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COMPARING DIFFERENT GRASS SPECIES, VARIETIES AND GRASS MIXTURES IN THE ENVIRONMENTAL CONDITIONS OF TÂRGU MUREȘ

Zsolt SZEKELY-VARGA, Reimond SIMPF, Endre KENTELKY, Klára BENEDEK, Katalin MOLNÁR, Béla BIRÓ-JANKA, Adalbert BALOG

Sapientia Hungarian University of Transylvania, Faculty of Technical and Human Sciences, Department of Horticulture, Calea Sighișoarei 2, 540485 Târgu Mureș, Romania

Corresponding author emails: kentelky@ms.sapientia.ro, adalbert.balog@ms.sapientia.ro

Abstract

Worldwide the land surface is covered 25–30% by grass. Our objectives were to determine the germination percentage, germination capacity, height, width, softness, disease resistance, density, trampling tolerance, fresh green weight of the different grass species, varieties and grass mixtures under the environmental conditions of Târgu Mures. For the experiment we have selected Festuca arundinacea 'Green dwarf', Festuca arundinacea 'Patron', Festuca arundinacea 'Titanium', Festuca arundinacea 'Greystone', Festuca arundinacea 'Asterix', Festuca rubra commutata 'Rushmore', Festuca rubra rubra 'Livision', Poa pratensis 'Arrowhead', Poa pratensis 'Evora', Poa pratensis 'Baron' varieties. Moreover, four types of lawn mixtures were analysed in the present study: which is suitable for full sunshine and shady places, for regenerative lawn and lawn mixture for sport fields. From the data obtained could be concluded that which selection of grass mixtures suitable for different purposes: ornamental, trampling tolerant. In conclusion, the present work strengthens the possibility of choosing the appropriate grass species, varieties and grass mixtures.

Key words*: grass, lawn mixtures, varieties.*

INTRODUCTION

The lawn is the hearth of the garden (De, 2017) moreover worldwide 25-30% of our land surface is covered with grass. They are considered one of the indispensable parts of gardens, parks, public landscape. De (2017) mentions that it could be named as natural green carpet for outdoor rooms. Lawns and flowers are one of the most important parts of cities (Gladkov et al., 2021) and public areas (Knot et al., 2017; Sehrt et al., 2020). Lawns are human-made habitats in urban green areas (Yang et al., 2019). A common use of the lawn is to increase the stability and erosion protection of embankments, fills and ditches, moreover to be a cover of sports fields and orchards (Nagy, 1978), furthermore they have gained popularity at residential houses, at various companies and establishment buildings, which can add a positive image, a higher standard of living for the owners (Jankowski et al., 2018). Such green urban areas are important parts of human well-being, and their appearance are closely related with the quality of life in cities and the health of their inhabitants (Parker & Simpson, 2018; Tsai et al., 2019). Nowadays lawns occupy 70-75% of the green open spaces of the cities (Ignatieva et al., 2015). According to Tiwari et al. (2015) lawn is an area where individual plants are crowded together and forced into an unnatural growth habitat, however they can absorb atmospheric pollution, remediate contaminated soils, provide cooling by evaporation, and help with the mental health. Even some grass species could be used potentially as phytoextractors of heavy metals, due to fast growth, extensive root system, adaptability to infertile soil (Rabêlo et al., 2018). In a study resulted that *Festuca arundinacea* and *Lolium perenne* are grass species which are least sensitive to polycyclic aromatic hydrocarbons from drilling waste (Gawryluk et al., 2022). Lawns are massively prefabricated elements of the landscape design (Ignatieva et al., 2020). Furthermore, they are mostly used as covering for places after demolition of buildings to increase the aesthetics of the place (Ignatieva & Hedblom, 2018).

Many studies suggest that intensively managed lawns reduce plant and insect diversity in urban areas (Lerman et al., 2018; Rudolph et al., 2017; Watson et al., 2020). Five turfgrass species

showed different germination rate, *Lolium perenne* had germinated in a higher and faster rate compared to the others, and on the other hand the *Poa pratens* recorded the lowest germination (Charif et al., 2019). In a previous study is demonstrated that the mixture grass seeds result in substantial improvement in coverage and density (Robins & Bushman, 2020).

