Effect of temperature on germination of different panic weed species

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Abstract

The millet species has been a serious problem for a long time in the maize production. They can be found in the largest maize producer countries in large quantities and species richness. The main reason of the spreading is that it is perfectly adapted to maize production technology. These weed species have a good herbicide tolerance, and if the soil is warmer than 15 ^{o}C, they can germinate in the complete vegetation period.

The experiment was designed to examine the effect of rising temperatures on germination of *Panicum miliaceum, P. ruderale* and *P. riparium*. We wish to determine the effect of increasing temperatures of seedlings viability and the effect on the shoot and the root length. We made an experiment in laboratory conditions, where we have investigated the germination of three panic species in different temperatures.

Keywords: *Panicum miliaceum, P. ruderale, P. riparium* germination, temperature

Összefoglalás

A köles fajok régóta komoly problémát jelentenek a kukoricatermesztőknek. A legnagyobb kukoricatermesztő régiókban nagy mennyiségben és fajgazdagsággal vannak jelen. Elterjedésének fő oka, hogy tökéletesen alkalmazkodott a kukorica termesztéstechnológiájához, jól viseli a gyomirtást, nem rendelkezik magnyugalommal, illetve amennyiben a talajhőmérséklet elérte a 15 ^{o}C-ot, folyamatosan képes csírázni (megfelelő csapadékmennyiség mellett). Kísérletünk célja az volt, hogy összehasonlítsuk három köles faj, a *Panicum miliaceum, P. ruderale* és *P. riparium* csírázását emelkedő hőmérsékleten, illetve vizsgáljuk a csíranövények növekedését. Kísérletünket a Pannon Egyetem Georgikon Karának Növényvédelmi Intézetében végeztük, laboratóriumi körülmények között. A vizsgálat során 20 Petri-csészébe helyeztünk 50-

50 magot, fajonként és hőmérsékletenként 4 ismétlésben. A vizsgálatokat 20, 25, 30 illetve 35 ^{o}C-on végeztük. Mindhárom fajból két-két mintát vizsgáltunk: egy 1985-ös keszthelyi gyűjtésű, illetve egy 2013-as tarjáni *Panicum miliaceum* mintát, két 2010-es gyűjtésű *Panicum riparium* mintát Mérkről illetve Nagykállóról, valamint két 2010-es gyűjtésű *Panicum ruderale* mintát Keszthelyről illetve Pusztadobosról. A mintákat fűthető termosztátba helyeztük. A harmadik napon vizsgáltuk a csírázási százalékot és az abnormális csírák számát, majd a hetedik napon a hajtás- illetve gyökérhosszt.

Kulcsszavak: *Panicum miliaceum, P. ruderale, P. riparium*, hőmérséklet, csírázás

Introduction

The millets (*Panicum*) are one of the largest, species-rich group of grasses, the number of species belonging to this group is more than five hundred in the world (Barkworth et al, 2007). The millet, in our country and throughout Europe, because of the intensification of crop production and the wide usage of herbicides, has become dangerous, hard to eradicate weed (Novák et al, 2009).

The common millet (*Panicum miliaceum subsp. ruderale*) is the wild form of the *(Panicum miliaceum L.)* proso millet (Scholz-Mikolás, 1991; Williams et al., 2007;). The common millet's subspecies, which can be found in large quantities in large-scale maize farming, evolved by reverse mutation from proso millet (Pinke-Pál, 2005).

In Central Europe, in the early 1990s a new independent, weed millet subspecies *(P. miliaceum subsp. agricola)* had been identified, which have been added to the European plant identification handbooks and to the list of invasive species. Hungarian name has not been found for it yet. The most important feature is that in many properties intermediate character can be seen between the proso millet and the *subsp. ruderale* (Magyar-Király, 2012a).

Fresh ripped millet seeds have high vitality (above 90%), however the germination dynamics of species are different. The proso millet seeds practically have no dormancy state, after a 30 days-after-ripening period the germination is almost 100% (Csala, 1975; Eberlein et al., 1990; Czimber-Hartmann, 2005). For the germination is required about 10 ^{o}C soil temperature and an amount of water which is equivalent to the 20-30 % of its weight (Láng, 1965).

