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The XXIII International Grassland Congress (Sustainable use of Grassland Resources for Forage Production, Biodiversity and Environmental Protection) took place in New Delhi, India from November 20 through November 24, 2015.

Proceedings Editors: M. M. Roy, D. R. Malaviya, V. K. Yadav, Tejveer Singh, R. P. Sah, D. Vijay, and A. Radhakrishna

Published by Range Management Society of India

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Paper ID: 596
Theme 4. Biodiversity, conservation and genetic improvement of range and forage species
Sub-theme 4.1. Plant genetic resources and crop improvement

Drought effect on yield of forages grass species

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Keywords: *Dactylis*, Drought, *Festuca*, *Lolium*, Pseudostems

Introduction

Climate 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 and Huang, 2001). Almost a third of the fresh water that is consumed in Europe is used in agriculture, mostly for irrigation (Flörke and Alcano, 2004). The main aim of the study was to evaluate the response production types of grasses to stress-induced reduction of normal precipitation in relation to their production characteristics and the structure of biological phytomass.

Materials and Methods

Experimental studies were conducted at the experimental site of the Mendel University in Brno (Czech republic, 49°15´5″N, 15° 58´15″E), in the Fodder Research Station of Vatín. From a geographical 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 pregrown 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 summer months, i.e. from 01. 04. to 31. 10. Evaluation of the precipitation course in the individual years, seasons and harvestings is found in the part with results. 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 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.

Rated characteristics:
- Number of stalk (a leaf) pseudostems
- Weight in dry matter

Results and Discussion

When applying the simulated grazing 5-fold mowing utilization (Table 1), was *Dactylis glomerata* with total weight of 470.5 g/1 plant in the average of moisture modes, then *Lolium perenne* with 391.2 g and *Festuca pratensis* with 367.5 g 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.

The number of pseudostems (Tab. 2) of the individual grass species, as well as of the varieties, is their specific biological property. *Lolium perenne* which is rather a pasture species produces the most shoots which are more delicate, thus a denser cover. *Dactylis glomerata* and *Festuca pratensis* belong rather to the meadow type, with fewer and thicker shoots, particularly in the first mowing. Statistical evaluation of species divergence in this case appears to be ineffective. It is more important to assess the response and formation of shoots in each species to the effect of drought. From the presented data concerning the meadow utilization of covers it follows that the largest reduction in the number of stems due to drought occurred in *Dactylis glomerata* (−34.7%), in *Lolium perenne* by −23.7% and in *Festuca pratensis* by −20.5%. However, in terms of statistical evaluation, these differences are not significant.

Table 1: Weight of plants

	Species	**Moisture mode**	**Weight of plants (g/1 piece) in dry state**			**∑ 2010 - 2012**
			2010	**2011**	**2012**	
Meadow utilization	***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	151.9a	198.6a	194.6a	545.1
		R	112.2a	149.7a	100.4b	362.3
		Rel. %	73.9	75.4	51.6	66.5
Grazing utilization	***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

Table 2: Number of pseudostems

	Species	**Moisture mode**	**Number of pseudostems (1 year/pieces)**			**∑ 2010 - 2012**
			2010	**2011**	**2012**	
Meadow utilization	***Lolium perenne***	N	388,1 a	330,7a	449,5a	1 168,30
		R	342,4a	225,7a	323,8a	891,9
		rel. %	88.2	68.2	72.0	76.3
	Dactylis glomerata	N	145,1a	217,0a	333,0a	695.1
		R	126.6a	162.0a	165.3a	453.9
		rel. %	87.2	74.6	49.6	65.3
	Festuca pratensis	N	150.5a	218.3a	287.7a	656.5

		R	140.8a	198.9a	191.7a	522.0
		rel. %	93.5	91.1	66.3	79.5
Grazing utilization	***Lolium perenne L***	N	404,9a	695,9a	685,3a	1786,13
		R	398,7a	452,2a	393,4a	1247,8
		rel. %	98.5	65.0	57.5	69.9
	Dactylis glomerata	N	149,9a	289,5a	262,7a	702.1
		R	143,7a	284,1a	269,7a	697.5
		rel. %	95.4	98.1	102.7	99.3
	Festuca pratensis	N	184,7a	506,1a	362,4a	1053.2
		R	191,4a	447,1a	276,9a	915.4
		rel. %	103.6	88.3	76.4	86.9

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 similar 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 (rel. only −9.9%) 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 (max. 15.7% in *Lolium perenne*) has not been proved.

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Acknowledgement

The paper was prepared under the support from Grant IGA TP 2/2015: Effect of selenium on the quality of plant and animal production from the perspective of health safety