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ADAPTATION OF *SPIRAEA JAPONICA* L. ´LITTLE PRINCESS´ TO WATER DEFICIENCY IN SOIL

Viera ŠAJBIDOROVÁ*, Daniela BARTOŠOVÁ KRAJČOVIČOVÁ, Helena LICHTNEROVÁ
Slovak University of Agriculture in Nitra, Slovakia

Water deficiency in soil is one of the most considerable limitating factors for successful plant cultivation. An intentional selection of species of woody plants and herbs resistant to the environment with changed conditions requires experimental verification of their adaptation mechanisms. In a selected woody plant of the species *Spiraea japonica* L. ´LITTLE PRINCESS´ we have observed its adaptation mechanisms which play a crucial role in case of water deficiency in soil. By way of particular laboratory methods we have evaluated the changes in water regime and their impact on the content of assimilation pigments, on the content of dry mass in the above-ground part of plants and also on the relative water content in the leaves. We evaluated a decrease in the weight of dry mass in the above-ground part of plants due to reduced irrigation. Water regime has not excerced any considerable influence on relative water content in the leaves. With reference to water deficit, we have detected an increase in the total content of chlorophylls and carotenoids. Through experimental methods, we have confirmed that the selected taxon of woody plant is capable of adaptation to water deficiency in soil.

Keywords: *Spiraea japonica* L. ´LITTLE PRINCESS´, water deficit, adaptation mechanisms

Introduction

The impacts of climate change now represent one of the most significant environmental, social and economic problems. The consequences of increasing temperatures, changes in the amount and frequency of rainfall affect different sectors of economy. Drought represents one of the most limiting factors for a plant. Plants are able to adapt to water deficiency in soil due to their adaptation mechanisms. More recently, emphasis is placed mainly on a targeted selection of the appropriate species of trees and herbs in the environment with less favorable conditions. The aim of our experiment is by way laboratory methods to verify the adjustment capacity of the selected species of *Spiraea japonica* L. ´LITTLE PRINCESS´ to a lack of water in the soil. We focused on changes in the content of chlorophylls and carotenoids, relative water content (*RWC*) in the leaves and dry matter content of the aboveground parts of plants, which are the crucial indicators of the adaptive capacity of plants in conditions of reduced presence of water in soil.

Material and metods

The investigated plant material of *Spiraea japonica* L. ´LITTLE PRINCESS´ was acquired from a nursery (through vegetative reproduction). The specimen are approximately five to six years old. After the winter, the plants were replanted into the substrate Klasmann TS3 standard + clay 20 kg m^{-3}; pH 5.5–6 + fertilizer 1 kg m^{-3} and acclimatised under the foiled cover in standard conditions. After rooting, we set a different irrigation regime based upon the content of water in the substrate, which had been determined by a gravimetric method. A half of the plants were irrigated by 60% water capacity (a control variant) and a half by 40% water capacity (a variant with a lower level of substrate saturation; in the pictures referred to as a stress variant). A different irrigation regime was set through the whole vegetation period from June to September 2012. The specimen of an investigated cultivar were growing under a plastic cover. During the reporting period, we made three analyses to determine the selected parameters. The initial analysis was performed on 6 June 2012, another one after 36 days (12 July 2012) and the last one after 69 days (14 August 2012) post the initial analysis. Within the experiment, there were 25 samples of reference taxon to be divided into tree analyses. Five samples were included in the initial analysis, ten samples (a 5 samples control variant, a 5 samples variant with lower levels of saturation of the substrate) were used in the first analysis performed 36 days after the initial analysis and ten samples (a 5 samples control variant, a 5 samples variant with lower substrate saturation) in the second analysis performed 69 days after the initial analysis.

Determination of chlorophylls and carotenoids was carried out using the methoad Šesták and Čatský (1966). From the randomly selected leaves from all the parts of the plant, we have cut off the butts, which were subsequently homogenized in an 80 percent acetone solution. Chlorophyll absorbance values were measured with a spectrophotometer SPEKTROVANT VEGA 400. The content of chlorophylls and carotenoids were calculated according Hojčuš et al. (1975) in units of mg m^{-2}. Relative

*Correspodence: Viera Sajbidorová, Slovak University of Agriculture in Nitra, Faculty of Horticulture and Landscape Engineering, Department of Planting Design and Maintenance, Slovakia, e-mail. Viera.Sajbidorova@uniag.sk

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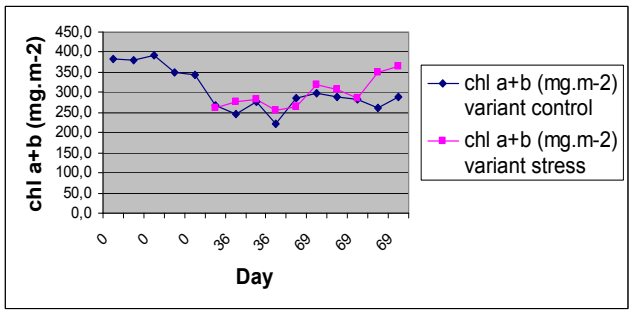

Figure 1 Changes in total chlorophyll content in the *Spiraea japonica* L.´LITTLE PRINCESS´ at 0, 36 and 69 days of the duration of a differentiated water regime

