EFFECT OF DROUGHT ON YIELD POTENTIAL OF SELECTED GRASS SPECIES

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Abstract: The main aim of this study was to evaluate the response of the production types of grasses to stress-induced reduction of normal precipitation in relation to their production characteristics and the structure of biological phytomass. The covers were established by planting of pre-grown plants of the individual grass species in the spring of 2009 in the form of a small-plot experiment in two blocks. Block A – normal precipitation mode, Block B – reduced precipitation mode consisting in roofing of 50% of the experimental area coverage by a special film with a minimum reduction of light conditions in order to drain a half of rainfall out of the area. In the crop year 2011 the annual total Rainfall was relatively lower by 14.0% (632.8 mm) than the long-term average, i.e. 736 mm. The species with the highest ability to create fodder of *Dactylis glomerata* significantly decreased fodder production and formation of above-ground shoots due to reduced precipitation in meadow utilization. A simile trend was also observed in the utilization in *Festuca pratensis*. The lowest reduction in production due to drought appeared in *Lolium perenne*.

Key Words: Drought, Dactylis, Festuca, Lolium

INTRODUCTION

In recent years, the increasingly frequent topic is climate change. This change (rising temperatures, lengthening of the growing season, increasing evaporation) significantly affects agricultural production in traditional production areas of Central Europe, as illustrated by example better results in growing of corn on its northern or upper height limit. Changes in the amounts and timing of rainfall events will probably affect ecosystem processes, including those that control carbon (C) cycling and storage. In relation to the ongoing global warming, it is desirable to test resistance of grass species to a lack of moisture. Seasonal variation in precipitation and temperature are important controls of soil and plant processes in grasslands (Fiala et al. 2012).

Many species respond to drought by maintaining high water potential by reducing water losses or better adsorption. Limitation of water losses can be reduced in the development of water stress by rolling the leaves or fast closing stomata. The plants, however, not only reduce transpiration, but also reduce photosynthesis and thus growth and development (Xu et al. 2006). Interaction of drought stress with high temperature has a greater effect than the damaging effects of each stressor separately. There is a loss of water by transpiration required for cooling and thus faster drying (Jiang, Huang 2001). Almost a third of the fresh water that is consumed in Europe is used in agriculture, mostly for irrigation (Flörkea, Alfami 2004).

A high water demand for creation of grass production is found in Novak (2008). The range of transpiration coefficient of 600–800 l of water for production of 1 kg of dry matter of foyer points to the differences between grass species. Rychnovska (1993) gives the daily maximum of transpiration in production grasses (cock's-foot, meadow fescue, timothy-grass) at the level of 10–30 mg· g^{-1} of dry matter per minute, and in case of grasses of hygrophyte character up to 60 mg· g^{-1} of dry matter per minute. On hot days, high evaporation causes a so-called saturation water deficit in grassland amounting to ca. 20% of the water needs even if there is sufficient moisture in the soil.

MATERIAL AND METHODS

Characterization of growing locality and experimental design

Experimental studies are conducted at the experimental site of the Mendel University in Brno, in the Fodder Research Station of Vatín. From an agronomic categorization point of view it is a potato-growing region, with altitude of 535 m.

Weather conditions:

• average annual temperature 6.9°C (of which for vegetation 12.6°C annual),

• amount of precipitation 736 mm (of which for vegetation 440 mm).

The covers were established by planting of pre-grown plants of the individual grass species in the spring of 2009 in the form of a small-plot experiment in two blocks. Block A – normal precipitation mode, Block B – reduced precipitation mode consisting in roofing of 50% of the experimental area coverage by a special film with a minimum reduction of light conditions so as to drain a half of rainfall out of the area. The mode of precipitation regulation was applied only in the second year after planting for the reason of allowing the same conditions for initial growth and development of plants. In the years 2010–2012, precipitation regulation was implemented during the warm months, i.e. from 01. 04. to 31. 10.

Growing Variants:

Each variant consisted of planting 25 pcs of individuals grown in layouts of 200 × 200 mm in triplicate (a, b, c). Planting was carried out in June 2009. In the first year, clearing the covers of weeds was done manually. Harvest of the covers (individual plants) was carried out 2× a year only in the year of establishment. From 2010 was subjected to a "model" 5-fold mowing grazing utilization and 3-fold mowing. NPK fertilizer was applied to the surface of the (dose of N 50 kg · ha^{-1}) before planting. In the next year's crop fertilization was 150 kg N · ha^{-1}, of which 1/3 NPK after hibernation and 2 more doses after mowing LAV 27.5%.

The subject matter of monitoring and evaluation was a total of 3 grass species (*Dactylis glomerata, Festuca pratensis* and *Lolium perenne*) and their suitable varieties, as for meadow and grazing character (see the overview given below). Harvest of the covers (individual plants) was carried out system of 3-fold mowing meadow utilization and "model" 5-fold mowing simulated grazing utilization.

