EFFECT OF WATER DEFICIT AND APPLICATION OF 24-EPIBRASSINOLIDE ON GAS EXCHANGE IN CAULIFLOWER PLANTS*

F. Hnilička[1], M. Koudela[2], J. Martinková[1], H. Hniličková[1], V. Hejnák[1]

Czech University of Life Sciences Prague, Faculty of Agrobiology, Food and Natural Resources, [1]Department of Botany and Plant Physiology, [2]Department of Horticulture, Prague, Czech Republic

Under partly controlled greenhouse conditions, an experiment was initiated to monitor the long-term effect of water deficit and the effect of the application of 24-epibrassinolide on the photosynthesis and transpiration rates. The model plant was cauliflower, the Chambord F1 variety. The cauliflower plants were grown in pots with a volume of 15 l, at the temperature of 25 °C during the day and 18 °C at night. The cauliflower plants were irrigated with Knop's nutritional solution once a week and with distilled water on the remaining days of the week. The plants were provided with a solution containing micro-elements according to Benson twice during the vegetation period. Irrigation was controlled according to the results obtained by the apparatus AT Theta Kit (Delta – T Device, the United Kingdom). The experiment plan contained 4 groups. The first group was the control group, irrigated with 25% of full water capacity (FWC); the second group was a stressed group. In this group, irrigation was limited to 20% of FWC throughout the vegetation period. In the third and fourth groups, 24-epibrassinolide in the concentration of 10^{-9} M was applied to the third and fourth groups with control plants and stressed plants at the stage of 6–7 leaves. It follows from the results obtained that water deficit provably reduces the rate of exchange of gases in cauliflower plants in comparison to the irrigated control group. The application of 24-epibrassinolide in the control plants reduced the photosynthesis and transpiration rates apparently due to unbalanced endogenous level of phytohormones. As opposed to that, in the stressed plants, the application of the tested substances increased the photosynthesis rate and reduced the transpiration rate in comparison to the untreated stressed plants. It is apparent from the above-mentioned findings that the application of 24-epibrassinolide reduces the transpiration rate in the monitored plants and has an effect similar to that of abscisic acid. Thus, it can be stated that in this case, it is an anti-transpiration effect.

drought; 24-epibrassinolide; cauliflower; *Brassica oleracea* conv. *botrytis*; rate of photosynthesis; rate of transpiration

INTRODUCTION

A lack of water (water deficit) in soil is one of the gravest problems in cultivation of crops on a global scale because Deng et al. (2005) states that there is precipitation lower than 500 mm on 61% of the area on the Earth.

Plants with high water requirements, such as vegetables, react to lack of water more sensitively by reducing metabolism and consequently production. Among vegetables, cauliflower has the highest water requirements. Cauliflower plants have the highest water requirements during the period of the maximum growth of their florets before harvest (Pekárková, 1997). Lack of water results in early start of growth of low-quality florets. It is also one of the main factors affecting the productivity of plants. The resulting water deficit is generally manifested first by reduction of the intensity of growth and then by reduction of assimilation of CO_2 (Lawlor, 1995). The negative effect of water deficit can be mitigated by the application of some natural or synthetic substances.

Among natural and synthetically produced substances, for example, brassinosteroids have this kind of effect. Brassinosteroids are endogenous hormones with a structure very similar to steroids (Singh, Shono, 2005).

Brassinosteroids are able to reduce the negative impact of the influences of the external environment such as extreme temperatures (Ogweno et al., 2008), water deficit (Jager et al., 2008) or excessive watering of the substrate (Takematsu, Takeuchi, 1999), excessive concentration levels of heavy metals (Anuradha, Rao, 2007), salinisation (El-Fattah, 2007), pesticides (Xia et al., 2006) and the effect of biotic stressors (Masuda et al., 2007). Ultimately, they increase the yield, as evidenced, for example, by the work of Khripach et al. (2000) and Müssig (2005).

These data were used to derive the hypotheses that were the basis of the experiment, the purpose of which was to establish the rate of gas exchange in cauliflower in correlation with the effect of water deficit and the application of 24-epibrassinolide.

* This research is supported by project NAZV QH 81110 and the research project of the Ministry of Education, Youth and Sports of the Czech Republic No. MSM 604607901.

