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INFLUENCE OF A POLYMER SUPERSORBENT ON SELECTED PHYSIOLOGICAL FEATURES OF STRAWBERRY

WPŁYW SUPERSORBENTU POLIMEROWEGO NA WYBRANE CECHY FIZJOLOGICZNE TRUSKAWKI

Abstract: The aim of the studies carried over 2007–2008 was to evaluate the physiological reaction of strawberry var. 'Elsanta' to the addition of AgroHydrogel to the medium. In the vegetation hall of the West Pomeranian University of Technology, a vegetation pot experiment in the system of complete randomization in four replications was carried out. The experimental factor was the addition of AgroHydrogel to the medium. Two doses were used (15 and 30 g per Kick's vessel) against the control, ie the medium without gel. During the vegetation season of plants, the content of assimilation pigments (chlorophyll *a*, *b*, total and carotenoids) in leaves was determined three times. Parameters of water balance – the index of relative water content and the water saturation deficit in tissues of leaves and the area of the leaves were also defined.

Keywords: strawberry, AgroHydrogel, assimilation pigments, water balance, leaf area

A factor affecting, to a significant degree, the yields of berry plants, among them strawberries, is water deficit. A characteristic feature of this species is its large sensitivity to drought and this results in decreasing the quantity and quality of crops [1]. Water and air properties of soil can be improved by using preparations that increase its water volume. These are so called hydrogels or supersorbents [2, 3]. These compounds are polymers capable of storing gravitational water, limiting the level of free water in favour of water accessible to the root system of plants. A positive feature of sorbents is also their capability of maintaining optimum water and air conditions of the medium, even at its strong compaction [4]. They can also enrich the soil with mineral components and be favourable to its rational relations [5].The available literature does not present explicit conclusions as to the effect of hydrogels on physiological features of plants, deciding about their productivity.

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The aim of the studies was to assess the effect of polymer supersorbent called AgroHydrogel, added to the medium, on selected physiological features of strawberry (*Fragaria ananassa* Duch) var. 'Elsanta'.

Material and methods

In 2007–2008 a vegetation experiment in the system of complete randomization was carried out in four replications in the vegetation hall of the West Pomeranian University of Technology in Szczecin.

The objective of the research was strawberry var. 'Elsanta'. The first experimental factor was the addtion of polymer supersorbent AgroHydrogel to the medium. Two levels were used: 1.8 and 3.6 g · dm^{-3}, ie 15 and 30 g per Kick's container, against the control that was the medium with no gel added. The 10 dm^3 capacity pots were filled with 8 dm^3 of soil material. Before the pots were filled, hydrogel had been added to the medium and then all was mixed thoroughly. Table 1 shows the characteristics of the soil material.

Table 1

The properties of soil

pH		Percent of clay fraction [%]	S_o [g/cm^3]	Pkw [%]	Pkv [%]	Wtw [%]	Wtv [%]
H_2O	KCl						
6.58	5.97	21	1.24	24.7	34.0	32.9	38.0

S_o – bulk density, Pkw – capillary weight, Pkv – capillary volume, Wtw – total water capacity in investigated soil – weight, Wtv – total water capacity in investigated soil – volume.

Mineral fertilizing was in the doses of 50, 80 and 100 kg NPK · ha^{-1}. Fertilizing with potassium, phosphorus and half a dose of nitrogen was used before planting.The soil was top dressed with half a dose of nitrogen before the blooming of plants.

In the second decade of April 2007 seedlings were placed in containers: 1 item per pot. The experiment was carried out in a roofed place. The plants wintered in an unheated greenhouse. The soil mixture was measured using contact soil tensometers. The plants were watered by 0.5 dm^3/pot, when the tensometer, which was fixed in the medium with 15 g of gel per pot, showed 450 hPa.

In both years of studies, three times during plants vegetation: in the second decade of May (blooming phase) – date I, June (fruiting phase) – date II and July (post fruiting phase) – date III, the content of assimilation pigments (chlorophyll *a*, *b*, total, carotenoids) was determined and the water balance parameters – the index of *relative water content* (RWC) and the *water saturation deficit* (WSD) of leaves tissues, were defined [6]. The research material was taken from three representative plants (healthy, full-grown leaves were selected) from each experimental variant. To determine the content of assimilation pigments the Lichtenthaler and Wellburn's method was used [7]. According to Arnon et al [8] the content of chlorophyll and carotenoids were calculated. After fruit picking (second decade of July), the total surface of leaf laminas of

individual plants, the assimilation surface of individual plants and the number of leaves on a plant (both features were determined in three replications) were also defined. The area of leaf laminas were determined by the DIAS computer apparatus.

In order to compare experimental objectives as to the results of the content of assimilation pigments, the two factor analysis of variance was used (the first experimental factor – the quantity of the dose of AgroHydrogel, the second factor – the term of the measurement). While for the results of assimilation surface and the number of leaves, the one factor analysis was carried out. The significance of differences between the averages was defined by means of Duncan's test at a level of significance $\alpha = 0.05$. Due to homogeneity of the error variance, synthesis of the results of two year research was carried out [9].

