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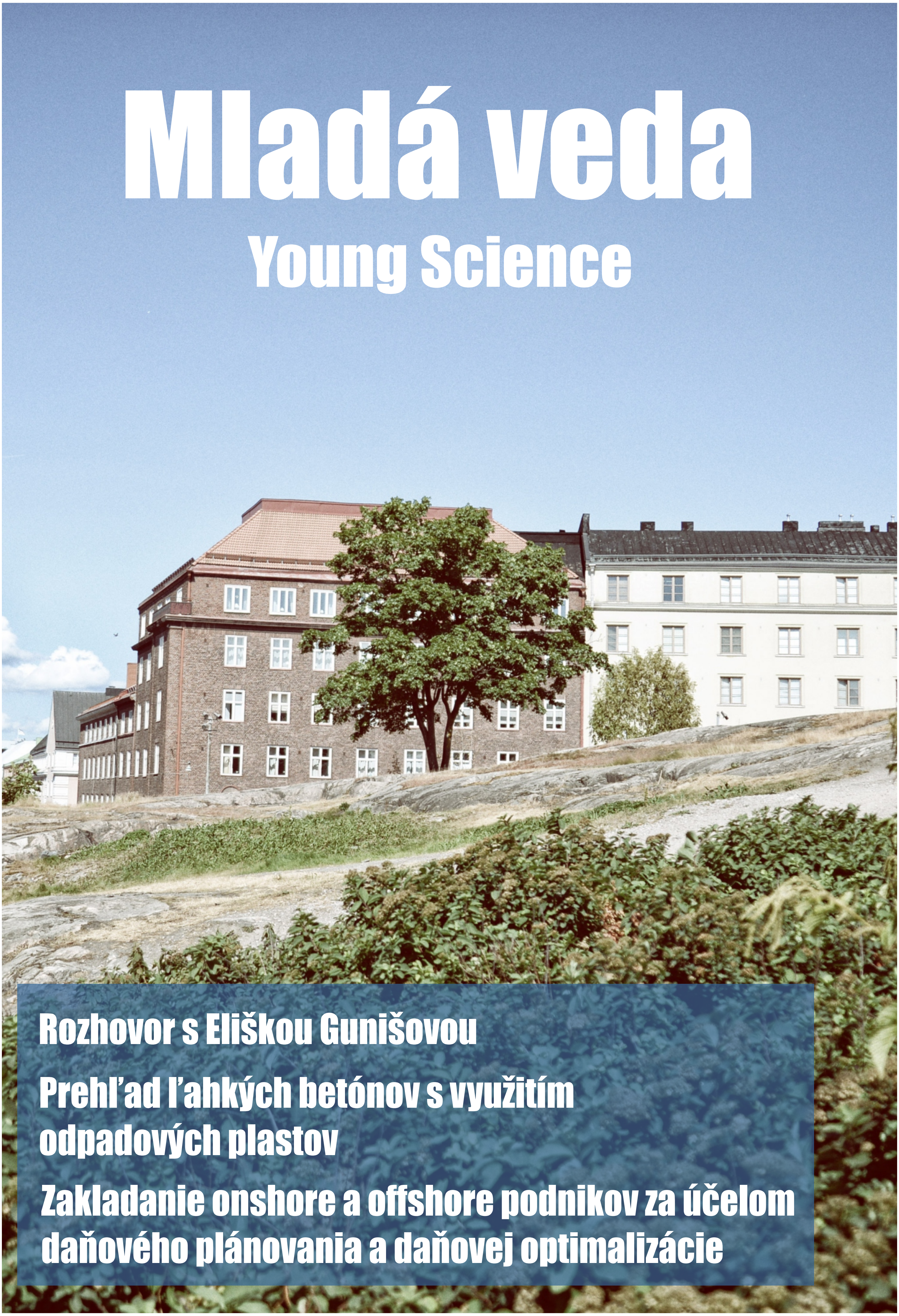

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POSSIBILITY OF GROWTH REGULATOR APPLICATION IN WINTER WHEAT

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Irena Bárányiová pôsobí ako interná doktorandka na Ústave agrosystému a bioklimatológie Mendelovej Univerzity v Brne. Vo svojej dizertačnej práci sa venuje vplyvu exogénnej aplikácie rastových regulátorov na fyziologické procesy a výnos u vybraných odrôd pšenice ozimnej v podmienkach sucha. Karel Klem, Jan Křen, Vladimír Smutný a Jan Brotan pôsobia ako akademickí pracovníci na Ústave agrosystému a bioklimatológie Mendelovej Univerzity v Brne.