MATERIAL AND METHODS

Under partly controlled greenhouse conditions, an experiment was initiated to monitor the long-term effect of water deficit and the effect of the application of 24-epibrassinolide on the rate of gas exchange in plants. The model plant was cauliflower, the Chambord F1 variety. The cauliflower plants were grown in a mixture of garden substrate and sand with the ratio of 2:1, in pots with a volume of 15 l.

The partly controlled conditions of a physiological greenhouse were allowing to regulate the length of the day and the temperature regime. The temperature was set at 25 °C + 2 °C during the day and at 18 °C + 2 °C at night.

The cauliflower plants were irrigated with Knop's nutritional solution once a week and with distilled water on the remaining days of the week. The plants were provided with a solution containing micro-elements according to Benson twice during the vegetation period. Irrigation was controlled according to the results obtained by the apparatus AT Theta Kit (Delta – T Device, the United Kingdom).

The locations of the vessels under the controlled conditions were based on the principle of the methods of the Latin square, with four repetitions. One cauliflower plant was grown in each vessel. The experiment plan contained four groups, Table 1. The quantity of irrigation water was 250 ml for the stressed plants. The phytohormone 24-epibrassinolide was applied to the plants by spraying after the 6^{th} or 7^{th} leaf appeared (the 3^{rd} period of measurement). The concentration used was 10^{-9} M. The said concentration represents 4.52624 x 10^{-7} g in 1 l of water. The phytohormone in this concentration was delivered by PHP-chem, s.r.o., based in Kutná Hora, the Czech Republic, and was dissolved in 25 l of water. There was 0.15 l of the spray substance applied to one vessel.

The rate of gas exchange was measured gasometrically, by an open system of an infrared gas analyser LCpro+ (ADC Bio Scientific Ltd., the United Kingdom). The photosynthesis and transpiration rates were measured from the appearance of the third leaf until the harvest at one-week intervals. The gas exchange was measured on physiological adult leaf (3^{rd}–4^{th} leaf from bottom). During the vegetation period, there were 9 measurements carried out. The said physiological characteristics were measured under standard conditions; in the measurement chamber, the conditions during measurement were as follows: the temperature was 25 °C + 2 °C; irradiance was 650 + 50 $\mu mol.m^{-2}.s^{-1}$; air humidity was 50% + 5% and concentration of CO_2 was 350 + 30 $\mu mol.mol^{-1}$.

The data obtained from measurement were statistically processed by the computer software StatSoft, Inc. (2001) – Statistica Cz, version 7.0.

RESULTS AND DISCUSSION

The photosynthesis rate in the cauliflower plants was changing depending on the ontogenetic development of the plant, as shown in Fig. 1. The said chart shows the gradual, nearly liner increase of the photosynthesis rate in all the monitored experimental groups until the end of the monitored period. The changes in the photosynthesis rate depending on the ontogenetic development of plants have been confirmed in their works for cereals, for example, by H n i l i č k a et al. (2004).

The lowest photosynthesis rate was identified in the control plants at the beginning of measurement, that is, at the time when 3^{rd} leaves were formed; at this time it reached 5.58 $\mu mol\ CO_2.m^{-2}.s^{-1}$. Conversely, the highest photosynthesis rate was measured during harvest: 20.93 $\mu mol\ CO_2.m^{-2}.s^{-1}$. A similar trend was identified in the control plants after the application of 24-epibrassinolide. At the time of the application of the tested substance, the photosynthesis rate of the treated control plants was higher by 0.33 $\mu mol\ CO_2.m^{-2}.s^{-1}$ in comparison to the untreated control plants. During harvest, the photosynthesis rate in the treated plants was provably lower by 10.94%, i.e. 18.64 $\mu mol\ CO_2.m^{-2}.s^{-1}$, as documented by Fig. 1.

Thus, Fig. 1 shows that during ontogenetic development, the stressed plants had a statistically provable lower photosynthesis rate in comparison to the plants irrigated under controlled conditions. This decrease is statistically provable, as evidenced by Table 2. The decrease of the photosynthesis rate resulting from a longer-time water deficit is confirmed by the works of X u et al. (2008).

Unlike the control plants, a decrease of the photosynthesis rate was registered in the stressed plants immediately after the application of 24-epibrassinolide; the photosynthesis rate decreased to the level of 6.71 $\mu mol\ CO_2.m^{-2}.s^{-1}$, as evidenced by Fig. 1. It also shows that after the application of 24-epibrassinolide, the photosynthesis rate gradually increased and, in comparison to the untreated stressed plants, the photosynthesis rate was higher. A marked difference within the group of stressed plants was identified one week before harvest. Thus, it is apparent from the results obtained that after the application of 24-epibrassinolide, the photosynthetic performance of leaves is prolonged in stressed plants.

