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Influence of Water Stress on Germinability of Selected Grass Species

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Abstract. Grasses are used for a lot of purposes: as a grazing land, the grass is mown and the phytomass is used in the energetic industry. It also fulfils a lot of non-production roles, not only the environmental one. Selection of a suitable crop stand type is conditioned by a lot of factors, e.g. the tolerance of grass to drought. This article describes the germinability of seeds (it is based on the initial trial outcomes) of particular grass species, which are suitable for the energetic industry (*Phleum pratense, Phalaris arundinacea, Bromus catharticus*), grown in different water conditions. *Bromus catharticus* is the most tolerant grass species to the water stress. Difference in the germinability rate between dry and wet conditions amounts to 13.8 %.

Keywords: Water stress, Germinability, Grasses, Energetic industry

1. Introduction

Perennial grassland farming is one of the most frequent farming activities. The cultivated herbage land represents approximately two thirds of all the farming land [1], the herbage stands are usually grown in an extensive way. As for the Czech Republic, the grassland represents 25 per cent of the farming land. However, the production role of the grassland has been currently suppressed [2], and the perennial grassland plays the environmental role in particular. The area covered by perennial grassland is approximately by one half smaller than the arable land, which is particularly covered by cereals [3]. On the other hand within the organic farming, the perennial grassland area is significantly larger than the arable one, the arable land represents less than 10 per cent of the entire farming land [4,5]. However, the organic herbage is also grown in the extensive way, as the dry matter yield rate does not do over 1.5 $t.ha^{-1}$ [6].

The intensive grasslands farming, which is particularly carried out in wetter locations (where the precipitation rate exceeds 1 thousand mm), may bring the dry matter yield rate of 18 $t.ha^{-1}$ or more [6], if a favourable nutrition level is respected (300 $kg.ha^{-1}$ of nitrogen), the grass is more frequently mown (six times), and there is a high diversity of species. In order to achieve the above-mentioned yield rate, we have to select the cultivars growing very fast despite a low temperature, which overwinter, are perennial [7], and tolerant to the water stress. Besides *Lolium multiflorum, Phleum pratese* and *Phalaris arundinacea* [6], are considered as the suitable grass cultivars. As for the energetic grass cultivars, some species of brome grass are considered as suitable ones, e.g. *Bromus inermis,* or *Bromus cartharticus* which are able to adapt to the particular local conditions, and which are highly tolerant to drought [8].

According to [9] and [10], the water deficiency (i.e. the drought), is the most significant abiotic stressing factor limiting the plant productivity. The grass crop stands are similar to the cereal ones from the point of view of the tolerance to drought [11,12]. [13] states the fact that the plant tolerance to drought is a complex feature depending on three aspects: drought avoidance, an ability to interfere with the desiccation and a tolerance to the desiccation. Growing in dry location, the grass crop stands have a very dense root system several meters deep. However, the root system formation usually limits the formation of an above-ground phytomass. Anyway, the above-ground phytomass is the most important energetic part of a plant. Therefore,

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the cultivars as resistant as possible to the water stress have to be chosen and grown. The water deficiency already limits the germination of seeds; the water stress influence may be studied and evaluated in this phase.

2. Research

2.1. Material and Methods

The research has been based on a monitoring and evaluation of the germinability and profitability of three grass species, which have been considered as potentially suitable for the energetic industry: *Phleum pratense* (Sobol cultivar), *Phalaris arundinacea* (Chrastava cultivar), and *Bromus catharticus* (Tacit cultivar). The studied grass samples were put into six Petri bowls (having 150 mm in diameter) covered with a wet piece of filter paper. Fifty grass caryopses were put into each Petri bowl, lying there in a regular span. Each grass species was tested in the dry and wet conditions too. The filter paper was maintained wet in the wet conditions (it was moistened every 24 hours). The watering was stopped 72 hours later in the dry conditions, just in time when the first germs were emerging on the seeds. The watering repeated until the emerged plants were 5 cm tall. The amount of germinated seeds was counted. A constant room temperature was maintained in the laboratory during the whole trial. The trial was repeated ten times in the first research year (2011), whereas further twenty repetition cycles are supposed to follow in the following years.

