HEAT AND DROUGHT TOLERANCE EVALUATION IN POTATO (*Solanum tuberosum* L) CULTIVARS

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Introduction

Heat stress due to increased temperature is an agricultural problem in many areas in the world. It is often defined as the rise in temperature beyond a threshold level for a period of time sufficient to cause irreversible damge to plant growth and development. Usually 10-15 °C above ambient, is considered heat shock or heat stress. In potato production the adverse effects of this stress can be mitigated by developing cultivars with improved thermotolerance using various genetic approaches. For this task, however, a thorough understanding of physiological responses of plants to high temperature is imperative. Potato is characterized by specific temperature requirements. The limits and optimal values for the growth of the above-ground part of the plant and for the tubers are different. At a temperature higher than optimum a reduction or complete inhibition of tuberization and the intensified development of aboveground part of plants take place (Monneveux, 2014; Rykaczewska, 2015). The aim of the study was to assess the response of chosen early potato cultivars to high temperature and drought during the different stages of plant growth in the experiment under controlled and field conditions

Materials and Methods

In 2015 two experiments were conducted.

The pot experiment was carried with following early cultivars: Lord, Milek, Gwiazda, Hubal, Tetyda, Oberon. The impact of heat stress (38 C/ 25 C) on potato plants was tested in four periods: : I – May 16-31, II – June 1-15, III - June 16-30 and IV - July 1-15. In these periods half of the plants were watered to a level close to optimal (Favourable Soil Moisture), while the other half remained without irrigation (Soil Drought). The control combination consisted of potato plants grown throughout the whole season under conditions close to optimal(Fig. 1,2).

The field experiment was carried out at Jadwisin (52°28'44"N and 21°02'38"E) with early cultivars registered recently in the Polish List of Varietes: Viviana, Bohun, Bogatka, Honorata, Laskara, Lavinia, Malaga and Otolia. Planting took place on April 28th on a poor clayey sand of a good agricultural suitability. During the growing season the plant phenological stages were observed. Directly after harvest, the total yield and tubers with physiological defects including tubers chronologically younger (immature), tubers with multidirectional deformations and with gemmations and tuber size were determined.

The results of the experiments were analyzed with ANOVA using a model of statistics program in Statistica 12. Means were separated with Tukey's test at 5% p-value.

Fig.1. Control plants of cultivar Lord on May. 31

Fig.2. Plants of cultivar Lord just after the I period of heat stress (on the left;) and after heat and drought stress es (on the right)

Results and Discussion

In the pot experiment significant impacts of the tested factors on the height of plants, chlorophyll a fluorescence in leaves, yield, number of tubers, mass of individual tuber, tubers defects and immature tubers were found. It was demonstrated here, however, that potato cultivars' response to high temperature during the growing season is dependent on the growth stage, in which the heat stress acts on the plants (Fig.1,2). The results obtained in this study indicate that among the tested cultivars 'Tetyda' was the most tolerant to heat and drought stresses acting on the plants during the growing season. This cultivar was characterized by a relatively small decrease in the total yield and tuber size in relation to the control and by a low level of tuber defects.

In 2015 thermal conditions in the experimental field were similar to those that were determined in the pot experiment (Table 1). The high maximum temperatures during the day from June to August and higher level of rainfall in July contributed to secondary vegetation lasted throughout August until mid-September.

