Scientific Papers. Series B, Horticulture. Vol. LXV, No. 1, 2021
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

RESEARCHES REGARDING THE GERMINATION CONDITIONS FOR THE SEEDS OF SPECIES USED IN THE LAWN MIXTURES

Diana VÂȘCĂ-ZAMFIR[1], Mihai Cristian POMOHACI[2], Mihai GÎDEA[3]

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Horticulture, 59 Mărăști Blvd, District 1, Bucharest, Romania
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Land Reclamation and Environmental Engineering, 59 Mărăști Blvd, District 1, Bucharest, Romania
[3]University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Agriculture, 59 Mărăști Blvd, District 1, Bucharest, Romania

Corresponding author email: dianazamfir2000@yahoo.com

Abstract

In the arrangement of the residential spaces, one of the most important stages is to identify the best mix of species that are suited to be used for the establishment or rapid correction of turf surfaces by modern techniques, which involve the use of pre-germinated seeds under the specifical condition of each site. In this research was tested the seeds of the species most often used in lawn mixtures, namely Poa pratensis, Festuca arundinacea and Lolium perenne. The research was consisting of a bifactorial experiment where the A factor was the germination temperature (in a range from 5 to 20°C), and the B factor was the seeds treatment. The analyzed parameters were the germination indicators. The statistical analysis for the differences between germination means was done using Student's t-test and Wilcoxon test for paired samples (done with the Jasp 0.14.3. program). Using the seed treatment is not determine an increase of germination characteristic in all de the cases by comparing with untreated variant for all the tested species of seeds. The increase in the temperature level was followed by the increase in the speed and in the level of germination.

***Key words**: germination, lawn mixtures, seeds.*

INTRODUCTION

By definition, a grassy surface should be flat, uniform, without spots or damaged areas, strong green in color, with an optimal density and a relatively soft texture (Steinberg, 2007; Slater, 2007). There are few species of grasses that fully meet these requirements and although the perfect lawn is said to be a classic example of monoculture (Stewart et al., 2009; Ignatieva and Stewart, 2009), in current practice mixtures of 2-3 species are used for the realization of turf surfaces.

These seed mixtures are based on grass species from humid climates in northwestern Europe, where they have been used since 1,000 years ago (Fort, 2000; Smith and Fellowes, 2014). With the economic and scientific development of society, innovative technologies in all fields of horticulture (including ornamental and landscape horticulture) could be widely accessed, so that the lawn becomes an important part of the urban landscape (Macinnis, 2009).

Lawn seeds used in landscaping in Romania are mostly imported (Netherlands, Denmark, France), not always meeting the specific pedo-climatic local. Imported from other countries and do not always meet the requirements of climatic conditions in our country, which can lead to lower results, with increased costs (establishment, correction or maintenance).

It is therefore imperative that better communication and cooperation be developed between domestic importers and producers of seed material, in order to establish the best performing and best-adapted seed mixtures for the profile market in the country (Popovici et al., 2008).

In recent years, the number of residential complexes and houses near large cities has steadily increased, which has had the effect of increasing the demand for landscaping.
Under these conditions, horticulturists must meet the challenge of finding the best mixtures to achieve a "lawn carpet" with different requirements for resistance to mechanical action, with minimal maintenance, but which can withstand extreme variations in environmental factors in the face of climate change.
In this context, this paper analyzes a series of plants from the botanical family Poaceae, generically called "turf species", which are most commonly found in mixtures to obtain turf surfaces, in terms of germination and growth conditions in the first vegetation phases, noting that this is the critical stage in obtaining a carpet that meets the requirements of landscapers and beneficiaries.
The seeds were intervened by applying treatments with substances stimulating the seed germination process, the results being compared with those of the control experimental variant, in which the seeds were not subjected to treatments.

MATERIALS AND METHODS

The ability of turf mixtures to cover the soil and form a continuous and uniform carpet is an essential requirement, to which is added the need for uniformity of emergence in the face of climate change.
In this context, a bifactorial experiment was organized within the Faculty of Horticulture in order to establish the behavior of different species found in lawn mixtures, thus:

- **A factor-** the germination temperature: 5°C, 10°C, 15°C, and 20°C in 5 repetitions.
- **B factor-** the applied stimulants: ASFAC, CROPMAX, ATONIK and water.