It follows from the results of the statistical analysis, which is shown in Table 2 that the plants under controlled

Table 1. Plan of the experimental groups

Group	FWC	Irrigation	Phytohormone concentration
Control (C)	25%	500 ml	0 M
Stress (S)	20%	250 ml	0 M
Control + phytohormone (CE)	25%	500 ml	10^{-9} M
Stress + phytohormone (SE)	20%	250 ml	10^{-9} M

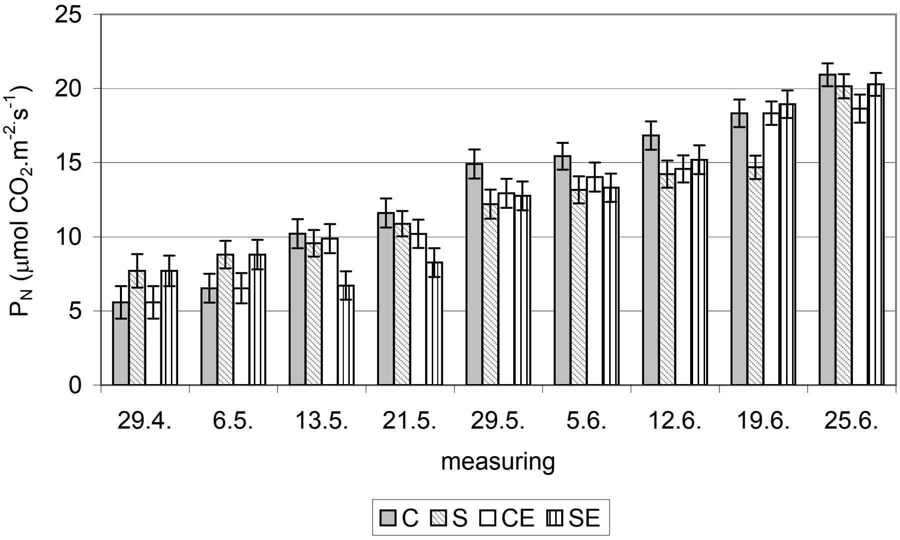

Fig. 1. The changes of photosynthesis rate (P_N) – µmol CO_2.m^{-2}. s^{-1} – in dependencies on ontogenetic development of plants and variants of trial. The legend of trial: C – control; S – stress; CE – control + phytohormone; SE – stress + phytohormone

conditions achieved the statistically provable highest rate of photosynthesis (14.29 µmol CO_2.m^{-2}.s^{-1}) and, conversely, the stressed plants achieved the lowest photosynthesis rate (12.81 µmol CO_2.m^{-2}.s^{-1}). According to Cabrera-Bosquet et al. (2007), the decrease of the water supply in soil only has a low effect on the decrease of the photosynthesis rate. This conclusion was not confirmed for the cauliflower plants because cauliflower belongs to a group of plants, which have high requirements for sufficient amount of water in soil.

After the application of 24-epibrassinolide to the stressed plants, their average photosynthesis rate increased, in comparison to the untreated group, by 0.62%, Table 2. The favourable effect of the application of 24-epibrassinolide on the photosynthesis rate is confirmed, for example, by Müssig (2005) in his work.

It also follows from the said table that after the application of 24-epibrassinolide on the control plants, the photosynthesis rate was lower by 7.63% than in the untreated control plants. The said decrease of the photosynthesis rate was probably caused by the fact that in these plants, unbalance of native phytohormones occurred. According to Hayat et al. (2001), the photosynthesis rate of irrigated plants of leaf mustard (*Brassica juncea*) increased after the application of 28-homobrasinolide.

In spite of the fact that the application of 24-epibrassinolide increased the photosynthesis rate of the stressed plants, the average height of the control plants was not achieved.

