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**PHYSIOLOGICAL RESPONSE OF STRAWBERRY
(*Fragaria ananassa* Duch.) TO FOLIAR APPLICATION
OF POTASSIUM AND SILICON FERTILIZER**

**REAKCJA FIZJOLOGICZNA TRUSKAWKI (*Fragaria ananassa* Duch.)
NA DOLISTNE NAWOŻENIE POTASOWO-KRZEMOWE**

Abstract: The aim of the performed studies was to assess the physiological reaction of two cultivars of strawberry to foliar application of potassium-silicon fertilizer. In 2005–2006 at the Experimental station of Orchard Department, University of Agriculture in Szczecin in Rajkowo (a locality near Szczecin), a two-factor vegetation experiment in the system of random blocks was carried out in three replications. The experimental factor was foliar application of potassium Alkaline with silicon (variant I – with fertilization, variant II – control, spraying with distilled water). Strawberry Senga–Sengana c.v. was chosen as biological material for the studies. The following gas exchange parameters of the investigated variety were determined: assimilation rate of CO₂, transpiration rate, index of water use efficiency in the photosynthesis.

Keywords: *Fragaria ananassa* Duch., potassium alkaline with silicon, assimilation, transpiration

Poland belongs to the leading strawberry growers. Along with growing popularity of the cultivation of these plants, the demand for their quality also increases. The quantity and quality of the yield are, to a large extent, determined by an appropriate supply of nutritive components and water to the plants. Foliar nutrition, being supplementation of traditional fertilization, is more and more often applied to strawberry growing. This way of supplying these elements to a plant may then result in obtaining stable yields of high quality [1].

The applied potassium Alkaline with silicon is a source of potassium and silicon, it is characterized by an alkaline reaction that has a favourable influence on limiting mainly fungous diseases. Productivity of plants is mainly dependent on their photosynthetic activity. The intensity of physiological processes in plants is mainly determined by genetic properties, but it can be modified by such factors as temperature and light intensity,

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availability of mineral components and the supply of water [2–5]. Potassium is an indispensable element directly affecting water management of plants. It affects the size and firmness of strawberry fruit. Whereas silicon, despite the fact that it does not belong to the group of indispensable elements, according to some authors, has a favourable effect on plant health, stable ion balance, biomass production and transpiration rate limitation. In plants this element is found in the cells of epidermis, sclerenchyma, mesophyll and xylem, mainly in the cell walls [6, 7]. It is believed that the potassium silicon Alkaline increases the synthesis of salicylic acid, a growth substance released as a result of the effect of stress factors.

The objective of the studies was the assessment of physiological activity of strawberry variety Sanga–Sengana under the influence of foliar application of potassium alkaline with silicon.

Material and methods

In 2005–2006, at the Experimental station of Orchard Department, University of Agriculture in Szczecin in Rajkowo (a locality near Szczecin), a two-factor vegetation experiment in the system of random blocks was carried out in three replications. 20 plants were included in one replication. The first experimental factor was foliar application of potassium Alkaline with silicon (variant I – with fertilization, variant II – control, spraying with distilled water); the second factor (II) was the date of measurement of the physiological features examined. Strawberry Senga–Sengana c.v. was chosen as biological material for the studies. The experiment was carried out on strawberries planted in 2005 on beds covered with a polyethylene white sheet at a spacing of 0.2 m × 1 m, on the grey-brown podsolic soil of talus origin. For the irrigation of the plantation a drip T-line mounted under the polyethylene sheet was used. Irrigation needs were determined by means of a soil contact tensiometer. Potassium Alkaline with silicon (43 g of N-NH₂, 360 g K₂O and 15 g of SiO₂ · dm⁻³), was used in the form of foliar spraying with a solution of 1 % concentration, at two dates: at the beginning of April (first decade of May) and directly after flowering of plants (first decade of June).

