REACTION OF SELECTED TYPES OF PLANT GROWTH REGULATOR FOR WATER STRESS ON WINTER WHEAT

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Abstract: The aim of this work was to clarify the impacts of water stress and describe the effects of stress on winter wheat. We observed the morphological and growth changes, as well as changes in selected physiological functions of plants. In this work we address the possible adaptive or defence mechanisms of plants to water scarcity. The main objective of my work was to monitor the impact of plant growth regulators on physiological parameters under drought stress. The experiment was conducted on a field experimental station in Žabčice on variety 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. Within this experiment following growth regulators and fungicide with growth regulation effect were used: Retacel extra R68 (chlormequat chloride 720 $g.l^{-1}$), Moddus (trinexapac-ethyl 250 $g.l^{-1}$), Cerone (ethephon 480 $g.l^{-1}$), Amistar (strobilurin 250 $g.l^{-1}$). Approximately 2 and 4 weeks since the beginning of drought stress were carried out physiological measurements of chlorophyll and flavonoid content. From our preliminary results it can be concluded that under drought stress the decrease of chlorophyll content in leaves was found. Growth regulators CCC and trinexapac mitigate the decline of chlorophyll content caused by drought in the upper leaves but rather increased the impact in older (lower) leaves. Fungicide azoxystrobin alleviates the decrease of chlorophyll caused by drought in all leaves. The results show that the positive effect of regulators reducing the impact of drought on the parameter FV/FM was seen in all growth regulator treatments with the most significant effect of the active ingredience trinexapac-ethyl.

Key Words: drought, chlorophyll, plant hormones

INTRODUCTION

Climate change is currently one of the most serious environmental, social and economic problems. On the one hand, it may be due to the warmer climate and shift of cultivation of certain crops to northern latitudes, on the other hand, areas that now experience drought stress period, will be further extended. The biggest risk from changing climate is related to agricultural water scarcity. Indeed, at present more than 40% of the world's food production comes from irrigated land and irrigation is 2/3 of global water consumption. The most alarming situation in Europe, the Mediterranean, where more than 70% of water resources is utilized for irrigation. Drought stress in winter wheat was more evident in Central Europe and is expected to be more pronounced and longer drought periods (Richardson et al. 2009). The ability of plants to adapt to adverse environmental conditions is regarded as essential for their survival. In terms of negative water balance leads to biochemical and functional changes at the roots and aboveground parts. Under water deficit is limited the uptake of mineral nutrients, and the assimilation of nitrogen in the leaves (Brestič, Olšovská 2001). Resistance to water stress can be achieved by plant stress escapes, almost ripe and avoid drought period, or the stress tolerance by retaining water uptake over the loss. The sign of tolerance to stress is also reduction of the diameter of the vascular bundles associated with change in resistance to the xylem water flow. The control of water loss by transpiration serves as the breathing level (stomatal conductivity) (Levitt 1980). Stomatal control of stressed plants depends exclusively on leaf water status (water potential) (Assman 1993) and the requirements of the plant for transpiration. It has long been known that some plants (e.g. cereals) reduce the stomatal conductivity even in the case where the water potential will not change in response to drought (Davies, Zhang 1991). The primary objective is to use plant growth regulators to prevent lodging of canopy causing in strong cases the loss of previous inputs and decreasing yield 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. Growth regulators can improve the efficiency of water use by stomata regulation. It also causes the increase in the root:shoot ratio. The application of growth regulators may also affect the accumulation of antioxidants protecting the plants during stress conditions.

MATERIAL AND METHODS

The experiment was carried out at the field experimental station in Žabčice with winter wheat variety Matylda. The experimental station is situated in Southern Moravia (the Czech Republic). The location is considered to be one of the hottest areas in the Czech Republic. Sowing of the variety Matylda was carried out on October 15th, 2013 in three replications randomly distributed on experimental area with sowing rate of 4 MGS.ha^{-1}. Variety Matylda belongs to the group 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 in leaves was done in the middle of drought stress (May 26th, 2014), and at the end of drought stress period. After wheat ripening evaluation of yield and yield structure has been done.

As an additional parameter for evaluation of primary phase of photosynthesis measuring of chlorophyll fluorescence by the apparatus FluorPen has been done. The maximum quantum yield of PS II was evaluated. The content of chlorophyll and flavonols was determined in vivo by the method of transmittance and UV screening of chlorophyll fluorescence by the instrument Dualex4 FLAV.

The individual devices for measuring physiological parameters are shown in the Figure 1.