2.2. Results and Discussion

The research was based on a monitoring and evaluation of the germination of dry and wet seeds of particular grass species. Besides the variations in the water management, the germinability rate was influenced by other factors, which influenced the outcomes of the trial repetition cycles: light regime, and periodicity of germination during the whole year. [14] state the fact that, as for the most of the plant species, there are the differences in the germinability of seeds, just as the germination speed, in different periods of time. The fact stated by [15] has been confirmed by our research trials. Dry conditions dominating at the beginning of the seed germination period may have a negative effect on the total germinability rate. The following Figures demonstrate the laboratory germinability (in per cent) of the tested species. Figure 1 shows that the germinability rate of *Phleum pratense* and *Bromus catharticus* exceeded the limit of 80 % when the wet conditions dominated. Contrary to them, *Phalaris arundinacea* has never exceeded the limit.

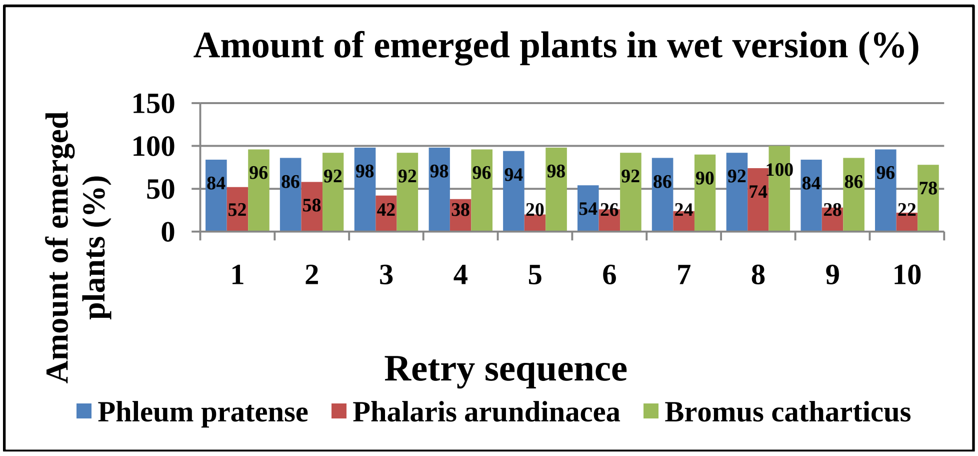

Fig. 1: Amount of emerged plants in wet version (%)

Figure 2 demonstrates the amount of plants (in per cent) which emerged in the dry conditions. We may deduce from the research trial outcomes (demonstrated in Figure 2), that *Bromus catharticus* is the most tolerant to drought of all the tested grass species. Contrary to it, *Phalaris arundinacea* is the least tolerant of all the tested species. Growing of *Phleum pratense* was accompanied by significant differences in the drought tolerance between the repetition cycles. Figure 3 demonstrates the differences in the germinability rate between the grass species grown in the dry and wet conditions.