The present paper aim is to determine which grass species, varieties and grass mixtures have good germination percentage, germination capacity, height, width, softness, diseases resistance, density, trampling tolerance, fresh green weight under the environmental conditions of Târgu Mures, to facilitate the selection of grass mixtures suitable for different purposes (ornamental, trampling tolerant, etc.). In this way, knowing the varieties, we can choose the mixtures or varieties that best meet our requirements.

MATERIALS AND METHODS

The experiment was conducted at Sapientia Hungarian University of Transylvania, in Târgu Mureș, between April and November. The soil was a sandy loam and marly clay, which is poorly drained, favouring the formation of stagnant wetland (Table 1). The average temperature during the experiment was 14.7C° (Figure 1) and the average precipitation 53.4 mm (Figure 2).

Table 1. Particle composition of the soil at the experimental site

Sample	1	2	3	4	5
0.25–2.00 mm sand %	19.1	19.3	19.3	17.7	18.6
0.05–0.25 mm sand %	31.4	26.9	20.4	15.6	10.8
Total sand %	50.5	46.2	39.7	33.3	29.4
0.02–0.05 mm silt %	0	0	4.1	10.5	22.9
0.01–0.02 mm silt %	0	0	0	0	0
0.005–0.01 mm silt %	28.8	33	22.9	23	18.8
0.002–0.005 mm silt %	2.1	2.1	0	0	0
Total silt %	30.9	35.1	27	33.5	41.7
0.002 > loam %	18.6	18.7	33.3	33.2	28.9
Depth cm	5–17	20–40	40–55	80–100	110–130
KA	39.1	38.7	41.8	48.8	46.8
Total P mg/kg	2280	1330	1000	860	786
Total K mg/kg	4440	3760	3680	3640	3360

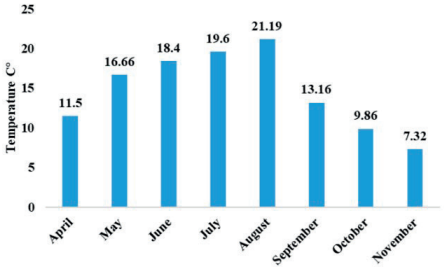

Figure 1. Average temperatures (C°) during the experiment

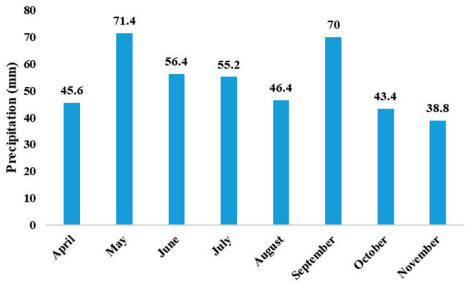

Figure 2. Average precipitation (mm) during the experiment

As plant material there were selected different species, varieties and mixtures of grasses, namely *Festuca arundinacea* 'Green dwarf' (FaGd), *Festuca arundinacea* 'Patron' (FaP), *Festuca arundinacea* 'Titanium' (FaT), *Festuca arundinacea* 'Greystone' (FaG), *Festuca arundinacea* 'Asterix' (FaA), *Festuca rubra commutata* 'Rushmore' (FrcR), *Festuca rubra rubra* 'Livision' (FrrL), *Poa pratensis* 'Arrowhead' (PpA), *Poa pratensis* 'Evora' (PpE), *Poa pratensis* 'Baron' (PpB) varieties. Furthermore, four types of lawn mixtures, which were acquired from Agrosel S.R.L.: full sunshine lawn (Sun), regenerative lawn (Reg), sports field lawn (Spo) and shady place lawn (Sha).

The four types of mixtures percentage distribution of grass mixtures are the following:

- full sunshine lawn (Sun): 40% *Lolium perenne*, 35% *Festuca rubra rubra*, and 25% *Festuca arundinacea*;
- regenerative lawn (Reg): 80% *Lolium perenne* and 20% *Festuca rubra rubra*;
- sports field lawn (Spo): 30% *Lolium perenne*, 20% *Festuca rubra rubra*, 20% *Poa pratensis*, and 30% *Festuca rubra commutate*;
- shady place lawn (Sha): 45% *Lolium perenne*, 20% *Festuca rubra rubra*, 10% *Poa pratensis*, and 25% *Festuca rubra commutate*.