Irena Bárányiová act as a PhD. student at the Department of Agrosystems and Bioclimatology at Mendel University in Brno. In her dissertation thesis, she deals with the effect of exogenous application of growth regulators on the physiology and the yield of selected varieties of winter wheat under drought stress. Karel Klem, Jan Křen, Vladimír Smutný a Jan Brotan act as a Academic staff at the Department of Agrosystems and Bioclimatology at Mendel University in Brno.

Abstract

The experiment was based on a field experimental station in Žabčice with variety of winter wheat Matylda. This area (Žabčice) is located in a warm area with prevailing continental climate , with average annual rainfall of 482 mm and an average annual temperature of 9.3°C. The field experiment testing various growth regulators in spring winter wheat was founded in 2013/2014. Within this experiment following growth regulators and fungicide with growth regulation effect were used: Retacel extra R68 (chlormequat chloride 720 g/l), Moddus (trinexapac-ethyl 250 g/l), Cerone (ethephon 480 g/l), Amistar (azoxystrobin 250 g/l). These growth regulators were applied at growth stages between BBCH 31 and BBCH 59. The aim of the experiment was to determine the impact of these regulators on the growth, development and yield of winter wheat when simulating the drought stress using experimental rain-out shelters. Results of field experiments can contribute to mitigating the impact of drought on yield formation and quality of winter wheat production in the realization of biological potential of wheat genotypes.

Key words: winter wheat, drought, plant growth regulators

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Introduction

The use of growth regulators in cereals may have three different objectives. The regulators are most often applied to reduce lodging. During the process, the effect of shortening and strengthen stem is put. The applications are carried out depending on the crop and used product from the beginning of the stem elongation till the time exactly before the inflorescence emergence. Another possibility is to use for the support of tillering and thickening stands. The application is taken throughout the duration of tillering. The last possibility of putting growth regulators is to increase the certainty of overwintering of overgrowing winter cereals in the autumn. For agricultural purposes, the growth regulators are substances influencing physiological processes in plant metabolism by the required way. It also positively affects crop yields and the quality of production. This is mainly to increase the resistance to winter, lodging limitation, straightening of offshoots, to reduce apical dominance, higher fitting of generative organs, more efficient use of nutrients, decreasing harvest losses, and facilitating the harvest (Vašák et al., 1997). The application of growth regulators is the important factor in the intensification of cereal cultivation, and currently it is also a necessary measurement. Therefore, the proper use of plant growth regulators forms the integral part of the intensive cultivation technology relating to modelling vegetation, harvest, and then the economy of growing (Bezdíčková, 2011). The primary objective is to use plant growth regulators to prevent lodging of vegetation causing in strong cases the damaging previous inputs such as decreasing harvest and its quality and increasing the costs for harvesting. The application of growth regulators can affect the straightening of productive tillers and prolongation of the activity of leaf surface.

The greenhouse research confirms that the growth regulators can reduce the evapotranspiration by up to 29 % (Green et al., 1990). Some studies confirm that growth regulators may actually increase rooting (Cooper et al., 1987). The previous studies have shown that the plants with slow growth can survive prolonged drought than the fast growing plants (Kondoh et al., 2006). The use of growth regulators is accompanied by many positive effects especially in conditions of water deficit. The application of growth regulator Trinexapac – ethyl promotes the formation of the root system, to ensure the increasing of stem stability, and to improve the transport of water and nutrients. The using of the CCC product can be achieved better regulation of stomata, stimulating root growth and the increasing of using of water efficiency. The application of fungicides of strobilurin type is provided higher photosynthetic rate and the reduction of stomata conductivity. The Ethephon product and its effect on the plant allows increasing of water potential. The use of phytohormones or synthetic regulators can be accomplished by the partial elimination of environmental stress, respectively, to alleviate the effect of stress or to facilitate plant regeneration after the stress action. It can be theoretically assumed that the controller itself causes the increase or decrease crop. Despite of its effect which is correlating with the influence of all other environmental parameters. It is not possible to stabilize the optimal conditions in which the regulator would cause to the crop to reache a higher crop because the interactive variable external conditions influence the conditions of the crop development at the same time. Drought belongs then to the most important environmental factors adversely affecting vegetation. The application of

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growth regulators can be achieved the partial elimination of the impacts of environmental stress. Growth regulators can improve the efficiency of water use in the case of closing of stomata. It also causes the increase in the root proportion. The above ground biomass may affect the accumulation of antioxidants protecting the plants during stress conditions.