Results and discussion

The addition of AgroHydrogel in a dose of 15 g per pot did not effect significantly the content of chlorophyll *a*, *b* and total in leaves of the examined variety of strawberry. No significant effects of 30 g dose of supersorbent on these physiological features were observed, either. Only in the case of chlorophyll *b*, its slightly larger content was noticed in the leaves of strawberry growing in the medium with 30 g of supersorbent added, than in the plants of the remaining experimental variants. It amounted to 0.553 mg · g^{-1} of fresh matter. As to the concentration of carotenoids, despite the fact that the statistical analysis did not show any significance of differences, a slightly smaller amount of these pigments (0.712 mg · g^{-1} of fresh matter) was observed in leaves of control plants, than in plants growing in the medium with AgroHydrogel added (Table 2).

Table 2

Content of chlorophyll *a*, *b*, *a* + *b* and carotenoids in leaves of strawberry variety 'Elsanta' [mg · g^{-1} fresh matter]

Dose of AgroHydrogel	Date of measurement			Mean
	I	II	III	
Chlorophyll *a*				
Control	1.240 ab*	1.487 b	1.068 a	1.265 a
15 g per pot	1.230 ab	1.266 ab	1.266 ab	1.254 a
30 g per pot	1.405 b	1.195 ab	1.088 a	1.229 a
Mean	1.292 ab	1.316 b	1.141 a	
Chlorophyll *b*				
Control	0.469 ab	0.649 c	0.450 a	0.523 a
15 g per pot	0.460 a	0.540 abc	0.540 abc	0.513 a
30 g per pot	0.542 abc	0.503 abc	0.614 bc	0.553 a
Mean	0.490 a	0.564 a	0.535 a	

Table 2 contd.

Dose of AgroHydrogel	Date of measurement			Mean
	I	II	III	
Chlorophyll *a* + *b*				
Control	1.709 ab	2.136 c	1.518 a	1.787 a
15 g per pot	1.690 ab	1.806 abc	1.806 abc	1.767 a
30 g per pot	1.947 bc	1.806 ab	1.702 ab	1.782 a
Mean	1.782 a	1.880 a	1.675 a	
Carotenoids				
Control	0.729 abc	0.802 bcd	0.605 a	0.712 a
15 g per pot	0.818 cd	0.687 abc	0.687 abc	0.731 a
30 g per pot	0.931 d	0.645 abc	0.617 ab	0.731 a
Mean	0.826 b	0.712 a	0.636 a	

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

The term of leaves gathering did not have any significant effect on the content of chlorophyll *b* and total. In the case of chlorophyll *a*, a significant decrease in its content was observed in leaves of plants gathered after fruiting, as compared with the amount during fruiting. The significantly largest amount of carotenoids (0.826 mg · g^{-1} of fresh matter) was noticed in the phase of blooming (Table 2).

The largest index of relative water content (RWC), and thus the smallest index of water saturation deficit (WSD), was observed in all the experimental variants after strawberry fruiting, whereas the smallest during the phase of blooming.

The 15 g dose of AgroHydrogel per pot did not cause considerable changes in the water balance of the studied plant. Only during the phase of fruiting, a slightly larger index of water saturation (89.67 %) was observed in plants with this dose of supersorbent than in control plants (88.08 %) – Fig. 1. Whereas the application of larger dose of AgroHydrogel (30 g per pot), in all the analysed growth phases of strawberry, had an unfavourable effect on the parameters of water balance, causing an increase in the index of water saturation deficit WSD, and thus a decrease in RWC. It was particularly distinct during the phase of blooming, when the index of water saturation deficit at this dose of AgroHydrogel was by 8.07 % larger than at the dose of 15 g per pot (Fig. 2). Such a relationship can prove that the 30 g dose of supersorbent could cause disturbances in water-air relations in the medium and that resulted in unfavourable parameters of water balance. Similar results of the research on the effect of hydrogel on the growth of tobacco were obtained by Kowalczyk-Jusko and Koscik [3].