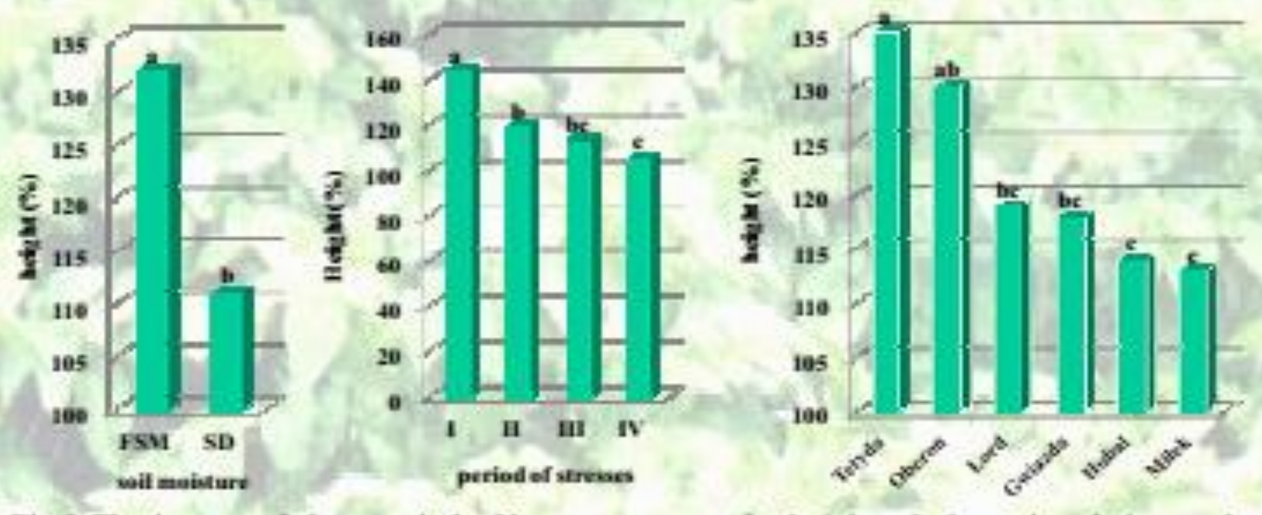

Fig.3 The impact of short period of heat stresses on the **height of plants** in relation to the control – depending on soil moisture, subsequent period and cultivar
Explanations: FSM – favourable soil moisture; SD – soil drought;

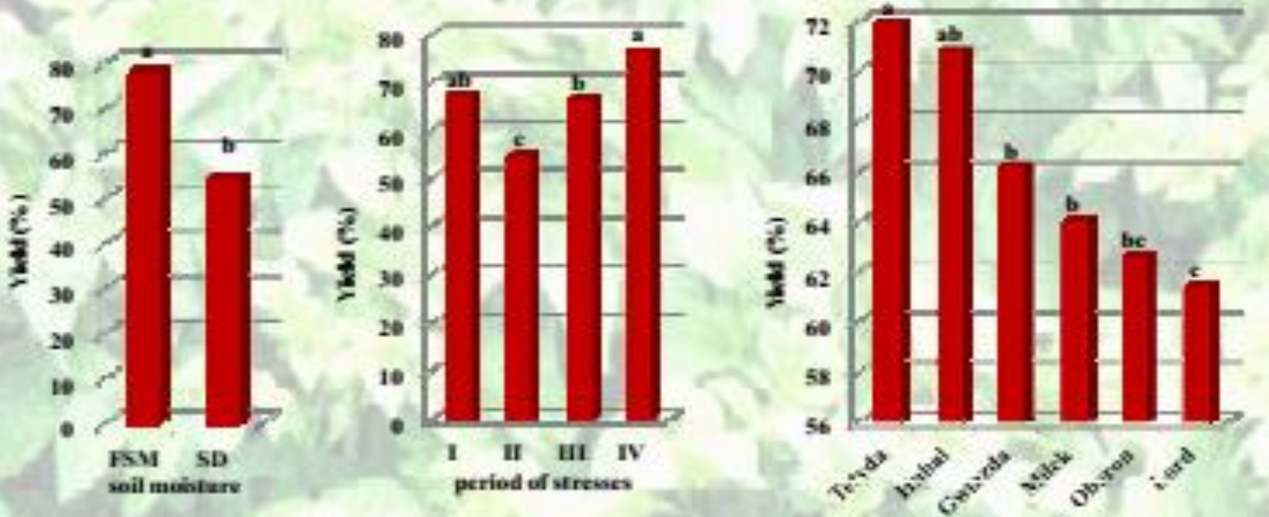

Fig.4. The impact of short period of heat stresses on the **total yield** in relation to the control – depending on soil moisture, subsequent period and cultivar
Explanations: FSM – favourable soil moisture; SD – soil drought;

Meteorological factor	Month				
	April	May	June	July	August
Total rainfall in mm	27.8	39.5	15.4	62.6	8.6
Mean air temperature in °C	8.3	12.9	17.5	19.6	22.5
Maximum air temperature in °C	20.4	23.5	28.4	33.9	35.2
Number of days with temp. > 25°C	0	1	12	16	24

Table 1.Meteorological factors during growing season in the year of study (data from a Campbell Weather Station)

Fig.5.The percentage share of tubers with physiological defects in the total yield of cultivars

Summing up all the physiological defects of tubers and the evaluation of their share in the total yield allowed to assess the tolerance of tested cultivars to heat and drought during the growing season. It was found that most tolerant cultivars were: Otolia, Honorata and Bohun.

Conclusion

The indication of tolerant cultivars allow their selection for cultivation in regions with higher temperatures and allow their use in breeding programmes of new genotypes.

References

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Acknowledgements

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