The aim of the experiment was to evaluate positive and negative impacts of growth regulators on physiology and winter wheat yield in conditions of drought, to choose suitable types of regulators and the time of applying in order to improve tolerance to drought.

Material and methods

The experiment was carried out on the experimental field station in Žabčice. Various options of treatment by growth regulators in winter wheat were evaluated there. The experiment was established in 2013/2014, variety Matylda seeded on 15th October in 2013. Seed quantity was 4 MGS. Variety Matylda belongs to the set of early varieties. The variety has a medium plant length with an average resistance to lodging. Variety Matylda has a very high yield potential. During the growth phase by the end of stem elongation period BBCH 39 there were over the half of the experimental area built short-termed rain out shelters providing induction of drought stress. Measuring of physiological parameters (water use efficiency, CO_2 assimilation rate and the chlorophyll content in leaves was done in the middle of drought stress (May 26th, 2014), and at the end of drought stress effect. N fertilization using LAD 27 fertilizer at the dose of 160 kg N/ha and DAM 390 (solution of water, Ammonium nitrate and urea) fertilizer at the dose of 30 kg N/ha. The crop was treated using the herbicide COUGAR FORTE + fungicide HUTTON FORTE. After wheat ripening evaluation of yield (Picture 5) and yield structure has been done. For evaluation of CO_2 assimilation rate, transpiration and stomatal conductivity gas exchange system LI 6400 XT with a assimilation chamber equipped with LED light source has been used. The measurement took place at constant temperature, relative air humidity, CO_2 concentration and at saturation light intensity. The observed parameters allowed calculation of water use efficiency (WUE) and indirect parameter of water use efficiency A/Gs.

The individual regulators were applied in the following phenophases and in amounts according the Table 1.

Number of variants	Name of product	The planned product na ha (l, kg)	The planned water na ha (l)	The term application
1	CONTROL			
2	CCC (Retacel R68)	1,88 l	300 l	3.4.2014 BBCH 31
3	TRINEXAPAX-ETHYL (Moddus)	0,4 l	300 l	23.4.2014 BBCH 32-35
4	ETHEPHON (Cerone 480SL)	0,6 l	300 l	7.5.2014 BBCH 45
5	AZOXYSTROBIN (AMISTAR XTRA)	0,8 l	300 l	13.5.2014 BBCH 59

Table 1: The individual regulators were applied in the following phenophases and in amounts
Source: Baráyiová, 2014

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Picture 1: Records of plant morphology (4.4.2014)
Source: Baranyiová, 2014

Picture 2: Records of plant morphology (23.4.2014)
Source: Baranyiová, 2014

Picture 3: Sheds over the experimental area of winter wheat
Source: Baranyiová, 2014

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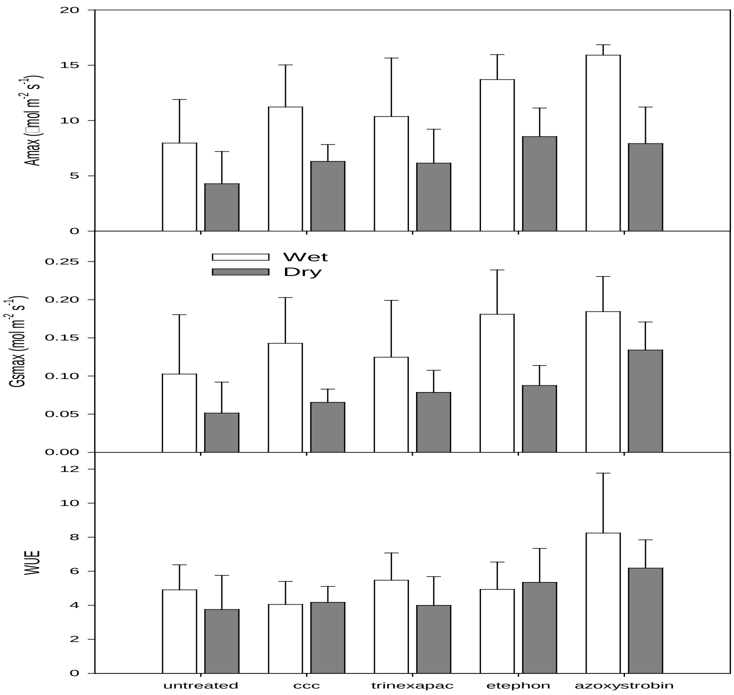
Results and Discussion