The germination percentage was determined after one week, and the capacity was determined after two weeks after placing in the Petri dish. Germination percentage and capacity were determined by adding the number of seeds germinated and dividing by the number of replicates. Since in each case four replicates were measured, the seeds germinated in the four Petri dishes were added together and divided by four to obtain the germination percentages and capacity.

The sowing of the seeds in the open field experiment was made on 23th April, which was distributed in 1 sq m parcels, between the parcels a 70 cm width were measured. On each 1 sq m parcel 40 g of seeds were sowed, from the selected grass species, varieties and grass mixtures. The experimental site was covered with commercially frost foil. The covering helped the seeds to germinate faster and also protects the seeds from leaching in case of heavy rains, the covered area was aerated one day a week. The covering was kept in place until the area had started to green up. After sowing, the experimental field was watered twice/day in the early morning and evening with 10 mm/sq m for three weeks, after the covering was removed. In May we have fertilized the area with PlantAktiv 2% solution. The first mowing was done according, when the grass reached 10 cm in height. After that the grass was mowed every 2-3 weeks at a height of 4 cm.

Height (cm) and width (cm) was determined of the selected different grass species, varieties and grass mixtures, 20 grass stems per replicate, resulting in 80 measurements per species/variety.

Density was determined using a 5 × 5 cm diameter square, which was fixed by poking it into the grass and cutting the inside out below root depth using a scalpel. After cutting, was obtained a 5 × 5 cm clump of grass, which was counted one by one; 4 samples per replicate to get a total of 16 grass clumps.

To determine the susceptibility to rust disease, were used 1 × 1 meter cardboard sheet on which 10 squares of 10 × 10 cm diameter were cut out. The cardboard sheet was placed on the grass and graded the exposed grass where the squares were cut out, according to its susceptibility to rust disease, from 0 to 5. Where 0 meant no disease tendency and 5 meant fully infested for the 10 × 10 cm square.

In order to determine the trampling tolerance an 80 × 80 cm wood board, which was placed on the top of the grass surface and two people stamp on it for 5 minutes. The trampling was performed on one replicate of each variety and mixture. After that, was observed daily when the grass surface regained its original shape.

The color of grass species within species was determined using the coloroid color system (Nemcsics, 2000). The samples were collected and then coded by using the color system.

Softness was determined by palpation. Ten people were selected to rate the grass species and mixtures within each species from 0 to 5 for softness per plot. A bonitation score of 0 meant harshest grass and a score of 5 meant softest.

The significance of the differences between the treatments was tested by applying one-way ANOVA, at a confidence level of 95%. When the ANOVA null hypothesis was rejected, Tukey's post hoc test was carried out to establish the statistically significant differences at $p < 0.05$.

Bars in Figures 4 and 5 represent the means ± SE ($n = 20$), furthermore in Figures 6, 7, 8, and 9 represent the means ± SE ($n = 4$). Different letters indicate significant differences between treatments ($p < 0.05$).

RESULTS AND DISCUSSIONS

Determining the germination of the seeds is important factor for sowing, because in case of low germination percentage, a larger amount of grass seeds should be used. From our results could be determined that the highest germination percentage (Figure 3a) was recorded at FaT (95.75%) and on contrary the lowest germination percentage at PpB (21.5%). At *Festuca* genus the germination percentage were almost similar at all species and varieties, however the FrrL recorded a lower germination percentage of 78%, on the other hand FaT recorded the highest. At the *Festuca* genus the average germination percentage was 86.82%. Furthermore, in the ca of *Poa* genus the germination percentage at the PpA (39.75%) and PpB (21.5) was lower compared to the other species, yet the PpE recorded the highest percentage with 82% of germinated seeds. Regarding, the lawn mixture the highest germination was determined at Reg (93%),

followed by Sun (84%), Sha (70.5%), and the lowest recorded percentage was at Spo (66.75%). Considering the germination capacity (Figure 3b), here again the greatest was observed at FaT (98%) and the smallest at PpB (45.25%). *Festuca* genus recorded a 92% of average germination capacity, in which case the lowest was at FrrL. Moreover, *Poa* genus reported an average germination capacity of 72% and the lawn mixture an 89.88%. According to the Romanian standard, (1999) the germination time for *Festuca arundinacea* is 14 days, for *Festuca rubra* 21 days, and for *Poa pratensis* 28 days.

