁻¹ in potato were recorded on 3 August 2008 and 23 August 2008, respectively, indicating a high intensity of transpiration.

Key words: pepper, potato, temperature, stomata, transpiration.

Introduction

Vegetable production involves cultivation of a wide range of species and cultivars. Findings of many different studies contribute to improvements in cultural operations, plant nutrition and, hence, yield quality.

The most important plant organ where organic matter is synthesized is the leaf. The structure of the leaf is adapted to its photosynthetic and transpiration functions. As a part of the shoot, the leaf is essential in plant nutrition. Increased yields of vegetable crops are affected not only by species, cultivar, climate and soil, but also by water relations. Water relations refer to water uptake by the plant and water loss (transpiration). Water release via transpiration and, accordingly, the intensity of transpiration, are dependent on species, cultivar, number of stomata, leaf,

and environmental factors (Stalfelt 1956, Bejdeman 1975, Kušnirenko 1975, Du-bravec *et al.* 1985). Therefore, this study focused on monitoring the above parameters in the leaves of pepper cultivar *Palanačko Čudo* and potato cultivar *Kondor*.

Material and Methods

The objective of this study was to study the leaf transpiration dynamics and its dependence on an environmental factor – soil temperature - in pepper cv. *Palanačko Čudo* and potato cv. *Kondor*, grown at the Kukići location (Municipality of Čačak).

The trial was established on vertisol (Table 1) where appropriate cultural operations were employed. The soil was slightly acid, with a medium phosphorus supply and a high content of available calcium, the said properties making the soil highly suitable for crop production.

Tab. 1. Main agrochemical properties of vertisol

Soil type	pH/nKCl	Humus (%)	Total nitrogen (%)	P ₂ O ₅ mg/100 g soil	K ₂ O
Vertisol	5.65	2.64	0.14	10.3	35.2

Leaf transpiration rates in pepper and potato were evaluated during the period 5 July 2008 - 15 September 2008 by the Stocker mathematical method (Stocker 1929). The transpiration rates were expressed as mg of evaporated (transpired) water per 1 gr of fresh weight of leaf per 1 minute ($\text{mg g}^{-1} \text{min}^{-1}$). The measurements were conducted using an analytical balance from 7 a.m. to 7 p.m. at two-hour intervals. Mercury thermometer was used to measure air temperature and soil temperature at depths of 10 cm and 20 cm.

Given the high importance of stomata for transpiration, their number was evaluated in both crops, using the infiltration method (96% alcohol and xylol).

Results and Discussion

The measured values for air temperature and soil temperature at depths of 10 cm and 20 cm are given in Table 2.

The lowest soil temperatures were 15.0°C at a depth of 10 cm – measured at 7 p.m. on 15 September 2008 – and 14.5°C at a depth of 20 cm, measured at 7 a.m. on 15 September 2008.

The highest soil temperature at a depth of 10 cm - 25.0°C - was measured at 3 p.m. on 3 August 2008 and that at a depth of 20 cm – 23.5°C – at 1 p.m. on 23 August 2008.

Air temperatures ranged from 13.1°C (7 a.m. – 15 September 2008) to 32.6°C (3 p.m., 23 August 2008).

Tab. 2. Air and soil temperatures

Date and time of measurement	Air temperature °C	Soil temperature °C	
		at a depth of 10 cm	at a depth of 20 cm
5 July 2008			
7 a.m.	14.0	16.4	17.1
9 a.m.	16.8	16.8	18.2
11 a.m.	23.4	18.1	20.3
1 p.m.	26.1	18.5	20.4
3 p.m.	28.6	18.5	20.0
5 p.m.	24.3	19.1	19.8
7 p.m.	22.0	19.0	19.7
	$\bar{X} = 22.17$	$\bar{X} = 18.057$	$\bar{X} = 16.5$
3 August 2008			
7 a.m.	20.2	19.8	19.2
9 a.m.	21.0	22.3	21.0
11 a.m.	25.2	24.0	23.2
1 p.m.	21.4	24.3	23.2
3 p.m.	31.0	25.0	22.0
5 p.m.	24.0	21.0	19.2
7 p.m.	20.1	19.3	18.2
	$\bar{X} = 24.13$	$\bar{X} = 22.24$	$\bar{X} = 18.26$
23 August 2008			
7 a.m.	19.1	20.0	19.6
9 a.m.	24.2	21.2	10.0
11 a.m.	19.1	24.7	22.1
1 p.m.	32.6	24.9	23.5
3 p.m.	30.0	23.6	20.7
5 p.m.	23.1	23.6	20.1
7 p.m.	20.2	22.0	19.3
	$\bar{X} = 25.47$	$\bar{X} = 20.23$	$\bar{X} = 20.76$
15 September 2008			
7 a.m.	13.1	15.2	14.5
9 a.m.	20.0	17.0	16.8
11 a.m.	25.3	17.2	17.0
1 p.m.	27.8	19.3	18.2
3 p.m.	27.3	19.8	19.0
5 p.m.	25.0	16.0	16.2
7 p.m.	22.0	15.0	15.7
	$\bar{X} = 22.93$	$\bar{X} = 17.07$	$\bar{X} = 16.77$

Mean values of leaf thickness and the number of stomata per unit area of 1 mm² are given in Table 3.