Another measured characteristic of gas exchange was the transpiration rate because a plant uses transpiration (E) to receive water but it also cools itself and cools its surroundings. If there is a lack of water in the nutritional material, i.e. in the soil, then the water potential and its components gradually change and this results in gradual closing of stomata. This trend is shown in Table III, which indicates that similarly like with the rate of assimilation of CO_2, the transpiration was different in the various groups used in the experiment; this follows from the results of the statistical analysis of the Tukey's HSD test. Based on the results of

Table 2. The effect of variants on the rate of photosynthesis (µmol CO_2.m^{-2}.s^{-1}). The average values are determined by the method of least squares

Variant	Average (µmol CO_2 .m^{-2}. s^{-1})	Standard deviation	– 95.00%	+ 95.00%
Control	14.29167 ^{b}	0.363136	13.57589	15.00746
Stress	12.89359 ^{a}	0.576428	11.75661	14.03058
Stress + 24-epibrassinolid	12.81443 ^{a}	0.402696	12.02035	13.60850
Control + 24-epibrassinolid	13.20266 ^{a,b}	0.354956	12.50252	13.90279

a, b, c – denoted differences are statistically significant on the level of significance α = 0.05

Table 3. The effect of variants on the rate of transpiration (mmol H_2O.m^{-2}.s^{-1}). The average values are determined by the method of least squares

Variant	Average (mmol H_2O .m^{-2}. s^{-1})	Standard deviation	– 95.00%	+ 95.00%
Control	2.374860 ^{c}	0.070627	2.235648	2.514073
Stress	2.003750 ^{a,b}	0.073163	1.859440	2.148060
Stress + 24-epibrassinolid	1.878308 ^{a}	0.068880	1.742484	2.014133
Control + 24-epibrassinolid	2.147969 ^{b}	0.072156	2.005644	2.290294

a, b, c – denoted differences are statistically significant on the level of significance α = 0.05

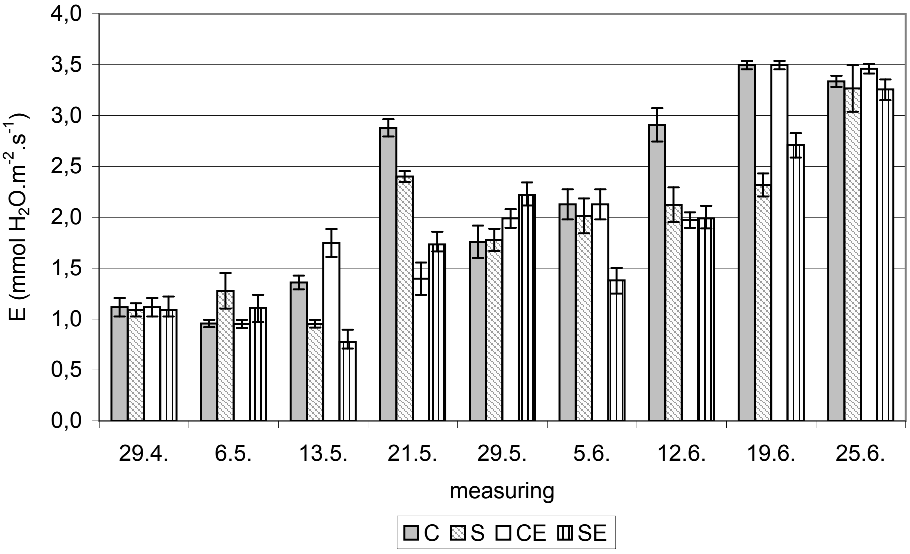

Fig. 2. The changes of transpiration rate (E) – mmol $H_2O.m^{-2}.\ s^{-1}$ – in dependencies on ontogenetic development of plants and variants of trial. The legend of trial: C – control; S – stress; CE – control + phytohormone; SE – stress + phytohormone

this test, an alternative hypothesis on the statistically provable differences between the different groups used in the experiment at the level of significance of α = 0.05. The said analysis shows a decrease of the transpiration rates in the stressed group in comparison with the control conditions, as documented by Table 3. The decrease of the levels of transpiration in the stressed plants in comparison with the plants cultivated in the control groups, which were irrigated, is 15.61%.

It also follows from Table 3 that after the application of 24-epibrassinolide to the stressed plants, provable decrease of transpiration by 6.00% was identified in comparison to the untreated group. Similarly, provable decrease of transpiration by 9.28% after the treatment with the phytohormone was identified in the plants from the control group.

It is apparent from the results that 24-epibrassinolide has an effect on the plants similar to that of abscisic acid; it is an anti-transpiration substance.