The experimental variants consisted of seeds belonging to three species considered by most specialists as basic for obtaining qualitative turf surfaces, namely *Festuca arundicancea*, *Lolium perenne* and *Poa pratensis*.
Festuca arundinacea Schreb. belongs to a genus comprising 621 accepted species (Clayton et al., 2006), widespread in the Holarctic region and in the temperate zones of the southern hemisphere (Watson and Dallwitz, 1992). *Festuca* species are characterized by their dorsally rounded lemmas and linear hilum (Catalan et al., 2004). The seeds sprout in approx. 6-12 days after sowing, the plants have a fast growth rate and a good - very good permanence. The plants have a leaf with a medium to coarse texture, dark green. They are very resistant to drought and have a good tolerance to low temperatures. It supports acceptable soil salting. Shadow adaptation has average values.
Lolium perenne L. (perennial ryegrass) is a species native to Europe, Asia and North Africa, with the following main characteristics: the seeds sprout in 5-12 days from sowing, fast growth rate, good perenniality, with medium resistance drought, good cold resistance, good adaptation to medium shade. The plants have a leaf with a fine to the coarse, bright light green texture (Hannaway et al., 1999).
Poa pratensis L. (Kentucky bluegrass) is a species native to Europe, North Asia, and the mountainous areas of Algeria and Morocco. The species is characterized by an emergence duration of 15-25 days from sowing, low to medium growth rate, good perenniality, good drought resistance, cold resistance and medium-good salting, adaptation to medium shade. The plants have a medium coarse, dark green foliage. *Poa* L. species are distinguished by their keeled lemmas and round to oval hilum (Catalan et al., 2004).
These seeds were treated with the application of stimulants (ASFAC, CROPMAX, ATONIK), and without treatment just using water (control variant) following at the same time the germination process under different temperature conditions (5°, 10°, 15° and 20°C).

CROPMAX is a growth stimulator for all types of crops. Its activity is based on the combination of trace elements, amino acids, vitamins and polysaccharides. It is very concentrated, 100% organic and suitable for application to all agricultural and horticultural crops source.

ATONIK is the oldest biostimulator of growth and fruiting in the world (since 1945), stimulates rooting, germination of seeds and pollen, growth of pollen tube and fruit source.

ASFAC BCO - 4 - is the only formula recognized worldwide. It has an influence on seed germination, causing a faster and more uniform growth of plants (it is a biostimulator - based on 4-clor-2 potasium amidosulfonil-fenoxiacetat + microelements and additives; produced in our country by Romchim Protect, Bacău - an invention of Corneliu Oniscu). It is a good stimulating substance for the germination of *Festuca arundinacea* seeds (Delian et al., 2019).

To determine the germination, 200 mm Petri dishes were used, and in each box were placed 100 seeds arranged evenly, on sterile and moist Whatman No. 1 filter paper. ASFAC, CROPMAX, ATONIK and distilled water were used. The dishes were covered with lids, also paper being used, and they were moistened, as well as it was mentioned above.

Germination was performed in a LabTech 320G incubator at 80% humidity.

The evaluation of germination was performed after 14 days of incubation, according to the following formula:

$$G=\frac{n}{N}*100;$$

where:

n - total number of germinated seeds/ Petri dish;

N - total number of seeds/Petri dish.

The Shapiro-Wilk test was used to verify the normality of the data. Where data were distributed normally we used the Student Test, in other cases the Wilcoxon test was used.

In both cases, we started from the premise that we have paired samples. All these statistical tools were used with the help of Jasp 0.14.3 software (Halter C., 2020, Marsman et al., 2017; Wagenmakers et al., 2020; Navarro D.J. et al., 2019). The test used for each comparison is specified in the appendices.

RESULTS AND DISCUSSIONS

In the statistical interpretation of the experimentally obtained data, the Shapiro-Wilk test was initially applied, following which the normality of the data was observed. Thus, the Student t-test can be applied for paired samples in order to identify significant differences in the average germination (for each species).

1. The influence of stimulant solutions on seed germination.

For this, the average results of seed germination, for each species, were compared at the different temperature values used in the experiments (5, 10, 15, 20°C), by applying the Student Test for paired samples (Figures 1-3).

Poa pratensis - Student's t test (paired samples)

Paired Samples T-Test

Measure 1		Measure 2	t	df	p
Water	-	Cropmax	0.974	3	0.402
Water	-	Atonik	1.044	3	0.373
Water	-	Asfac	0.132	3	0.903
Cropmax	-	Atonik	0.694	3	0.537
Cropmax	-	Asfac	−0.785	3	0.490
Atonik	-	Asfac	−1.632	3	0.201

Note. Student's t-test.