The studies included the measurements of assimilation rate of CO₂ in the leaves (A) and transpiration rate (E). The measurements were taken at three dates: in the third decade of May (1st date), 3rd decade of June (2nd date) and 3rd decade of July (3rd date). Parameters of gas exchange were measured using a portable IRGA analyzer, an LCA-4 model (ADC Bioscientific LTD. Hoddeson, Great Britain), equipped with a PLC-4 leaf chamber, at constant lighting by a halogene lamp (Xenophot HLX, OSRAM) – 1000 μmol · m⁻² · s⁻¹ PAR on the leaf surface. On the basis of the obtained results of assimilation and transpiration rates, the photosynthetic efficiency of water use (ω_w) was calculated and it was assessed by the A:E ratio.

For the comparison of the experimental objects, a two-factor ANOVA was used. In order to determine the differences between means and for the interaction, semi-intervals of Tukey confidence at a level of $\alpha = 0.05$, were calculated. For the sake of homogeneity of variance of error, a synthesis of the results of two years' studies was carried out [8]. Coefficients of linear correlation between assimilation and transpiration rates were

also computed. When the coefficient of linear correlation between variables was significant at the level of $\alpha = 0.05$, the relationship was presented in the diagrams.

Results and the discussion

Leaves of strawberry fertilized with potassium Alkaline and the control leaves were characterised by approximate rate of CO₂ assimilation. Whereas a significant effect of the date of measurement on the rate of this physiological process was shown, for the highest rate of assimilation ($1.91 \mu\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$) was observed at the first date of the measurement ($2.08 \mu\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$) (Table 1). Some authors report that plants which take larger amounts of silicon are characterised by a smaller coefficient of transpiration. According to Brogowski [9] rice fertilized with this component shows lower transpiration by 12 to 15 %, wheat by about 10 %. The applied fertilization with potassium Alkaline and silicon did not modify significantly the intensity of the transpiration process in the strawberry variety studied, whereas a significant decrease in the intensity of this process was observed at successive dates of the measurement, both in the plants fertilized and in the control variant. The rate of transpiration at the third date (3rd decade of July) was by 23 % lower than at the first date (3rd decade of May) (Table 1).