The results indicate a negative effect of drought on the CO_2 assimilation rate (A_{max}) and stomatal conductance (G_s). In the untreated control were A_{max} and G_s reduced by almost 50%. The application of growth regulators increased CO_2 assimilation rate in both treatments with ambient rainfall and drought stress, with the highest increase recorded after application of azoxystrobin and etephon. Relative differences between dry and wet treatment, however, changed relatively little. The decrease of relative reduction of A_{max} due to drought stress occurred mainly after application of etephon and trinexapac-ethyl. In the case of G_s the decreased reduction was noted after the application of azoxystrobin and trinexapac-ethyl. The most significant effect on increasing water use efficiency (WUE), was found following the application of azoxystrobin both in dry and wet variants. Yield results showed a positive effect of all applications of growth regulators, with the highest impact of the trinexapac-ethyl, etephon and azoxystrobin. All three treatments also reduced the negative impact of drought on yield.

Definitely positive influence on water use efficiency was caused only by fungicide with regulatory effects - azoxystrobin.



Picture 4: CO_2 assimilation rate (A_{max}), stomatal conductivity (G_{smax}) and water use efficiency (WUE)
Source: BARányiová, 2014

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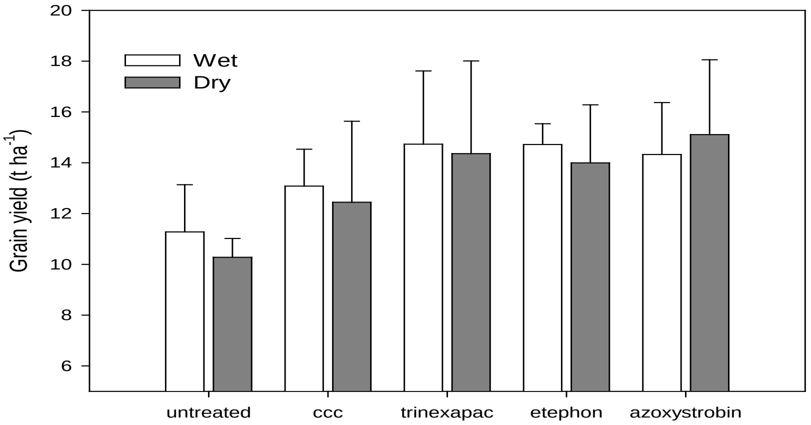
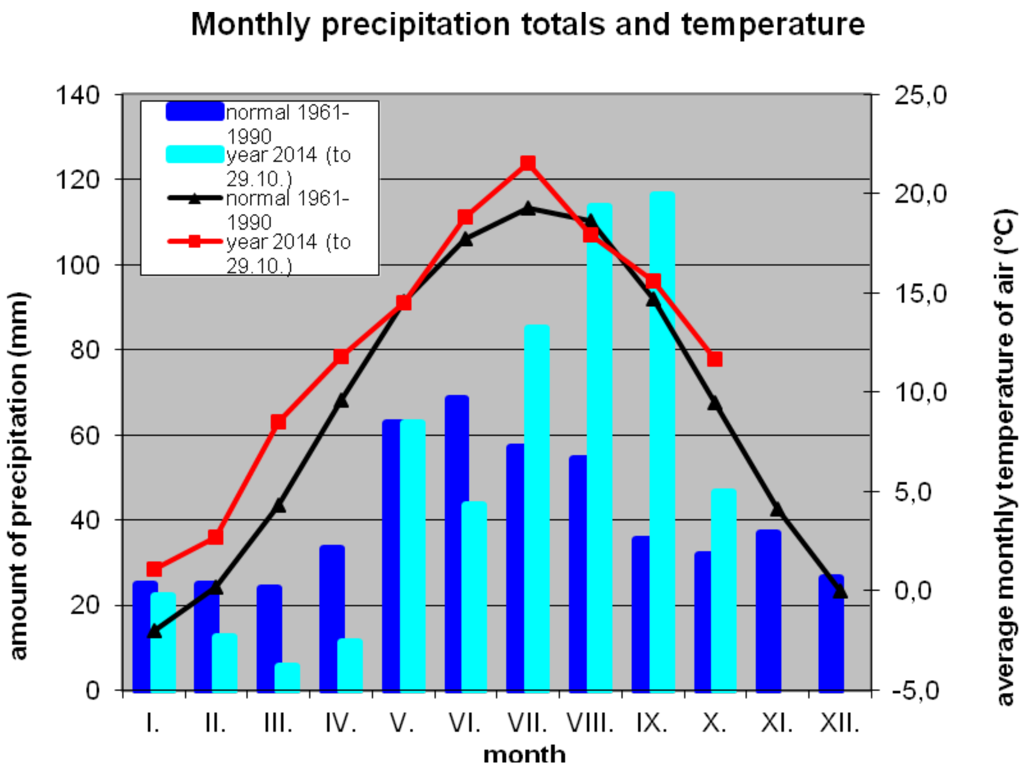
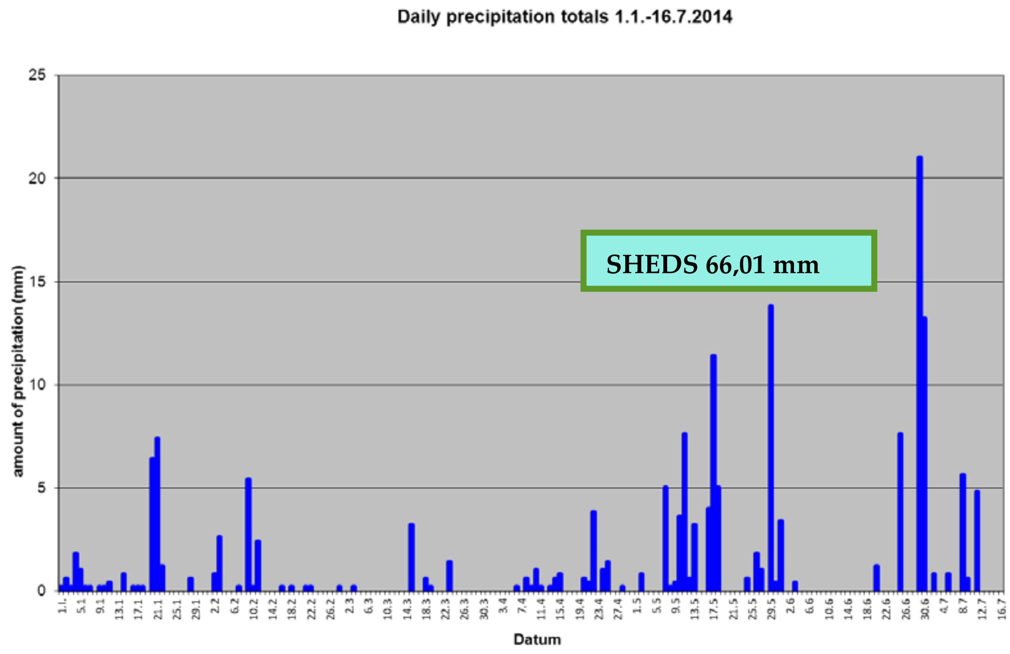