Assumption Checks

Test of Normality (Shapiro-Wilk)

			W	p
Water	-	Cropmax	0.976	0.876
Water	-	Atonik	0.901	0.437
Water	-	Asfac	0.813	0.128
Cropmax	-	Atonik	0.888	0.372
Cropmax	-	Asfac	0.972	0.856
Atonik	-	Asfac	0.939	0.648

Note. Significant results suggest a deviation from normality.

Figure 1. The influence of stimulant solutions on seed germination - *Poa pratensis*

Since for each solution a $p > 0.05$ value was obtained for each comparison, it can be said that the stimulants did not have an impact on the results of seed germination, for none of the grass species among the taken into study.

Festuca arundinacea - Student's t test (paired samples)

Paired Samples T-Test

Measure 1		Measure 2	t	df	p
Water	-	Cropmax	1.147	3	0.335
Water	-	Atonik	0.683	3	0.544
Water	-	Asfac	−1.035	3	0.377
Cropmax	-	Atonik	−0.507	3	0.647
Cropmax	-	Asfac	−1.469	3	0.238
Atonik	-	Asfac	−1.087	3	0.357

Note. Student's t-test.

Assumption Checks ▼

Test of Normality (Shapiro-Wilk) ▼

			W	p
Water	-	Cropmax	0.976	0.879
Water	-	Atonik	0.921	0.541
Water	-	Asfac	0.958	0.764
Cropmax	-	Atonik	0.874	0.312
Cropmax	-	Asfac	0.878	0.332
Atonik	-	Asfac	0.958	0.765

Note. Significant results suggest a deviation from normality.

Figure 2. The influence of stimulant solutions on seed germination - *Festuca arundinacea*

It is known from the literature that the initiation of seed germination is marked by a process of imbibition, which leads to a strong increase in their water content.

Lolium perenne - Student's t test (paired samples)

Paired Samples T-Test

Measure 1		Measure 2	t	df	p
Water	-	Cropmax	0.264	3	0.809
Water	-	Atonik	0.712	3	0.528
Water	-	Asfac	0.212	3	0.846
Cropmax	-	Atonik	0.343	3	0.754
Cropmax	-	Asfac	−0.189	3	0.862
Atonik	-	Asfac	−2.530	3	0.085

Note. Student's t-test.

Assumption Checks

Test of Normality (Shapiro-Wilk)

			W	p
Water	-	Cropmax	0.871	0.302
Water	-	Atonik	0.841	0.198
Water	-	Asfac	0.854	0.240
Cropmax	-	Atonik	0.930	0.593
Cropmax	-	Asfac	0.968	0.827
Atonik	-	Asfac	0.940	0.653

Note. Significant results suggest a deviation from normality.

Figure 3. The influence of stimulant solutions on seed germination - *Lolium perenne*

The transition of the embryo from the state of latency to that of active life therefore begins with imbibition (seed hydration), which will cause an increase in respiration values and an increase in cellular metabolic level.

For the germination of the seeds they use their own reserve substances, stored at their level, without an external supply of substances, in the first phases of germination, so that then, after the seeds have germinated the new plant can feed autotrophic (Burzo et al., 2005). This may probably explain why there are no significant differences between the experimental variants that used the respective water and substance solutions.

2. The influence of temperature on seed germination

The results that express the differences between the germination media at different temperatures depending on the species can be found in Figures 4-7.

Regarding the influence of temperature on the germination of *Poa pratensis* seeds, there were significant differences between the average results obtained from the analysis of seed germination, as follows:

•m5°C>m15°C ($t=6.73$; $p=0.007<0.05$)

•m5°C>m20°C ($t=3.21$; $p=0.049<0.05$).

Poa pratensis - Student's t test (paired samples)

Paired Samples T-Test

Measure 1		Measure 2	t	df	p
V5 °C	-	V10 °C	1.988	3	0.141
V5 °C	-	V15 °C	6.730	3	0.007
V5 °C	-	V20 °C	3.206	3	0.049
V10 °C	-	V15 °C	2.673	3	0.075
V10 °C	-	V20 °C	1.483	3	0.235
V15 °C	-	V20 °C	−0.400	3	0.716

Note. Student's t-test.

Assumption Checks

Test of Normality (Shapiro-Wilk)

			W	p
V5 °C	-	V10 °C	0.939	0.648
V5 °C	-	V15 °C	0.881	0.344
V5 °C	-	V20 °C	0.918	0.525
V10 °C	-	V15 °C	0.916	0.513
V10 °C	-	V20 °C	0.973	0.857
V15 °C	-	V20 °C	0.928	0.585

Note. Significant results suggest a deviation from normality.