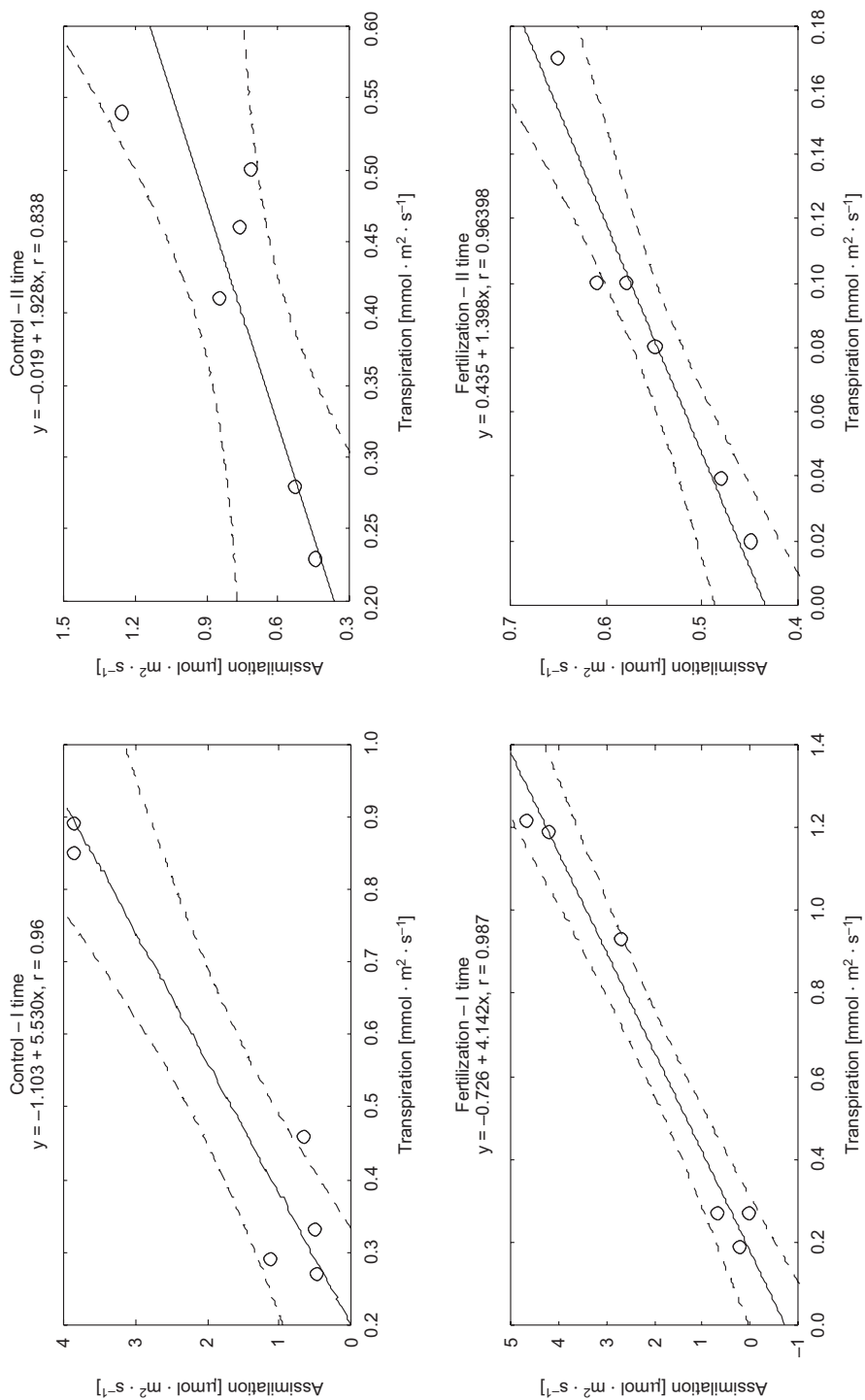
Table 1

Intensity of CO₂ assimilation ($\mu\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$), transpiration ($\text{mmol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$) and water use photosynthetic efficiency ($\text{mmol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$) *Fragaria ananassa* Duch.

	Time			Mean II
	I	II	III	
Assimilation (A)				
Control	1.745 ab*	0.758 ab	0.500 a	1.001 a
Fertilization	2.083 b	0.683 a	0.553 a	1.107 a
Mean I	1.914 b	0.7208 a	0.527 a	
Transpiration (E)				
Control	0.515 bc	0.403 abc	0.197 ab	0.372 a
Fertilization	0.678 c	0.338 abc	0.085 a	0.367 a
Mean I	0.597 c	0.370 b	0.141 a	
Water use photosynthetic efficiency (ω_w)				
Control	2.92 a	1.88 a	5.67 ab	3.49 a
Fertilization	2.36 a	3.45 a	9.52 b	5.11 a
Mean I	2.64 a	2.66 a	7.59 b	

* Averages denoted with the same letters do not differ significantly at the level of significance $\alpha = 0.05$.

An important indicator of plant productivity is the photosynthesis of water use efficiency (ω_w) [10–12]. The results presented in the table show that despite the fact that no statistically significant differences were observed in the strawberry variety studied, larger efficiency of gas exchange (5.11) was characteristic of the plants fertilized with

Fig. 1. Dependence of CO₂ assimilation on transpiration of *Fragaria ananassa* Duch.

potassium Alkaline. Photosynthetic efficiency of water use shown at the third date of measurement, was twice as large in comparison with the remaining two. A high value of this parameter at the third date resulted first of all from a low rate of transpiration.

On the basis of the results of the gas exchange parameters, an analysis of straight-line correlation between assimilation (A) and transpiration (E) was performed – Table 2, Fig. 1.

Table 2

Equations of linear regression and values of coefficients of correlation between the parameters of the parameters of the gaseous exchange of *Fragaria ananassa* Duch.