At a small part of the grains (5-8%) a secondary dormancy can be occurred, because the seeds are heavily surrounded by the awn, and the core is not able to take the moisture needed for the germination. In such a case the seeds only will germinate if the awn dissolved enough to be able to let through the moisture (Czimber-Hartmann, 2005). To the persistence of millet species contributes a morphological characteristic, that the seed crust of the darker coloured seeds is thicker, so in their case the water absorption and also the germination can take place much more slowly than in the case of the lighter coloured seeds. Such seeds remain viable for up to 5 years in the soil (Kahn et al, 1996).

The optimal germination temperature in laboratory conditions, according to Trivedi (2010) is 27-34 ^{o}C, however Baskin and Baskin (1985) have proved that the most intensive germination takes place at alternating temperature (20/35 ^{o}C).

The seeds of different millet species germinate from the topsoil (on average 2.5 cm) (Bough-Cavers, 2009). While the quantity of common millet core is significant, depending on the soil type from 12-17 cm depth viable seeds can develop (Trivedi, 2010). Seeds from the shallower layers usually can germinate in 5 days, but from deeper layers may be 10-14 days required for the first appearance of seedlings (James et al, 2010).

Its prosperity may begin on the 30th day after germination, flowers bloom constantly, so the seed formation can be delayed (Reddy et al, 2007). The millet species have no special strategy in seed dispersal, the seeds fall (Magyar-Király, 2012b) hard by the mother plant. In seed dispersal especially the anthropogenic factor plays a role, because the seeds can be delivered by different agricultural machines in a short area, within or between boards (Csala, 1975; Westra, 1990; Bough-Cavers, 2009).

Material and method

The experiment was conducted in the Institute of Plant Protection, Georgikon Faculty, University of Pannonia, under laboratory conditions. The millet seeds have been deep-frozen immediately after collection (-40 ° C), until the start of the experiment. Millet seeds were placed in 20 cm diameter glass Petri dishes on a double layer of filter paper, 50-50 seeds of each species at different temperature with 4 replicates. The temperatures were 20, 25, 30 and 35 °C. 3 millet species were tested, two *P. miliaceum* samples (one is from 1985, Keszthely and the other is from 2013, Tarján), two *P. riparium* samples (both from 2010, Mérk and Nagykálló) and two *P. ruderale* samples (from 2010, Keszthely and Pusztadobos). The samples were placed in a thermostat and evaluation was performed in two occasions. The germination percentage and the number of abnormal seedlings were determined on the third day and then the length of the shoot and the root on the seventh day.

Results

Table 1. The germination percentage of millet species at different temperatures

Germination %	20 °C	25 °C	30 °C	35 °C
PANMI 1985	98%	100%	96%	98%
PANMI Tarján	98%	96%	100%	98%
PANRU Keszthely	98%	100%	96%	98%
PANRU Pusztadobos	98%	100%	100%	98%
PANRI Mérk	98%	94%	94%	90%
PANRI Nagykálló	98%	94%	92%	90%

A first evaluation of the experiment was carried out on the third day. The percentage of germinated seeds and the number of abnormal seedlings were determined in each Petri dish (table 1.). The lack of these suggests that by the increase of the temperature, even on 35 °C, the seedlings were not damaged. Furthermore, it was observed that the number of germinating seeds was not decreased by the increase of the temperature, which leads to the conclusion that under laboratory conditions, if sufficient amount of water is available, the high temperature will not prevent the seeds from germination.

The termination of the experiment was performed on the seventh day, when the length of the shoot and the root was measured.

Table 2. Average shoot length of the tested P. miliaceum samples at different temperatures

Shoot length (mm)				
	20 °C	25 °C	30 °C	35 °C
PANMI 1985	77,5	78,82	82,45	78,5
PANMI Tarján	76	76,5	79,5	74,15

By the increase of the temperature in the case of the two tested *P. miliaceum* samples significant change has not occurred, the shoot formation was not affected by the increased stable temperature verifiably (table 2.).