Figure 4. The influence of temperature on seed germination - *Poa pratensis*

For *Festuca arundinacea* seeds, the influence of temperature on seed germination materialized in the existence of significant differences between the average germination, as follows:

• m5°C>m20°C (t=6.16; p=0.009<0.05)

Festuca arundicancea - Student t-test (paired samples)

Paired Samples T-Test

Measure 1		Measure 2	t	df	p
V5 °C	-	V10 °C	−1.233	3	0.306
V5 °C	-	V15 °C	−0.581	3	0.602
V5 °C	-	V20 °C	−6.161	3	0.009
V10 °C	-	V15 °C	0.802	3	0.481
V15 °C	-	V20 °C	−2.546	3	0.084

Note. Student's t-test.

Assumption Checks

Test of Normality (Shapiro-Wilk)

			W	p
V5 °C	-	V10 °C	0.923	0.556
V5 °C	-	V15 °C	0.771	0.059
V5 °C	-	V20 °C	0.980	0.902
V10 °C	-	V15 °C	0.917	0.519
V15 °C	-	V20 °C	0.881	0.341

Note. Significant results suggest a deviation from normality.

Figure 5. The influence of temperature on seed germination - *Festuca arundicancea* (whitout V10°C vs V20°C)

On the other hand, when comparing the average seed germination results at 10°C and 20°C respectively, the normality condition is not met.

Festuca arundicancea - Wilcoxon test (paired samples)

Paired Samples T-Test

Measure 1		Measure 2	W	df	p
V10 °C	-	V20 °C	0.000		0.098

Note. Wilcoxon signed-rank test.

Assumption Checks

Test of Normality (Shapiro-Wilk)

			W	p
V10 °C	-	V20 °C	0.691	0.009

Note. Significant results suggest a deviation from normality.

Figure 6. The influence of temperature on seed germination *Festuca arundinacea* (V10 vs V20 °C)

In this case, the Wilcoxon test was used to compare the experimental results on seed germination at 10 and 20 °C.

Following the application of the Wilcoxon test, the existence of insignificant differences is observed (p = 0.098> 0.05).

From the analysis of the experimental results obtained at the germination of *Lolium perenne* seeds, in different temperature conditions, there are significant differences between the average germination, as follows:

• m5°C>m15°C (t=7.35; p=0.005<0.05)

Lolium perenne - Student's t test (paired samples)

Paired Samples T-Test

Measure 1		Measure 2	t	df	p
V5 °C	-	V10 °C	1.815	3	0.167
V5 °C	-	V15 °C	7.346	3	0.005
V5 °C	-	V20 °C	2.502	3	0.088
V10 °C	-	V15 °C	2.524	3	0.086
V10 °C	-	V20 °C	0.775	3	0.495
V15 °C	-	V20 °C	−2.627	3	0.079

Note. Student's t-test.

Assumption Checks ▼

Test of Normality (Shapiro-Wilk) ▼

			W	p
V5 °C	-	V10 °C	0.891	0.387
V5 °C	-	V15 °C	0.950	0.717
V5 °C	-	V20 °C	0.933	0.611
V10 °C	-	V15 °C	0.916	0.516
V10 °C	-	V20 °C	0.993	0.972
V15 °C	-	V20 °C	0.880	0.339

Note. Significant results suggest a deviation from normality.

Figure 7. The influence of temperature on seed germination - *Lolium perenne*

If the germination of the seeds is not influenced by the treatments with stimulants of the type used, the same cannot be said of the temperatures at which the germination process of the seeds was directed, depending on the temperature level there are significant differences, as follows:

• *Poa pratensis*: the highest percentage of seed germination was recorded in the experimental variant with temperatures of 5 °C, significantly higher than the results recorded for the other two experimental variants (15 °C < 20 °C).

• *Festuca arundicancea*: the best results were obtained in the experimental variant in which the seed germination was conducted at 20 °C, followed by the variant at 5 °C but here we have the higher percentage at 20 °C (unlike Poa)

• *Lolium perenne*: the best results in terms of seed germination were obtained in the experimental version with a temperature of 5 °C and the minimum was recorded by the percentage of germination at 15 °C the other experimental variants having intermediate results (20 °C <10 °C).

CONCLUSIONS

As a general trend, it can be said that for *Lolium perenne* seeds the germination percentage is the highest, at the opposite pole being Poa pratensis seeds, with the lowest germination percentage (for both factors taken into account: treatment with substances stimulators respectively temperatures at which seed germination is conducted).

The experimental results confirm the data from the literature, seed germination, for all three grass species having the highest values in the area of optimal temperatures (Beard J.B., 1973).