Character (y)	Character (x)	Time	Regression equation	Correlation coefficients (r)
Control				
A	E	I	$y = -1.103 + 5.530 \cdot x$	0.96**
		II	$y = -0.019 + 1.928 \cdot x$	0.84*
		III	—	0.73
Fertilization				
A	E	I	$y = -0.726 + 4.142 \cdot x$	0.99**
		II	—	0.34
		III	$y = 0.434 + 1.398 \cdot x$	0.96**

The analysis of correlation coefficients showed a significant positive relationship between assimilation and transpiration in strawberry at the first date of measurement, both in the plants fertilized with Alkaline and in the control variant. The correlation coefficient (r) was in these cases very high, close to the unity, and it amounted to 0.99 and 0.96, respectively. In the fertilized plants, a significant positive correlation between discussed parameters of gas exchange was also recorded at the third date of measurements (coefficient r – 0.96), while in the control variant such relationship was observed at the second date. In the other cases coefficients were insignificant.

Conclusions

1. The applied fertilization with potassium Alkaline and silicone did not modify in a significant way the processes of CO₂ assimilation and transpiration rates in the strawberry variety studied.
2. The highest rates of assimilation and transpiration in strawberry were recorded at the first date of measurement (3rd decade of May).
3. The highest photosynthetic efficiency of water use was characteristic of the investigated strawberry variety at the third date of measurement (3rd decade of July).
4. In the plants fertilized with potassium Alkaline and silicon, a significant positive correlation was observed between assimilation and transpiration at the third date of measurement.

References

- [1] Michalski P.: Mat. I National Symp. "Mineral of plants nourishment". Odz. Rośl. Sadow. Skierniewice, 1998, 240–249.
- [2] Nalborczyk E.: *Fragm. Agron.* 1993, **4**, 147–150.
- [3] Karczmarczyk S., Koszański Z. and Podsiadło C.: *Acta Agrobiol.* 1993, **46**, 15–30.
- [4] Podsiadło C., Karczmarczyk S., Koszański Z. and Rumas E.: *Folia Univ. Agric. Stetin.* 1999, **193**, 197–207.
- [5] Wojcieszka U., Wolska E., Podleśna A. and Kocoń A.: *Bull. Pol. Acad. Sci., Biol.* 1994, **42**(2), 183–187.
- [6] Nowakowski W.: *Aura* 2001, (12), 26–28.
- [7] Kopcewicz J. and Lewak S.: *Fizjologia roślin*, PWN, Warszawa 2002.
- [8] Wójcik A.R. and Ludański Z.: *Planowanie i wnioskowanie statystyczne w doświadczałnictwie*, PWN, Warszawa 1989.
- [9] Brogowski Z.: *Zesz. Post. Nauk Roln.* 2000, (6), 9–16.
- [10] Turner N.C.: *Adv. Agron.* 1997, **58**, 293–338.
- [11] Górny A.G. and Garczyński S.: *J. Appl. Genet.* 2002, **43**(2), 145–160.
- [12] Wróbel J., Mikiciuk M. and Stolarska A.: *Zesz. Probl. Nauk Roln.* 2006, **509**, 269–281.

REAKCJA FIZJOLOGICZNA TRUSKAWKI (*Fragaria ananassa* Duch.) NA DOLISTNE NAWOŻENIE POTASOWO-KRZEMOWE

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Abstrakt: Celem przeprowadzonych badań była ocena reakcji fizjologicznej dwóch odmian truskawki na dolistne żywienie nawozem potasowo-krzemowym. W latach 2005–2006 w Stacji Doświadczalnej Katedry Sadownictwa Akademii Rolniczej w Szczecinie w miejscowości Rajkowo koło Szczecina, przeprowadzono dwuczynnikowe doświadczenie wegetacyjne, w układzie bloków losowanych, w trzech powtórzeniach. Czynnikiem doświadczalnym stanowiło nawożenie dolistne alkalinem potasowym z krzemem (wariant I – z nawożeniem, wariant II – kontrola, oprysk wodą destylowaną). Biologiczny materiał badań stanowiła odmiana truskawki: Senga–Sengana. Oznaczono parametry wymiany gazowej badanej odmiany truskawki: intensywność asymilacji CO₂, natężenie transpiracji, wskaźnik efektywności wykorzystania wody w fotosyntezie.

Słowa kluczowe: *Fragaria ananassa* Duch., alkaliny potasowy z krzemem, asymilacja, transpiracja