Evaluation of inter-species differences in production and differences in production among the water mode were subjected to the ANOVA test. Results were evaluated with Tukey's test. Differences were declared to be statistically significant when $P \leq 0.05$.

RESULTS AND DISCUSSION

Grazing utilization

When applying the simulated grazing 5-fold mowing utilization, was *Dactylis glomerata* with total weight of 470.5 g · 1^{-1} plant in the average of moisture modes, then *Lolium perenne* and *Festuca pratensis* with a relative decrease of 16.9% and 21.9%. In *Dactylis glomerata*, the production was even slightly higher (rel. + 3.1%). In *Lolium perenne* there was a decline in production due to reduced precipitation of rel. - 15.3%, while a conclusively lower production applies to years 2011 and 2012. In *Festuca pratensis* the production was relatively reduced by - 11.9%. A lower production is conclusive in 2012. Despite the overall lower fodder production, utilization of multiple mowing may be related to better adaptation to an uneven course of precipitation during the growing season.

Influence of the year on differences in plant weight is generally very significant. In *Lolium perenne* differences between the year 2010 and the two following harvest years are significant, with a clear tendency to decreasing production capability and in both good moisture modes. In *Dactylis glomerata*, there was a significant difference only of decline in production in the third year 2012 in the normal moisture mode. In *Festuca pratensis* there is a significant drop in production in the third year 2012, too, in both moisture modes.

Table 1 Weight of plants of grass species (in grams per plant) in dry state in simulated grazing utilization (5 mowings), in two moisture mode, 2010–2012.

Species	Moisture mode	Weight of plants (g · l^{-1} piece) in dry matter			∑ 2010–2012
		2010	2011	2012	
Lolium perenne	N	218.6 a	113.0 b	88.6 b	420.2
	R	226.3 a	81.7 a	48.3 a	356.3
	Rel. %	103.5	72.3	48.3	84.7
Dactylis glomerata	N	177.1 a	166.2 a	114.6 a	457.9
	R	183.1 a	169.3 a	119.7 a	472.1
	Rel. %	103.4	101.9	104.4	103.1
Festuca pratensis	N	162.7 a	145.2 a	79.3 a	387.2
	R	142.2 a	134.8 a	67.9 a	344.9
	Rel. %	87.4	92.8	84.2	89.1

Different letters indicate statistically significant differences.

Meadow utilization

The highest weight of dry fodder plants for three harvest years and an average of both moisture modes were achieved in *Dactylis glomerata* 586.4 g · 1^{-1} plant. Production in *Lolium perenne* 464.2 g · 1^{-1} plant and *Festuca pratensis* 453.7 g · 1^{-1} plant is relative lower by - 20.8% and 22.6%, which is a significant difference. The effect of reduced precipitation was manifested in decreased production at most in *Dactylis glomerata* to the level of 58.8%, further in *Festuca pratensis* by a decrease of 1/3 (rel. to 66.5%) and at least in *Lolium perenne* where the production dropped to the level of 90.1%. However, a significant effect of reduced precipitation on production was, except for partial differences in certain mowings, only found in *Festuca pratensis* and that was only in 2012. The influence of year on production was significant.

Table 2 Weight of plants of grass species (in grams per plant) in dry state in meadow utilization (3 mowings/year), in two moisture mode, 2010–2012

Species	Moisture mode	Weight of plants (g · l^{-1}piece) in dry matter			∑ 2010–2012
		2010	2011	2012	
Lolium perenne	N	245.9 a	116.9 a	125.7 a	488.5
	R	236.8 a	114.0 a	89.2 a	440.0
	Rel. %	96.3	97.5	70.0	90.1
Dactylis glomerata	N	163.1 a	236.8 a	338.8 a	738.7
	R	132.9 a	137.7 b	163.5 a	434.1
	Rel. %	81.5	58.1	48.3	58.8
Festuca pratensis	N	151.9 a	198.6 a	194.6 a	545.1
	R	112.2 a	149.7 a	100.4 b	362.3
	Rel. %	73.9	75.4	51.6	66.5

Different letters indicate statistically significant differences.

CONCLUSION

The species with the highest ability to create fodder of *Dactylis glomerata* significantly decreased fodder production and formation of above-ground shoots due to reduced precipitation in meadow utilization. A simile trend was also observed in the utilization in *Festuca pratensis*. The decrease in both production and the number of shoots was conclusive due to the year. The lowest reduction in production due to drought appeared in *Lolium perenne*. In this species, production decreases

significantly with ageing of the cover. In case of the grazing system, production of all grass species was insignificantly lower as compared with meadow exploitation. The effect of drought on decrease in production (in *Lolium perenne*) has not been proved.

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