Based on a calculation of the Tukey's HSD test, an alternative hypothesis was accepted at the level of significance of α= 0.05 that the transpiration rate is limited not only by the experimental group but also by the ontogenetic development of cauliflower plants, as documented by Fig. 2. As opposed to the nearly linear growth of the photosynthesis rate during ontogenesis of cauliflower, this trend was not identified in the changes of the transpiration of cauliflower leaves.

In both groups of plants from the control group, a decrease of the transpiration rate was identified between the first time of measurement (1.12 mmol $H_2O\ .m^{-2}.\ s^{-1}$) and the second time of measurement (0.96 mmol $H_2O\ .m^{-2}.\ s^{-1}$). The highest transpiration rate was identified one week before the harvest (3.50 mmol $H_2O\ .m^{-2}.\ s^{-1}$) and during the harvest (3.34 mmol $H_2O\ .m^{-2}.\ s^{-1}$), see Fig. 2.

In the stressed plants, the water output through stomata was at its lowest in the third week after initiation of the experiment because the transpiration rate was 0.95 mmol $H_2O\ .m^{-2}.\ s^{-1}$ and it was at its highest during the harvest when it was 3.27 mmol $H_2O\ .m^{-2}.\ s^{-1}$. After the third time of measurement, the transpiration rate in the stressed plants was growing up until the harvest. The fifth measurement, at which the transpiration rate decreased, in comparison to the preceding measurement, was an exception to the described trend, see Fig. 2. The decrease of the transpiration rate in the stressed plants, in comparison to the plants from the control group, during their ontogenetic development is also confirmed, for example, by the works of A h m a d i and S i o s e m a r d e h (2005).

A b u - G r a b and H a m a d a (2002) also state in their work that after a drought stress is induced at various development stages of wheat, there is a decrease of transpiration rate during the ontogenetic development of plants. Similar conclusions are also stated by L u et al. (2005).

There was a similar trend in the increase or decrease of the levels of transpiration rate in the stressed plants treated with 24-epibrassinolide. At the time of the application of the phytohormone (the 3rd time of measurement), the transpiration rate was 0.77 mmol $H_2O\ .m^{-2}.\ s^{-1}$, lower by 0.18 mmol $H_2O\ .m^{-2}.\ s^{-1}$ in comparison to the untreated group. The highest level of transpiration rate was measured during the harvest: 3.26 mmol $H_2O\ .m^{-2}.\ s^{-1}$. The maximum rate of transpiration in the treated stressed plants was improvably lower by 0.30% in comparison to the untreated group, as it is apparent from Fig. 2.

The decrease of the transpiration rate as a consequence of using the 24-epibrassinolide spray nearly until the harvest is also apparent in the control plants. In the treated control plants, the transpiration rate increased by 0.39 mmol $H_2O\ .m^{-2}.\ s^{-1}$ (the 3rd time of measurement) after the plants were sprayed with the phytohormone. At the following time of measurement, the transpiration rate decreased to the level of 1.40 mmol $H_2O\ .m^{-2}.\ s^{-1}$ and this was followed by gradual growth until the 6th time of measurement (2.13 mmol $H_2O\ .m^{-2}.\ s^{-1}$). Identically with the untreated plants, the highest transpiration rate was identified one week before the harvest (3.50 mmol $H_2O\ .m^{-2}.\ s^{-1}$) and during the harvest (3.46 mmol $H_2O\ .m^{-2}.\ s^{-1}$), as documented by Fig. 2.

The reduction of the transpiration rate in the cauliflower plants treated with 24-epibrassinolide is confirmed by the work of Yadav and Pandey (1997) with wheat. The said authors were monitoring the effect of the application of ABA, CCC and Si on the transpiration rate. Identical results were reported by Sairam et al. (1989) for the application of ABA alone to wheat plants.

It follows from the results obtained that water deficit provably decreases the gas exchange rate in cauliflower plants in comparison to the irrigated control group. The application of 24-epibrassinolide in the control plants reduced the photosynthesis and transpiration rates apparently due to imbalanced endogenous level of phytohormones. As opposed to that, after the application of the tested substance to the stressed plants, the photosynthesis rate increased and the transpiration rate decreased in these plants in comparison to the untreated stressed plants. It follows from the above that the application of 24-epibrassinolide decreases the transpiration rate in the monitored plants and that it has an effect similar to that of abscisic acid. Thus, it can be stated that it is an anti-transpiration effect in this case.