The biggest reduction of drought stress influence (shed) on yield was evident at strobilurin and partially at trinexapac as well.



Picture 5: Effect of drought and growth regulators application on grain yield
Source: Barányiová, 2014



Picture 6: Monthly precipitation totals and temperature
Source: Brotan, 2014



Picture 7: Daily precipitation totals 1.1.-16.7.2014. Sheds eliminated 66 mm of precipitation
Source: Brotan, 2014

Conclusion

The use of growth regulators is highly dependent on the weather conditions. In 2013/2014, there was dry vegetation period at experimental location Žabčice corresponding to the experimental results. The use of growth regulators is accompanied with a number of positive effects, especially in the conditions of water deficit. By applying growth regulators we can reach a partial elimination of environmental stress effect. Growth regulators can improve water use efficiency. They also have influence on increase of roots: above ground biomass ratio and can also influence the accumulation of antioxidants that protect plants during stress conditions. According to our preliminary results it is possible to be stated that, practically, all growth regulators used increase the CO_2 assimilation rate and stomatal conductance. The results of field experiments can significantly contribute to reduction of drought impact on yield formation and quality of production of winter wheat in realization of biological potential of varieties.

This article recommended for publication in a scientific journal Young Science: Doc. Ing. Vladimír Smutný, Ph.D.

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