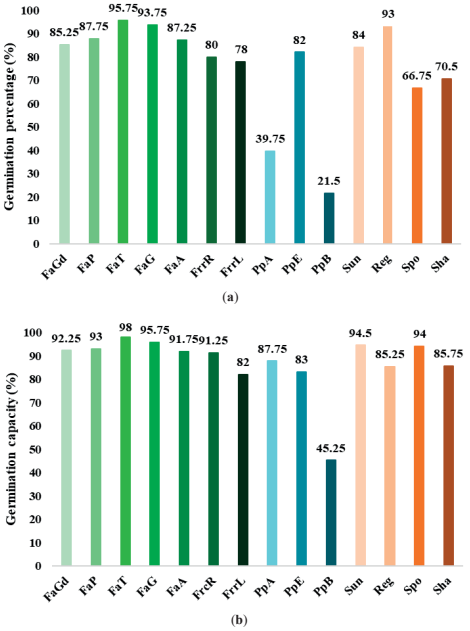

Figure 3. Germination percentage (**a**) and capacity (**b**) of the selected grass species, varieties and grass mixtures. *Festuca arundinacea* 'Green dwarf' (FaGd), *Festuca arundinacea* 'Patron' (FaP), *Festuca arundinacea* 'Titanium' (FaT), *Festuca arundinacea* 'Greystone' (FaG), *Festuca arundinacea* 'Asterix' (FaA), *Festuca rubra commutata* 'Rushmore' (FrcR), *Festuca rubra rubra* 'Livision' (FrrL), *Poa pratensis* 'Arrowhead' (PpA), *Poa pratensis* 'Evora' (PpE), *Poa pratensis* 'Baron' (PpB), full sunshine lawn (Sun), regenerative lawn (Reg), sports field lawn (Spo) and shady place lawn (Sha)

Considering the height of the selected grass species, varieties and grass mixtures could be clearly observed that statistically significant differences were present among them (Figure 4). In this case the species and varieties height were determined, because the mixtures contained the similar seeds, however in different percentages. The FaT, FaG, FaA, FrrL and PpA recorded significant increases compared to the other grass seeds. At *Festuca* genus FaGd, Fap and FrcR reported a smaller growth compared to the other species/varieties. Regarding the *Poa* genus statistically significant changes were determined at PpB compared to the other two varieties, moreover this variety obtained the smallest growth.

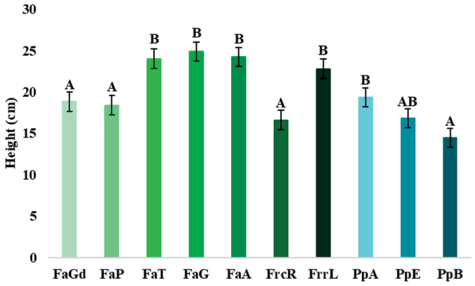

Figure 4. Growth (cm) of the of the selected grass species, varieties and grass mixtures. *Festuca arundinacea* 'Green dwarf' (FaGd), *Festuca arundinacea* 'Patron' (FaP), *Festuca arundinacea* 'Titanium' (FaT), *Festuca arundinacea* 'Greystone' (FaG), *Festuca arundinacea* 'Asterix' (FaA), *Festuca rubra commutata* 'Rushmore' (FrcR), *Festuca rubra rubra* 'Livision' (FrrL), *Poa pratensis* 'Arrowhead' (PpA), *Poa pratensis* 'Evora' (PpE), *Poa pratensis* 'Baron' (PpB), full sunshine lawn (Sun), regenerative lawn (Reg), sports field lawn (Spo) and shady place lawn (Sha)

From our data, can be determined that, in most of the case the *Festuca* genus reported wider blade of grass than the *Poa*. However, FrcR and FrrL were significantly slimmer than the other species from this genus. No significant differences were observed at the *Poa* genus.

Under our experimental conditions, statistically significant differences were determined in the case of the density (pcs) when the selected grass species, varieties and grass mixtures were compared (Figure 6). The highest values were recorded at FrcR and the thinnest density at FaA. When comparing the selected species and varieties from the *Festuca* genus, significant increases were observed at FrcR and FrrL compared to the others. However, in the case of FaGd, FaP, FaT, FaG, and FaA no significant differences were observed.