Tab. 3. Average leaf thickness and number of stomata

Species	Leaf thickness	Number of stomata per 1 mm ² – leaf backside
Pepper	140.0	184.1
Potato	171.82	241.6

Leaf thickness and number of stomata per 1 mm² were much greater in potato than in pepper.

The dynamics of daily leaf transpiration is given in Table 4.

Tab. 4. The dynamics of daily leaf transpiration as expressed in mg/g/min in vegetable crops grown at the Kukići location

Measurement date	Transpiration rate mg g ⁻¹ min ⁻¹							Mean daily <i>Tr</i> mg g ⁻¹ min ⁻¹
	7 a.m.	9 a.m.	11a.m.	1 p.m.	3p.m.	5 p.m.	7 p.m.	
Pepper								
a=5 Jul 2008	5.00	7.2	6.31	7.21	7.00	6.20	5.40	6.33
b=3 Aug. 2008	6.30	8.41	18.00	17.00	11.31	8.41	7.00	10.92
c=23 Aug. 2008	4.10	10.22	15.11	10.41	13.20	6.51	5.40	9.28
d=15 Sep. 2008	5.51	3.91	5.90	7.82	7.10	4.00	5.00	5.61
Potato								
a=5 Jul 2008	6.11	18.4	18.00	10.00	5.20	2.20	2.00	8.84
b=3 Aug. 2008	16.70	14.80	16.10	6.20	8.10	5.10	3.10	10.14
c=23 Aug. 2008	3.10	8.20	17.70	15.90	12.10	13.40	8.20	11.23
d=15 Sep. 2008	0.00	11.44	11.00	5.00	6.10	6.21	6.80	6.69

Table 4 shows higher variations in daily leaf transpiration rates in pepper than in potato. Mean daily transpiration rates indicate that the highest mean value (10.92 mg/g/min) was recorded on 3 August 2008, and the lowest (5.61 mg/g/min) on 15 September 2009. The findings were as expected, given the plant development phenophase. In view of the fact that water uptake is directly associated with transpiration, the obtained results showing the water uptake by peppers to be highest between 12 a.m. and 3 p.m. suggested that the transpiration rate was also highest during the period, which conformed to the results of Gvozdenović and Takač (2004).

On 23 August 2008, mean daily transpiration rates ranged from 6.69 to 11.23 mg/g/min.

In the early morning hours of 15 September 2008, the measured transpiration rate was 0.0, indicating that no transpiration occurred during the night.

Conclusion

The obtained results suggest the following:

Leaf thickness was far greater in potato (171.82 μ) than in pepper (140.0 μ). Likewise, the number of stomata per 1 mm² was much higher in potato (241.6) than in pepper (184.1).

The highest mean daily transpiration rate of 10.92 mg/g/min in pepper was recorded on 3 August 2008 and that of 11.23 mg/g/min in potato on 23 August 2008, suggesting a high transpiration intensity.

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FIZIOLOŠKA SVOJSTVA LISTOVA PAPRIKE I KROMPIRA

- prethodno saopštenje -

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Rezime

U radu su prikazana fiziološka svojstva listova paprike i krompira. Praćena je debljina lista, broj stoma na 1mm^2 , temperatura zemljišta (na 10 i 20 cm) i temperatura vazduha, a sve u funkciji određivanja srednje vrednosti transpiracije za period 05.07.2008. - 15.09.2008. godine.

Na osnovu dobijenih rezultata može se konstatovati da je debljina lista kod krompira ($171,82\text{ }\mu\text{m}$) značajno veća nego kod paprike ($140,0\text{ }\mu\text{m}$). Ista konstatacija važi i za broj stoma po 1mm^2 i kod krompira iznosi 241,6 odnosno kod paprike 184,1.

Najveća srednja dnevna vrednost transpiracije u iznosu od $10,92\text{ mg g}^{-1}\text{ min}^{-1}$ je konstatovana 03.08.2008. godine kod paprike, odnosno 23.08.2008. u iznosu od $11,23\text{ mg g}^{-1}\text{ min}^{-1}$ kod krompira, što ukazuje na njen visoko izraženi intenzitet.