Figure 1 The individual devices for measuring physiological parameters

RESULTS AND DISCUSSION

Drought stress led to a general decline in chlorophyll content in both upper leaves (F and F-1) (see Figure 2). All growth regulators used in the experiment reduced this decline, particularly in the flag leaf. The highest mitigating effect on drought caused decline in chlorophyll content was observed for active ingredient azoxystrobin. Active ingredient etephon reduced negative effect of drought on chlorophyll content, but also led to a decrease in chlorophyll content in lower leaf (F-1), both in the treatment well watered and drought stressed. Conversely, the flavonoid content in leaves of plants exposed to drought stress increased particularly in the lower leaf (F-1) (see Figure 2). Growth regulators generally reduce this effect, while the most significant effect was found for application of etephon where flavonoid content in drought stressed plants dropped below a level of well watered plants.

Chlorophyll fluorescence parameters Vi and Fv/Fm were affected differently within the vertical canopy profile. Vi parameter shows response to drought stress in virtually all leaves within the vertical canopy profile, while the values increased in direction to the lower leaves (see Figure 3). Conversely, a parameter Fv/F, was significantly affected by drought stress only in the lowest leaf (F-3). The positive effect of growth regulators on partametr Vi occurred only in the lower leaves, particularly for growth regulators CCC and etephon. Conversely, the positive effect of regulators reducing the impact of drought on the parameter Fv/Fm was seen in all growth regulator treatments with the most significant effect of the active ingredience trinexapac-ethyl.

Figure 4 show that in 2014 has effect of drought and hight temperature more than last decade.

Figure 2 Changes in chlorophyll and flavonol content in flag leaf (F) and second leaf from the top (F-1) under drought stress and the effect of growth regulator applications. The means (points) and standard deviations (error bars) are presented (n=3). II. Term