Similar results were obtained by measuring root length (table 3.). The minimal differences at the shoot length almost disappeared at the root length; equalized root length was produced at all temperatures. The only well-marked difference from the aspect of shoot and root length was in the samples from Tarján, if only minimally, but weaker growth was observed.

Table 3. Average root length of the tested *P. miliaceum* samples at different temperatures

Root length (mm)				
	20 °C	25 °C	30 °C	35 °C
PANMI 1985	11,15	11,12	11,02	11,63
PANMI Tarján	9,912	9,512	9,22	9,737

Table 4. Average shoot length of the tested *P. ruderale* samples at different temperatures

Shoot length (mm)				
	20 °C	25 °C	30 °C	35 °C
PANRU Keszthely	75,45	76,25	77,15	76,45
PANRU Pusztadobos	76,1	77,12	76,15	77,85

Similar results were obtained on the *P. ruderale* samples as on *P. miliaceum* samples, the growth of shoot was equalized, no outliers were observed (table 4.). However, compared to the samples of *P. miliaceum* the growth of shoot was found to be weaker, which has been observed during previous tests. The effect of temperature proved to be insignificant for this species.

Table 5. Average root length of the tested *P. ruderale* samples at different temperatures

Root length (mm)				
	20 °C	**25 °C**	**30 °C**	**35 °C**
PANRU Keszthely	10,25	11,15	9,85	9,91
PANRU Pusztadobos	9,71	9,65	9,72	9,67

Similar results were obtained by root length measurements, in this case also the increased temperature did not affected significantly the development of roots, but compared to the *P. miliaceum* samples, the rooting of these two samples proved to be weaker (table 5.).

Table 6. Average shoot length of the tested *P. riparium* samples at different temperatures

Shoot length (mm)				
	20 °C	**25 °C**	**30 °C**	**35 °C**
PANRI Mérk	36,75	35,25	34,12	32,15
PANRI Nagykálló	41,25	45,75	44,95	44,75

By evaluating *P. riparium* samples, was found that although the increase of temperature only influenced slightly the growth of shoot, but significantly decreased the length of shoot compared with the other two species (table 6.). The reason can come from the size of the seeds, because the test item was a small grain crop, which accumulate less reserve nutrient, and therefore the seedlings is much weaker than the large grain millet species.

Table 7. Average root length of the tested *P. riparium* samples at different temperatures

Root length (mm)				
	20 °C	**25 °C**	**30 °C**	**35 °C**
PANRI Mérk	5,25	5,75	5,5	5,415
PANRI Nagykálló	6,125	6,55	5,715	5,915

Because of the less reserve nutrient the rooting was also much weaker. By measuring the samples from Nagykálló was observed that by increasing temperature the root length, although slightly, but decreased (table 7.).

Discussion

The aim of the experiments was to evaluate the germination vigour of millet species, as well as its change in variable temperatures. As previous germination tests and field experience has shown, the millet as a former crop, during the growing season if sufficient moisture is available, at any time the germination is possible. The experiment proved the stable viability of germs in a temperature range from 20 to 35 °C, and the germs were not damaged at increased temperature and decline in their development was not observed.

It was found examining the *P. miliaceum* samples from 1985, that the highest values of shoot and root length was measured by frozen seed samples. The development of samples from Tarján was very similar to that of *P. ruderale* samples; this suggests that *P. miliaceum* is genetically closer to *P. ruderale*.

The *P. riparium* samples due to the smaller seed sizes showed weaker growth, the germination percent also showed a slight decline compared with the other species, but the weaker efficiency was caused by the small grains and less reserved nutrient, the temperature did not affect significantly the development of the seedlings. However, the samples from Nagykálló showed, both in shoot and root length, bigger growth than the samples from Mérk.

It was observed about the tested millet species that by increasing the temperature, under laboratory conditions the germination cannot be influenced. This suggests that in field conditions, if sufficient moisture is available millet species will be able to germinate in the entire growing season.

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