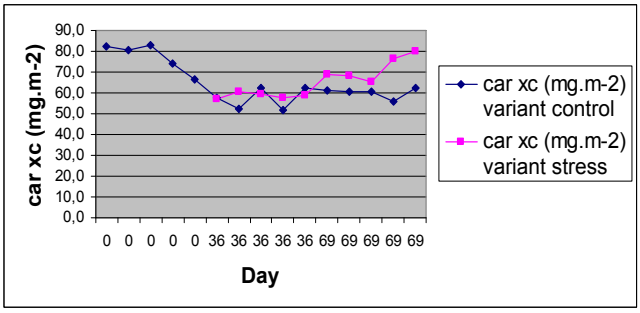

Figure 2 Changes in carotenoids content in the *Spiraea japonica* L.´LITTLE PRINCESS´ at 0, 36 and 69 days of the duration of a differentiated water regime

water content of leaves (RWC) was determined according to the method of Mata and Lamattina (2001). The leaves were weighed (*FW*), then saturated with distilled water for three hours and after saturation were weighed (*SW*) and dried in an oven at 80 °C for 48 hours. We found out the weight of leaves in a dry state (*DW*). The obtained data were fit to the formula for calculating the relative water content. Equation for the calculation of the relative water content *RWC* (%) = 100 × *FW - DW*/*SW - DW*, where *FW* is the fresh weight of leaves, *DW* is the dry weight of leaves and SW is the weight of leaves after saturation.

The dry matter content in the aboveground part of the plants was determined gravimetrically. The aboveground part of the plants after the analysis was dried in an oven at 105 °C to constant weight. For statistical evaluation, we used the dry weight of samples in grams.

The statistical significance of relations between the amount of irrigation (40% and 60% of substrate saturation) and the selected parameters – the content of chlorophylls and carotenoids, the content of dry mass in the aboveground part of plants and also relative water content in the leaves was observed by way of a statistical programme STAT GRAPHIC Centurion XV, a analysis of variance (ANOVA) and the Fisher LSD homogenity test on the level of importance α 0.05.

Results and discussion

During the reported period, we found a significant increase in chlorophyll and carotenoids content by plants from the variant with lower substrate saturation of 40% after 69 days of duration of differentiated water regime (Fig. 1, 2). Although as stated by Ashraf (2003) and Lei et al. (2006), water stress results mostly in the decrease in chlorophyll content, as determined by the results of Pukacki and Kamińska-Rožek (2005) in *Picea abies* (L.) Karst., Lei et al. (2006) in *Populus przewalskii* Maximowicz and Gallé and Feller (2007) in *Fagus sylvatica* L. Authors Raček et al. (2009), Bakay (2010), Peguero-Pina et al. (2008) and Gallé et al. (2007) found also the high level of assimilation pigments in the selected tree species under water deficit. The changes in chlorophyll content are considered a sign of adaptability of plants to extreme conditions (Maslova et al. 1993), which has been confirmed by the findings.

Relative water content in leaves (*RWC*) was not a significant indicator of a lack of water in soil of *Spiraea japonica* L. ´LITTLE PRINCESS´. The average values of RWC of plants of variant with lower levels of saturation of the substrate after 69 days of the duration of the water deficit reached 92.44 % (Coefficient of variation 1.99 % minimum = 90.40 %, maximum = 94.90%). The control variant was recorded at RWC level of 92.10% (Coefficient of variation 0.98 %, minimum = 90.81%, maximum = 93.12 %). Our findings confirm that the decrease of *RWC*, but also the decrease in chlorophyll content is lower, respectively absent in a species resistant to a lack of water in the soil substrate (Keyvan, 2010).

We examined the impact of reduced water content in soil on dry matter content in the aboveground part of the plants. Water is one of the limiting factors of the formation of dry mass in plants. Reduction in dry matter accumulation is due to a significant slowdown in the process of growth

Table 1 Summary statistics for the dry matter content of aboveground parts of plants in the *Spiraea japonica* L. ´LITTLE PRINCESS´; the results of analysis of variance – LSD test at 95% strength level of significance

	Variant	Count	Average	P-value	Standard deviation	Coeff. of variation	Min	Max	Range
The dry matter content of aboveground parts in g after 36 days	C	5	7.32	0.0015*	1.31	17.95%	6.48	9.63	3.15
	S	5	3.46		1.29	37.20%	1.39	4.86	3.47
The dry matter content of aboveground parts in g after 69 days	C	5	10.59	0.0632	1.39	13.08%	8.63	12.11	3.48
	S	5	7.546		2.84	37.60%	4.10	11.36	7.26

* statistically significant difference, C – control variant, S – stress variant

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and photosynthesis during water stress (Kostrej et al., 2000). After 36 days of the duration of differentiated irrigation regime we observed a significant reduction in dry matter content in the aboveground part of plants of the variant with lower levels of saturation of the substrate (Tab. 1). After 69 days of the duration of a differentiated irrigation regime we reported a reduction in the dry matter content, which was statistically insignificant. The impact of drought on the amount of dry matter content accumulated in the aboveground part and also at the level of the roots was studied by Tsialtas (2001), Willekens (1995), Steinberg et al. (1990) on several species of woody plants.

Conclusion

In 2012 we investigated on *Spiraea japonica* L. ´LITTLE PRINCESS´ the effect of reduced water presence in soil at 40% of substrate saturation on content of assimilation pigments, of dry matter content in the aboveground parts of plants and also the relative water content in leaves. In case of a variant with lower levels of saturation of the substrate, we have seen an increase in the total content of chlorophylls and carotenoids for the duration of a differentiated water regime. The dry matter content in the aboveground parts of plants declined in course of the period. There was no significant impact of water deficit set at 40% of substrate saturation to reduce the relative water content in the leaves (RWC). We assume that notably the increase in chlorophylle and caroteinoid content while currently reducing the weight of dry mass and maintaing relatively higher water content in the leaves can be considered as adaptive manifestation of the plants in conditions of available water deficit in soil.

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