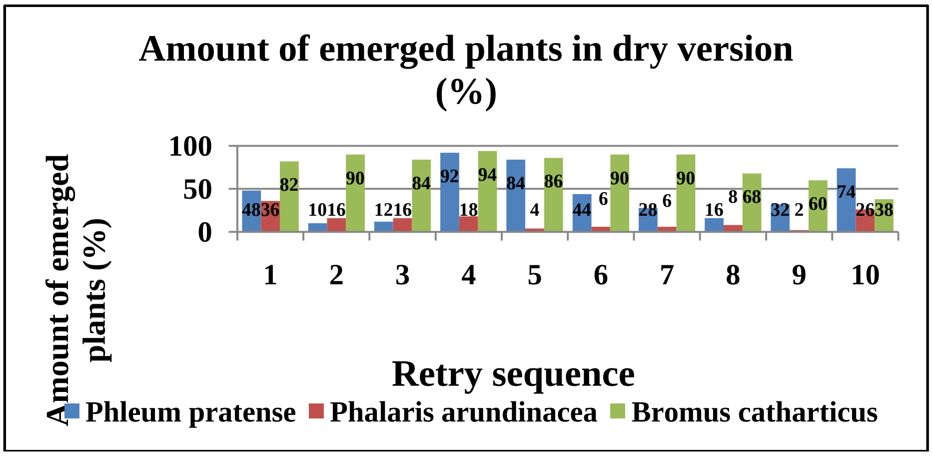

Fig. 2: Amount of emerged plants in dry version (%)

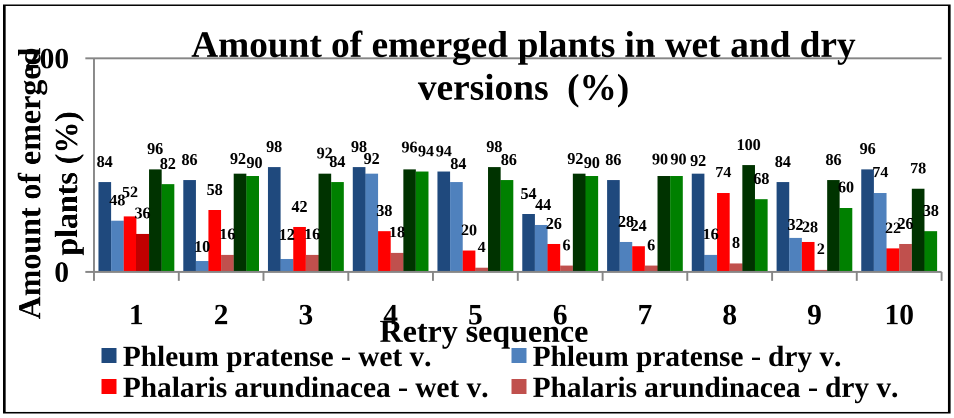

Fig. 3: Amount of emerged plants in wet and dry versions (%)

Figure 4 shows the largest amount of vital plants of *Bromus cartharticus* emerging in the wet conditions, and the simulated water stress conditions (counted as an average of all the repetition cycles). 92 per cent of *Bromus cartharticus* caryopses germinated when the plants were grown in the wet conditions. As for the dry conditions, when the grass seeds were facing the water stress conditions in the germination period, the amount of germinated caryopses was by 13.8 per cent lower. *Phleum pratese* grown in the wet conditions was also characterised by a favourable germinability rate (87.2 per cent). On the other hand, only 44 per cent of the caryopses grown in the dry conditions emerged and changed into the vital plants. It means the difference of 40 per cent between the dry and wet version. *Phalaris arundinacea* achieved a very low germinability rate in both versions (38.4 per cent in the wet conditions, 13.8 per cent in the dry conditions). As for the dry version, the germinability of seeds is conditioned by a length of the water stress period and a temperature. E.g. [15] present the outcomes of their research: the germinability rate of the grass caryopses dried under the temperature of 30 ℃ for three days was by four per cent higher than the germinability rate of the caryopses which were dried under the temperature of 35 ℃ for five days.