Regarding, the *Poa* genus statistically significant differences were observed only in the case

of PpB compared to the other two varieties (PpA and PpE). Furthermore, no significant changes were determined between the lawn mixture.

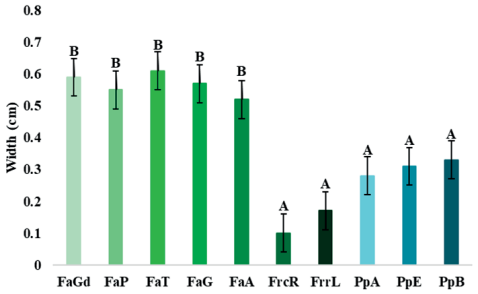

Figure 5. Width (cm) of the of the selected grass species, varieties and grass mixtures. *Festuca arundinacea* 'Green dwarf' (FaGd), *Festuca arundinacea* 'Patron' (FaP), *Festuca arundinacea* 'Titanium' (FaT), *Festuca arundinacea* 'Greystone' (FaG), *Festuca arundinacea* 'Asterix' (FaA), *Festuca rubra commutata* 'Rushmore' (FrcR), *Festuca rubra rubra* 'Livision' (FrrL), *Poa pratensis* 'Arrowhead' (PpA), *Poa pratensis* 'Evora' (PpE), *Poa pratensis* 'Baron' (PpB), full sunshine lawn (Sun), regenerative lawn (Reg), sports field lawn (Spo) and shady place lawn (Sha)

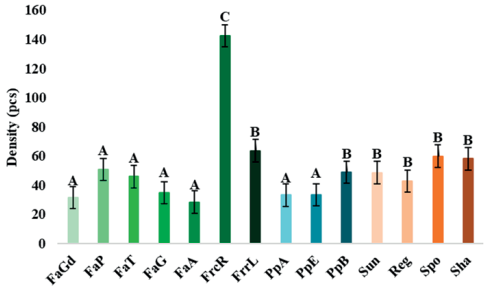

Figure 6. Density (pcs) of the of the selected grass species, varieties and grass mixtures. *Festuca arundinacea* 'Green dwarf' (FaGd), *Festuca arundinacea* 'Patron' (FaP), *Festuca arundinacea* 'Titanium' (FaT), *Festuca arundinacea* 'Greystone' (FaG), *Festuca arundinacea* 'Asterix' (FaA), *Festuca rubra commutata* 'Rushmore' (FrcR), *Festuca rubra rubra* 'Livision' (FrrL), *Poa pratensis* 'Arrowhead' (PpA), *Poa pratensis* 'Evora' (PpE), *Poa pratensis* 'Baron' (PpB), full sunshine lawn (Sun), regenerative lawn (Reg), sports field lawn (Spo) and shady place lawn (Sha)

From the obtained results, could be clearly determined that, statistically significant differences were observed between the selected grass species, varieties and mixtures (Figure 7). The lowest bonitation points were reported at FaG (1), on the other hand the highest points were gathered from FrcR. When comparing the species and varieties from the *Festuca* genus, between FaGd, FaP, FaT, and FaA no significant differences were determined, however at FaG, FrcR, and FrrL statistically significant changes were recorded compared to the others. Regarding the *Poa* genus no significant differences were observed. Furthermore, at the lawn mixtures, here again no statistically significant changes were determined.

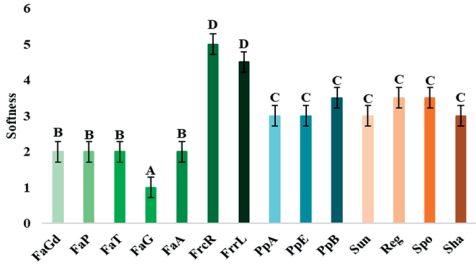

Figure 7. Softness of the of the selected grass species, varieties and grass mixtures. *Festuca arundinacea* 'Green dwarf' (FaGd), *Festuca arundinacea* 'Patron' (FaP), *Festuca arundinacea* 'Titanium' (FaT), *Festuca arundinacea* 'Greystone' (FaG), *Festuca arundinacea* 'Asterix' (FaA), *Festuca rubra commutata* 'Rushmore' (FrcR), *Festuca rubra rubra* 'Livision' (FrrL), *Poa pratensis* 'Arrowhead' (PpA), *Poa pratensis* 'Evora' (PpE), *Poa pratensis* 'Baron' (PpB), full sunshine lawn (Sun), regenerative lawn (Reg), sports field lawn (Spo) and shady place lawn (Sha)

One of the important characteristics of grass varieties is their colour and to distinguish them more easily it is necessary to identify them (Table 2).

