"THE EFFECT OF DROUGHT STRESS ON YIELD, PHYSIOLOGICAL PROCESSES AND CHEMICAL COMPOSITION OF FORAGE GRASSES OF *LOLIUM, FESTUCA* AND *FESTULOLIUM*"

ABSTRACT

In view of the expected climate change, including longer periods of drought, grass breeders and researchers are interested in selection the species and varieties of forage grasses more tolerant to drought. The aim of this study was to evaluate the differential responses of selected forage grass species and varieties under mild drought stress in the pot and the field experiment, based on estimate of dry matter yield, dry matter content, gas exchange and chlorophyll *a* fluorescence parameter, concentration of flavonoids, phenolic acids, proline and forage quality parameters. Nine varieties of forage grasses of different ploidy levels were evaluated: *Lolium perenne* var. Melluck, Meltador, *Lolium multiflorum* var. Meldiva, Melmi, *Festuca pratensis* var. Merifest, Merifest Tp, *Festuca arundinacea* var. Barolex, Callina and *Festulolium braunii* var. Felopa.

A completely randomized pot experiment was carried out in a greenhouse of the Institute of Soil Science and Plant Cultivation, State Research Institute (IUNG) in Puławy (Poland) in 2013. The whole experiment was divided into 4 water regimes: the first control group kept at 70% field water capacity (FWC, well-watered conditions) during all cuts, the second group kept at 70% FWC and reduced to 40% FWC (drought stress) during three weeks before the first cut, the third group kept at 70% FWC during the first cut but reduced to 40% FWC during three weeks before the second cut and the fourth group kept at 70% FWC during the first and second cut and reduced to 40% FWC during three weeks before the third cut. A split-plot experimental design with three replicates was conducted in the field in 2013-2014 in the Institute for Agricultural and Fisheries Research (ILVO) in Melle (Belgium). A mild drought stress treatment was applied in the period of regrowth before cut III in 2014 and 2015 using three large mobile rain-out shelters equipped with sprinkler irrigation systems. The rain-out shelter experiment consisted of two soil moisture treatments: in the control treatment a soil moisture level of around 20% v/v was obtained using the irrigation system, while in the drought stress treatment plants were only irrigated when the soil moisture level was less than 7.5% v/v.

The results showed that drought stress significantly decrease total dry matter yield in all tested grass varieties in the pot experiment. *L. perenne* had a highest total dry matter yield reduction, and the lowest was found for *F. pratensis*. A significant reduction of total dry matter yield (DMY) was also found in all tested varieties in 2015 in the field experiment. The dry matter yield reduction was the highest in *F. arundinacea* in 2014 and in *F. pratensis* in 2015. However, the lowest reduction of DMY had *L. perenne* in 2014 and *F. arundinacea* in 2015. The highest productivity under optimal and drought stress conditions had *L. multiflorum* in 2014 and *F. arundinacea* in 2015. Dry matter content (DMC) clearly increased in all tested varieties in the pot and field experiment under drought stress conditions. *F. braunii* had the highest increase of dry matter content in both investigated years, while *Festuca* and *Lolium* species had a similar increase in the field experiment. The same trend within species was observed in the pot experiment. Total leaf area significant decreased in all grass varieties in the pot experiment under drought stress. In general, *Festuca* and *Lolium* species had similar reduction of total leaf area.

Gas exchange parameters were significantly lower under drought stress than optimal conditions. *F. braunii* had the lowest reduction of photosynthesis and the highest was found in *F. pratensis* in pot experiment. *L. multiflorum* and *F. pratensis* had a highest decrease of photosynthesis in 2014 and the lowest was observed in *F. arundinacea*. All species reduce CO2 assimilation rate on similar level in 2015. Mild drought stress lead to reduction of transpiration rate and stomatal conductance in all grass varieties in the pot experiment *L. multiflorum* and *F. pratensis* species had the highest decrease of transpiration rate while the highest reduction on stomatal conductance was observed in *L. multiflorum* in the pot experiment. In contrast the lowest decrease of transpiration rate was found in *F.braunii*, while the lowest reduction of stomatal conductance was observed in *L. perenne* and *F. pratensis.* In the field experiment the highest decrease of transpiration rate was found in *F. braunii* and *L. perenne* while the lowest in *F. pratensis.* Stomatal conductance reduction under drought stress treatment was significantly higher in 2015 than in 2014, but *Lolium* species, especially *L. perenne* had lower reduction of this process than *Festuca* species in 2014. In 2015 all species reacted with a similar decrease of stomatal conductance. Water use efficiency (WUE) was quite different in tested varieties in the pot experiment. WUE was significantly higher under drought stress than in optimal conditions in period I. The highest increase of WUE was found in *L. multiflorum.* A better water use efficiency was observed in the field experiment

than in the pot experiment. The highest increase of WUE had *L. perenne* and the lowest was found for *L. multiflorum* and *F. pratensis*.

Maximum quantum efficiency of photosystem II (F_v/F_m ratio) decreased slightly under drought stress in the pot experiment. During yield experiment a minor decrease of F_v/F_m ratio was observed in all tested varieties, but the reduction was higher in 2015. The average decrease of PI for all varieties was also higher in 2015 than in 2014.

Drought stress significantly increased proline, flavonoids and phenolic acids concentration in pot and field experiment. *F. pratensis* had the much higher increased of proline concentration, than *Lolium* species in pot experiment. In the field experiment the highest significant increase of proline content was found for *L. perenne* and *F. pratensis.* The highest increase of flavonoids had *F. pratensis* in the pot and *L. multiflorum* in the field experiment. *L. perenne* characterized the highest increase of phenolic compounds in the pot experiment, while *L. perenne* and *F. braunii* had the highest increase in the field experiment.

All tested grass varieties grown under drought stress conditions had a lower content on NDF and ADF compared to optimal water conditions during pot and field experiment. Content of CP was different in the three periods in the pot experiment with a tendency to increase in period II and III. During the field experiment a decrease of CP was observed in 2014 and an increase in 2015. Drought stress triggered an increase of WSC in two investigated experiments. Under drought stress conditions, a tendency to decrease of NDFD in pot and field experiment was observed. In contrast, OMD had a tendency to increase in the pot experiment and in 2015 in the field experiment.