REFERENCES

ABU-GRAB, O. S. – HAMADA, A. A.: Sensitivity of some wheat cultivars to drought under middle delta zone condition. Ann. Agric. Sci., *40*, 2002: 51–66.

AHMADI, A. – SIOSEMARDEH, A.: Investigation on the physiological basis of grain yield and drought resistance in wheat: leaf photosynthetic rate, stomatal conductance, and non-stomatal limitations. Int. J. Agric. Biol., *7*, 2005: 807–811.

ANURADHA, S. – RAO, S. S. R. Effect of 24-epibrassinolide on the growth and antioxidant enzyme activities in radish seedlings under lead toxicity. Indian J. Plant Physiol., *12*, 2007: 396–400.

CABRERA-BOSQUET, L. – MOLERO, G. – BORT, J. – NOGUES, S. – ARAUS, J. L.: The combined effect of constant water deficit and nitrogen supply on WUE, NUE and Delta C-13 in durum wheat potted plants. Ann. Appl. Biol., *151*, 2007: 277–289.

DENG, X. P. – SHAN, L. – INANAGA, S. – INOUE, M.: Water-saving approaches for improving wheat production. J. Sci. Food Agr., *85*, 2005: 1379–1388.

EL-FATTAH, R. I. A.: Osmolytes-antioxidant behaviour in Phaseolus vulgaris and Hordeum vulgare with brassinosteroid under salt stress. American Eurasian J. Agric. Environm. Sci., *2*, 2007: 639–647.

HAYAT, S. – AHMAD, A. – MOBIN, M. – FARIDUDDIN, Q. – AZAM, Z. M.: Carbonic anhydrase, photosynthesis, and seed yield in mustard plants treated with phytohormones. Photosynthetica, *39*, 2001: 111–114.

HNILIČKA, F. – HNILIČKOVÁ, H. – ČESKÁ, J.: The influence of abiotic stresses upon photosynthesis and growth of wheat. Žemdirbyste, *86*, 2004: 54–66.

JAGER, C. E. – SYMONS, G. M. – ROSS, J. J. – REID, J. B.: Do brassinosteroids mediate the water stress response? Physiol. Plantarum, *133*, 2008: 417–425.

KHRIPACH, V. – ZHABINSKII, V. – DE-GROOT, A.: Twenty years of brassinosteroids: Steroidal plant hormones warrant better crops for the XXI century. Ann. Bot., *86*, 2000: 441–447.

LAWLOR, D. W.: The effects of water deficit on photosynthesis. In: SMIRNOFF, N. (ed.): Environment and Plant Metabolism, pp. 129–160. Oxford, Bios Scientific Publishers 1995.

LU, L. H. – LI, Y. M. – HU, Y. K.: Effect of water stress on photosynthetic characteristics and yield characters of two wheat cultivars with different resistances to drought. Journal of Agricultural University of Hebei, *28*, 2005: 1–5.

MASUDA, D. – ISHIDA, M. – YAMAGUCHI, K. – YAMAGUCHI, I. – KIMURA, M. – NISHIUCHI, T.: Phytotoxic effects of trichothecenes on the growth and morphology of Arabidopsis thaliana. J. Exp. Bot., *58*, 2007: 1617–1626.

MÜSSIG, C.: Brassinosteroid promoted growth. Plant Biol., *7*, 2005: 110–117.

OGWENO, J. O. – SONG, X. S. – SHI, K. – HU, W. H. – MAO, W. H. – ZHOU, Y. H. – YU, J. Q. – NOGUES, S.: Brassinosteroids alleviate heat-induced inhibition of photosynthesis by increasing carboxylation efficiency and enhancing antioxidant systems in Lycopersicon esculentum. J. Plant Growth Regul., *27*, 2008: 49–57.

PEKÁRKOVÁ, E.: Zelenina (Vegetables). Brio Praha, 2007. 126 pp.

SAIRAM, R. K. – DESHMUKH, P. S. – SHUKLA, D. S. – WASNIK, K. G. – KUSHWAHA, S. R.: Effect of abscisic acid and triadimefon on photosynthesis and nitrate reductase activity during water stress in wheat. Indian J. Plant Physiol., *32*, 1989: 51–56.