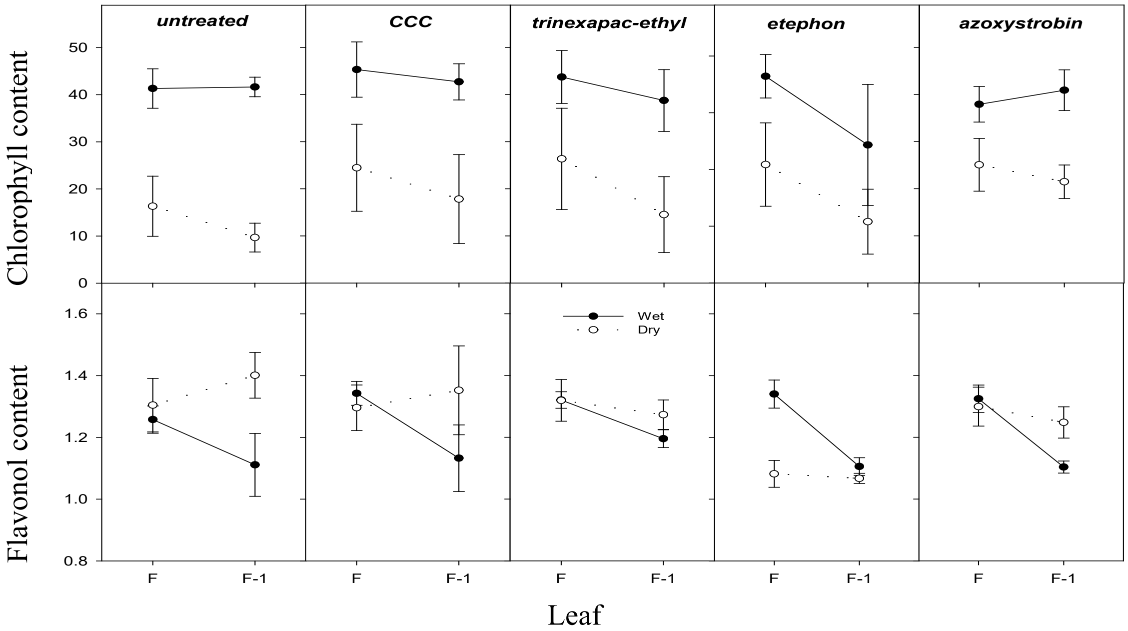


Figure 3 Chlorophyll fluorescence of winter wheat

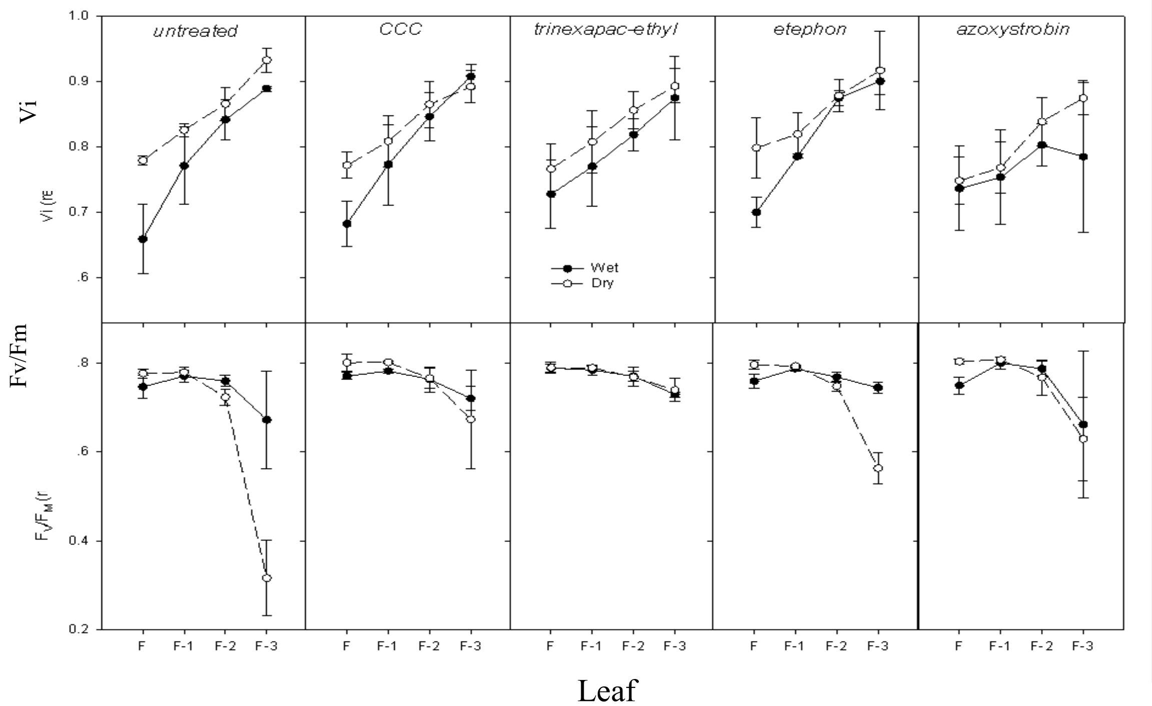
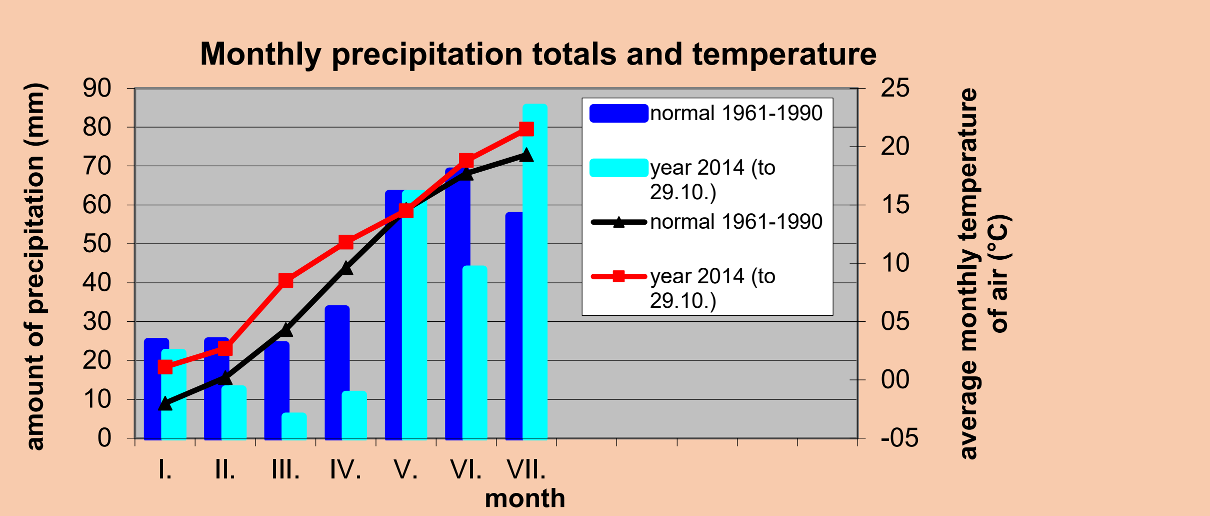


Figure 4 Monthly precipitation totals and temperature 1. 1.–29. 10. 2014



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. Due to drought stress there is decrease of chlorophyll content in leaves. Regulators CCC and trinexapac reduced decrease of chlorophyll content caused by drought at upper leaves but on the other hand they increase it at older lower leaves. Fungicide azoxystrobin reduces decrease of chlorophyll content caused by drought in all leaves. Conversely, the flavonoid content in leaves of plants exposed to drought stress increased particularly in the lower leaf (F-1). It is evident from the measurements that all the regulators reducing the impact of drought on the parameter FV/FM was seen in all growth regulator treatments with the most significant effect of the active ingredience trinexapac-ethyl.

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