Table 2. Colour identification of grass species using the Coloroid colour system

Species and varieties	Coloroid cod
Festuca arundinacea 'Green dwarf' (FaGd)	A73, 15/45
Festuca arundinacea 'Patron' (FaP)	A73, 10/45
Festuca arundinacea 'Titanium' (FaT)	A73, 15/45
Festuca arundinacea 'Greystone' (FaG)	A73, 20/55
Festuca arundinacea 'Asterix' (FaA)	A73, 20/55
Festuca rubra commutata 'Rushmore' (FrcR)	A74, 20/50
Festuca rubra rubra 'Livision' (FrrL)	A73, 30/60
Poa pratensis 'Arrowhead' (PpA)	A72, 20/60
Poa pratensis 'Evora' (PpE)	A72, 25/55
Poa pratensis 'Baron' (PpB)	A73, 30/60

In the present experiment we have used the Coloroid colour atlas by Antal Nemcsics to determine the colour of the varieties. The colours correspond to codes in the colour atlas. It is mentioned that the colour of the grass in the most part is influenced by the species and variety composition, yet the soil, water, nutrients

availability, weather and light conditions and even diseases can have affect (Głąb et al., 2020). The rust diseases appearance on the selected grass species, varieties and lawn mixtures was determined during the experiment (Figure 8). The highest diseases appearance was observed at PpA and PpE. On the other hand, the most resistant varieties were the FrcR and FrrL. When comparing the species and varieties from the *Festuca* genus, the highest infection with rust disease was determined at FaG and the lowest at FrcR and FrrL. The varieties belonging to *Poa* genus were the mostly infected by the rust disease. Regarding the lawn mixtures the highest diseases index was observed at Spo, which was statistically significantly higher, compared to the other three lawn mixtures.

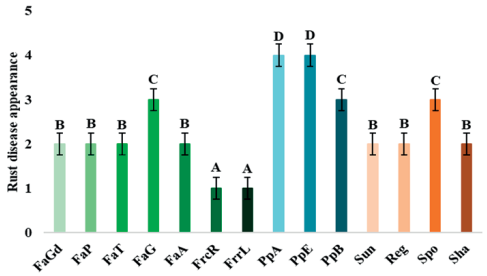

Figure 8. Rust disease appearance of the of the selected grass species, varieties and grass mixtures. *Festuca arundinacea* 'Green dwarf' (FaGd), *Festuca arundinacea* 'Patron' (FaP), *Festuca arundinacea* 'Titanium' (FaT), *Festuca arundinacea* 'Greystone' (FaG), *Festuca arundinacea* 'Asterix' (FaA), *Festuca rubra commutata* 'Rushmore' (FrcR), *Festuca rubra rubra* 'Livision' (FrrL), *Poa pratensis* 'Arrowhead' (PpA), *Poa pratensis* 'Evora' (PpE), *Poa pratensis* 'Baron' (PpB), full sunshine lawn (Sun), regenerative lawn (Reg), sports field lawn (Spo) and shady place lawn (Sha)

Under our experimental conditions, the highest fresh mass was measured at the FaG, which was statistically significantly higher compared to the others (Figure 9). On the contrary the smallest fresh-green mass was determined at the varieties belonging to the *Poa* genus.