SINGH, I. – SHONO, M.: Physiological and molecular effects of 24-epibrassinolide, a brassinosteroid on thermotolerance of tomato. Plant Growth Regul., *47*, 2005: 111–119.

TAKEMATSU, T. – TAKEUCHI, Y.: Effects of brassinosteroids on growth and yields of crops. In: SAKURAI, A. – YOKOTA, T. – CLOUSE, S. D. (eds.): Brassinosteroids, pp. 1–253. Tokyo, Springer-Verlag 1999.

XIA, X. H. – HUANG, Y. Y. – WANG, L. – HUANG, L. F. – YU, Y. L. – ZHOU, Y. H. – YU, J. Q.: Pesticides-induced depression of photosynthesis was alleviated by 24-epibrassinolide pretreatment in Cucumis sativus L. Pest. Biochem. Physiol., *86*, 2006: 42–48.

XU, X. – MARTIN, B. – COMSTOCK, J. P. – VISION, T. J. – TAUER, C. G. – ZHAO, B. – PAUSCH, R. C. – KNAPP, S.: Fine mapping a QTL for carbon isotope composition in tomato. Theor. Appl. Genet., *117*, 2008: 221–233.

YADAV, R. S. – PANDEY, A. K.: Effect of antitranspirants on wheat genotypes under moisture stress. Indian J. Plant Physiol., *2*, 1997: 229–231.

Received for publication on September 9, 2009
Accepted for publication on January 20, 2010

HNILIČKA, F. – KOUDELA, M. – MARTINKOVÁ, J. – HNILIČKOVÁ, H. – HEJNÁK, V. (Česká zemědělská univerzita, Fakulta agrobiologie, potravinových a přírodních zdrojů, Praha, Česká republika):

Vliv vodního deficitu a aplikace 24-epibrassinolidu na výměnu plynů květáku.

Scientia Agric. Bohem., *41*, 2010: 15–20.

V částečně řízených skleníkových podmínkách byl založen pokus na sledování dlouhodobého vodního deficitu a vlivu aplikace 24-epibrassinolidu na rychlost fotosyntézy a transpirace. Modelovou rostlinou byl květák, odrůda Chambord F1. Rostliny květáku byly pěstovány v nádobách o objemu 15 l, při teplotě 25 °C ve dne a 18 °C v noci. Rostliny květáku byly 1x týdně zalévány Knopovým živným roztokem a zbývající dny v týdnu destilovanou vodou. Rostlinám byl dodán 2x za vegetační období roztok s mikroelementy podle Bensona. Zálivka byla řízena na základě výsledků získaných přístrojem AT Theta Kit (Delta – T Device, Velká Británie). Schéma pokusu zahrnovalo 4 varianty. První varianta byla kontrolní, zavlažovaná 25 % PVK, druhá varianta byla stresovaná. U této varianty byla závlaha omezena po celou dobu vegetace na 20 % PVK. U třetí a čtvrté varianty byl na rostliny kontrolní a stresované aplikován ve fázi 6.–7. listu 24-epibrassinolid v koncentraci 10^{-9} M. Ze získaných výsledků vyplývá, že vodní deficit průkazně snižuje rychlost výměny plynů rostlin květáku ve srovnání se zavlažovanou kontrolou. Aplikace 24-epibrassinolidu u kontrolních rostlin snížila rychlost fotosyntézy a transpirace patrně v důsledku nevyvážené endogenní hladiny fytohormonů. Oproti tomu u rostlin stresovaných se po aplikaci testované látky zvýšila rychlost fotosyntézy a snížila rychlost transpirace v porovnání s neošetřenými stresovanými rostlinami. Z výše uvedeného je patrné, že aplikace 24-epibrassinolidu snižuje rychlost transpirace sledovaných rostlin a má obdobný účinek jako kyselina abscisová. Lze tedy konstatovat, že v tomto případě se jedná o antitranspirační účinek.

vodní deficit; 24-epibrassinolid; fotosyntéza; transpirace; květák; *Brassica oleracea* conv. *botrytis*

Contact Address:

Ing. František H n i l i č k a , Ph.D., Česká zemědělská univerzita v Praze, Fakulta agrobiologie, potravinových a přírodních zdrojů, katedra botaniky a fyziologie rostlin, Kamýcká 129, 165 21 Praha 6-Suchdol, Česká republika, tel.: +420224382519, e-mail: hnilicka@.af.czu.cz