At the same time, the germination of the seeds of the grass species studied is not influenced by the treatments with stimulants such as those used (or the effect it is not visible at this stage- after 14 days of incubation).

REFERENCES

Beard J.B., 1973. Turfgrass: science and culture, Prentice Hall, Inc, Englewood Cliffs, N.J., 558 p

I. Burzo, E. Delian, A. Dobrescu, V. Voican, L. Bădulescu, 2004. *Fiziologia plantelor de cultură, vol. I- Procesele fiziologice din plantele de cultură,* Ed. CERES, București, p.319

Catalan, P., Torrecilla, P., Lopez-Rodriguez, J.A. & Olmstead, R. G., 2004. Phylogeny of festucoid grasses of subtribe Loliinae and allies (Poae, Pooideae) inferred from ITS and trnL-F sequences. *Molecular Phylogenetics and Evolution, 31: 517-541*.

Clayton, W. D.; Vorontsova, M. S.; Harman, K.T. & Williamson, H., 2006. onwards: GrassBase- *The Online World Grass Flora. Available at: http://www.kew.org/data/grasses-db.html.*

Elena Delian, Liliana Bădulescu, Diana Vâșcă-Zamfir, Andreea Petcu, 2019. *Seed priming with Asfac-bco-4 improves Festuca arundinacea* Schreb. *Seed germination and seedlings growth under moisture stress.* University of Agronomic Sciences and Veterinary Medicine of Bucharest, International Conference "Agriculture for Life, Life for Agriculture" Scientific Papers. Series B, Horticulture. Vol. LXIII, No. 1, p.513-520

Fort, T., 2000. The Grass is Greener. Harper Collins, London

Halter C., 2020. The Jasp Workbook - Creative Minds Press Group.

Hannaway D., S. Fransen, J. Cropper, M. Teel, M. Chaney, T. Griggs, R. Halse, J. Hart,P. Cheeke, D. Hansen, R. Klinger, and W. Lane, 1999. Perennial Ryegrass (Lolium perenne L.), *Oregon State University, available from: https://www.researchgate.net/publication/45793996_Perennial_ryegrass_Lolium_perenne_L*

Ignatieva, M.E., Stewart, G.H., 2009. Homogeneity of urban biotopes and similarity of landscape design language in former colonial cities. In: Mcdonnell, M.J., Hahs, A.K., Breuste, J.H. (Eds.), *Ecology of Cities and Towns: A Comparative Approach. Cambridge University Press, Cambridge, UK, pp. 399–421.*

Maarten Marsman & Eric-Jan Wagenmakers (2017). Bayesian benefits with JASP, *European Journal of Developmental Psychology, 14:5, 545-555*

Macinnis, P., 2009. The Lawn. A Social History. Murdock Books, Millers Point, NSW

Navarro, D.J., Foxcroft, D.R., & Faulkenberry, T.J. (2019). Learning Statistics with JASP: A Tutorial for Psychology Students and Other Beginners.

C. I. Popovici, V. Vîntu, C. Samuil, 2008. Calitatea gazonului – evaluarea unor soiuri de graminee perene utilizate în cultură pură sau în amestecuri pentru gazon. *Universitatea de Ştiinţe Agricole şi Medicină Veterinară Iaşi, Lucrări Ştiinţifice – seria Agronomie vol. 51(3),112-115*,

Slater, E., 2007. The Front Lawn as a work of art and nature in the age of chemical reproduction. In: *Annual Meeting of the American Sociological Association 2007, New York.*

Smith, L.S., Fellowes, M.D.E., 2014. The influence of species number on productivity, ground coverage and floral performance in grass-free lawns. *Landsc. Ecol. Eng., http://dx.doi.org/10.1007/s11355-014-0264-9*

Steinberg, T., 2007. American green: The Obsessive Questfor the Perfect Lawn. W.W. Norton & Co, New York, NY.

Stewart, G.H., Ignatieva, M.E., Meurk, C.D., Buckley, H., Horne, B., Braddick, T., 2009. *URban Biotopes of Aotearoa New Zealand (URBANZ) (I): composition and diversity of temperate urban lawns in Christchurch. Urban Ecosyst. 12, 233–248*

Wagenmakers Eric-Jan, Šimon Kucharský, and and the JASP Team (2020). *The JASP Data Library, https://jasp-stats.org/wp-content/uploads/2020/05/The_JASP_Data_Library_1st_Edition.pdf*

Watson, L. & Dallwitz, M. J., 1992. The Grass Genera of the World. -C.A.B. International, Wallingford, Oxon, UK.