No significant effect of the addition of AgroHydrogel on the total assimilation area of the leaves of examined strawberry variety was observed. However, the 30 g dose of supersorbent caused a significant decrease in the number of leaves on an individual

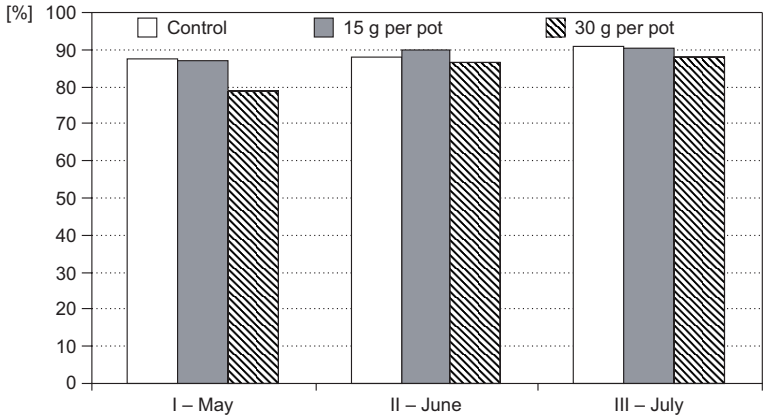

Fig. 1. Index of relative water content (RWC) in leaves of strawberry variety 'Elsanta'

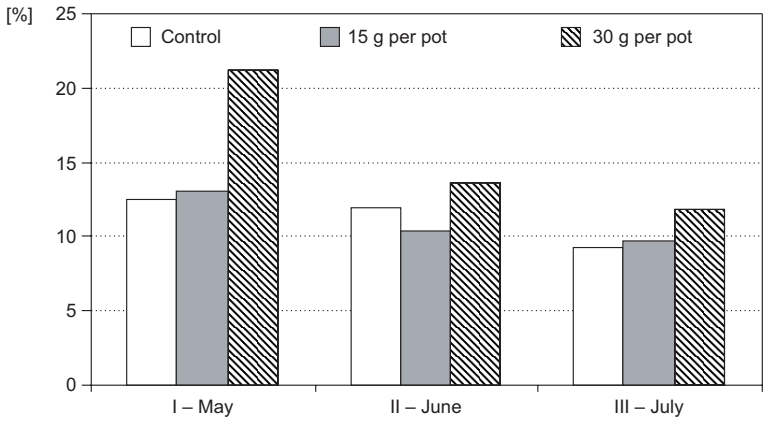

Fig. 2. Index of water saturation deficit (WSD) in leaves of strawberry variety 'Elsanta'

plant (27.5 pieces) and at the same time, a significant increase in the quantity of assimilation area of an individual leaf (55.8 dm^2) (Table 3).

Table 3

Area and number of the leaves of strawberry variety 'Elsanta'

Dose of AgroHydrogel	Quantity of the leaves	Area of the leaves [$cm^2 \cdot plant^{-1}$]	Area of the leaf [cm^2]
Control	38.5 a	1653 a	42.9 a
15 g per pot	33.5 a	1658 a	49.3 a
30 g per pot	27.5 a	1412 a	55.8 a
Mean	33.2	1574	49.3

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

According to Makowska [10], the application of larger doses of hydrogel leads to a stronger binding of water by a large amount of hydrogel particles and that can have an unfavourable effect on the growth of plants. Thus, it seems very important to choose appropriate quantities of polymer supersorbent, depending on its type and on physical and chemical properties of the medium and the needs of species and varieties of the plant.

Conclusions

1. No significant effect was observed of the applied supersorbent on the content of assimilation pigments in leaves of strawberry var. 'Elsanta'.

2. The largest amount of chlorophyll *a* was characteristic of the leaves of the investigated variety during the fruiting phase, whereas the largest content of carotenoids was characteristic of the blooming phase.

3. The 15 g dose of AgroHydrogel per pot did not affect the parameters of water balance of strawberry. While the application of 30 g of this supersorbent resulted in an increase in the index of water saturation deficit WSD.

4. No significant influence was shown of AgroHydrogel on the quantity of the total assimilation area of strawberry leaves.

5. The addition of 30 g of supersorbent per pot had a significant effect on a decrease in the number of leaves on a plant and at the same time on an increase in the area of an individual leaf.

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WPŁYW SUPERSORBENTU POLIMEROWEGO NA WYBRANE CECHY FIZJOLOGICZNE TRUSKAWKI

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Abstrakt: Celem badań przeprowadzonych w latach 2007–2008 była ocena reakcji fizjologicznej truskawki odmiany 'Elsanta' na dodatek AgroHydrogelu do podłoża. W hali wegetacyjnej Zachodniopomorskiego Uniwersytetu Technologicznego w Szczecinie przeprowadzono wazonowe doświadczenie wegetacyjne, w układzie kompletnej randomizacji, w czterech powtórzeniach. Czynnikiem doświadczalnym był dodatek

AgroHydrogelu do podłoża – zastosowano dwa poziomy (15 i 30 g na pojemnik Kicka) na tle kontroli – podłoże bez dodatku żelu. Trzykrotnie w czasie sezonu wegetacyjnego roślin określono zawartość barwników asymilacyjnych (chlorofilu *a*, *b*, całkowitego oraz karotenoidów) w liściach. Określono także parametry bilansu wodnego – wskaźniki względnej zawartości wody i deficytu wysycenia wodą tkanek liści.

Słowa kluczowe: truskawka, AgroHydrogel, barwniki asymilacyjne, bilans wodny, powierzchnia liści