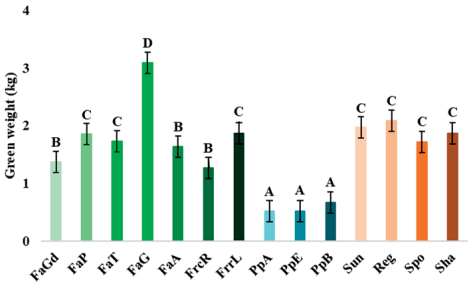

Figure 9. Fresh-green weight of the of the selected grass species, varieties and grass mixtures. *Festuca arundinacea* 'Green dwarf' (FaGd), *Festuca arundinacea* 'Patron' (FaP), *Festuca arundinacea* 'Titanium' (FaT), *Festuca arundinacea* 'Greystone' (FaG), *Festuca arundinacea* 'Asterix' (FaA), *Festuca rubra commutata* 'Rushmore' (FrcR), *Festuca rubra rubra* 'Livision' (FrrL), *Poa pratensis* 'Arrowhead' (PpA), *Poa pratensis* 'Evora' (PpE), *Poa pratensis* 'Baron' (PpB), full sunshine lawn (Sun), regenerative lawn (Reg), sports field lawn (Spo) and shady place lawn (Sha)

The varieties of the different genera recovered their original form after different or equal periods of time (Table 3). The FaGd, FaP, and FaT varieties in the table regained their original shape the day after trampling. PpE regained its shape two days after trampling. From the observations after the third day the PpA, PpB, and mixtures Spo and Sha regained their shape. Varieties FaG, FaA, and Reg mixture achieved full shape recovery on the fourth day. Even the latest FrcR and the Sun mixture regained their original shape six days after trampling.

Table 3. The recovery of grass species after trampling

Species, varieties and grass mixtures	Days					
	1 day	2 days	3 days	4 days	5 days	6 days
Festuca arundinacea 'Green dwarf' (FaGd)	1	1	1	1	1	1
Festuca arundinacea 'Patron' (FaP)	1	1	1	1	1	1
Festuca arundinacea 'Titanium' (FaT)	1	1	1	1	1	1
Festuca arundinacea 'Greystone' (FaG)	2	2	2	1	1	1
Festuca arundinacea 'Asterix' (FaA)	2	2	2	1	1	1
Festuca rubra commutata 'Rushmore' (FrcR)	3	2	2	2	2	1
Festuca rubra rubra 'Livision' (FrrL)	3	2	2	1	1	1
Poa pratensis 'Arrowhead' (PpA)	2	2	1	1	1	1
Poa pratensis 'Evora' (PpE)	2	1	1	1	1	1
Poa pratensis 'Baron' (PpB)	2	2	1	1	1	1
Full sunshine lawn (Sun)	3	2	2	2	2	1
Regenerative lawn (Reg)	2	2	2	1	1	1
Sports field lawn (Spo)	3	2	1	1	1	1
Shady places lawn (Sha)	3	2	1	1	1	1

1 - regenerative, 2 - intermediate, 3 - non-regenerative

These present study results are partly explained by the fact that *Festuca rubra* and *Poa pratensis* are the "weakest" in terms of plant height and fresh weight, and that these two species are also tracked bedstraws, which germinate and sprout more slowly, are shorter but have a longer life span. On contrary *Festuca arundinacea* is a loosestrife that germinates and develops quickly, has greater height and vigour, but a shorter life span. In a previous study conducted that the 'Landscaper Pro Rapid' (*Festuca rubra* 'Cathrine' 15%, *Lolium perenne* 'Vermino' 40%, *Lolium perenne* 'Groundforce' 35%, *Poa pratensis* 'Heatmaster' 10%) resulted the best germination percentage (Buru et al., 2021). In a study is mentioned that returning the cut grass to the mowed area, has a beneficial impact on the colour and height (Knot et al., 2017).

CONCLUSIONS

The present experiment provides data on the comparison of different species, varieties and grass mixtures. According to the obtained results, it can be concluded that at the highest germination percentage and capacity was recorded at FaT. Regarding the height FaT, FaG, FaA, FrrL, and PpA obtained the greatest data, furthermore in the case of width FaGd, FaP, FaT, FaG, and FaA varieties. Considering the density, from the present results, could be concluded that the densest grass was the FrcR. In the case of the softness, again the FrcR obtained the most points. Moreover, at rust disease appearance, the most resistant were the FrcR and FrrL grass varieties. Regarding the fresh green mass, the lowest weight was determined at the *Poa* genus, which in some case would be a good thing, expect that the grass main reason is to cover the soil, and bring a little bit of nature into our outdoor relaxing places. All together we can conclude that the FrcR is the most preferable, because of a good density, softness, and it is rust resistant.

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