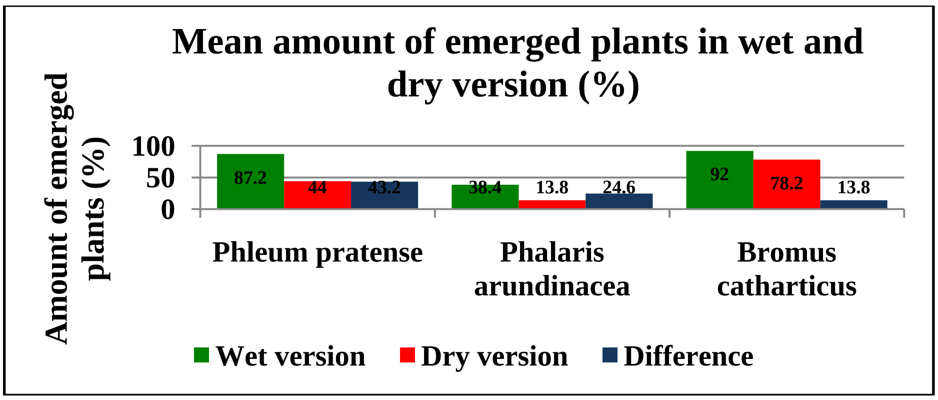

Fig. 4: Mean amount of emerged plants in wet and dry version (in per cent)

Table 1 shows the difference in the germinability rate (in per cent) between the dry and wet version. The amount of emerged plants in the wet version is considered as 100 per cent. The dry version germinability rate decline (presented in Table 1 in per cent) is derived from the wet version germinability rate. Let's demonstrate the germinability rate decline on e.g. *Phleum pratese.* The germinability rate of the dry version seeds was by 43 per cent lower than the germinability rate of the wet version seeds. [15] have found out that the germinability of seeds facing the water stress probably relates to a caryopsis size and a water absorption capacity of this caryopsis. *Bromus cartharticus* has confirmed this finding. It has much bigger caryopses than the other grass species; the difference in the mean germinability rate between the dry and wet versions represented only 16 per cent. Table 1 and Figure 4 show *Bromus cartharticus* to be the most tolerant species to drought of all the tested species. However, [16] points out that a certain species or cultivar may be tolerant to drought, when facing the water stress. However, if the existing water stress intensity increases, this species/cultivar becomes intolerant to drought, and any tolerant genotypes do not exist anymore. There were significant differences in the germinability rate between the grass species, which have been confirmed by [17]. He, based on research experiments also with other grass species, states the fact that the germinability rate varies not only on the species level. It might be also different within the same species (there may be differences between the cultivars of the particular species).

Table 1: Decline in the germinability rate (%) – the dry version being compared to the wet version

	Number of repetition cycle										
Grass species	1	2	3	4	5	6	7	8	9	10	Mean
Phleum pratese	43	88	88	6	11	9	77	83	62	23	49
Phalaris arundinacea	31	72	62	53	80	77	75	89	93	-18	61
Bromus cartharticus	15	2	9	8	12	2	0	32	30	51	16

2.3. Conclusions

As several studies predict, the climate could become more arid, dry periods could become more frequent and they could prolong in the Czech Republic. Therefore, the tolerance to drought will be increasingly important factor also for grassland, even since the establishment phase of stand. As the outcomes of the research trials have shown, *Bromus cartharticus* (Tacit cultivar in particular) is characterised by the lowest differences in the germinability rate between the dry and the wet version (16 per cent). Such difference is by 23 per cent lower than the difference in the germinability rate between the dry and the wet version of *Phleum pratese*, and 45 per cent lower than the difference in the germinability rate between the dry and the wet version of *Phalaris arundinacea*. *Bromus cartharticus* is the most suitable grass species to be grown in the locations where the climatic conditions change a lot. On the other hand, *Phalaris arundinacea* (Chrastava cultivar in particular) is not suitable grass species to be grown in the arid regions, as the total germinability rate was low. Moreover, there was a considerable difference in the germinability rate between the dry and the wet version (61 per cent). We also noticed significant dry and wet version differences in *Phleum pratese* germinability rate (43.2 per cent). The amount of the above-ground grass phytomass plays the important role in the energetic industry. It is conditioned by the crop stand quality in the germination and emergence periods. As the research outcomes have shown, *Bromus cartharticus* is supposed to be the most suitable grass species for arid conditions.

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