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

SEED GERMINATION RATE OF DIFFERENT TURFGRASS MIXTURES UNDER CONTROLLED CONDITIONS

Timea BURU, Erzsebet BUTA, Maria CANTOR, Ioana CRIȘAN, Zsolt SZEKELY-VARGA, Valentin DAN

University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Faculty of Horticulture, 3-5 Mănăștur Street, Cluj-Napoca, Romania

Corresponding author email: dan.valentin@usamvcluj.ro

Abstract

Green areas are, in both domestic gardens and public places. In many cases, based on the landscape architecture design layout of a green space, lawns can occupy the largest surface. The lawn is used to gather all the elements of the designed landscape, thus finding the most suitable turfgrass seed mixtures is a priority in landscaping, but their success depends on the percentage of germination. The present research was undertaken to analyze the germination of eight different turf seed mixtures, available to Românian retail consumers in recent years, as follows: 'Landscaper Pro Finesse', 'Landscaper Pro Performance', 'Turfline DLF', 'Gebrauhsrasen Schattenrasen', 'Turfline DLF Sunshine', 'Landscaper Pro Rapid', 'DLF Ecolawn' and 'Landscaper Pro Sun&Shade'. Within the study, the seed mixtures were sown in a growing chamber with controlled temperature and lighting period for 14 days. The results indicated that the best germination percentage was obtained by the turf seed mixture named 'Landscaper Pro Rapid' (Festuca rubra 'Cathrine' 15%, Lolium perenne 'Vermino' 40%, Lolium perenne 'Groundforce' 35%, Poa pratensis 'Heatmaster' 10%).

Key words*: landscape, green area, grass seed, germination.*

INTRODUCTION

In many landscape architecture design layouts of a green space, the lawns occupy the largest area. Meanwhile, in the beginning, grass seeds were used more in an economical way, being a particularly important world crop from grasslands in the agriculture and animal production (Jones, 2013). Today green areas of grass have also an ornamental purpose, becoming more and more popular in landscaping (Dongmei, 2009; Haq, 2015). Lawns are a human-created and culture-shaped habitat in urban green areas (Yang et al., 2019), but etymologically defines a grass-covered surface and dates from the 15th century in America (Jenkins, 2015; Steinberg, 2006; Bormann et al., 2001; Teyssot, 1999). In medieval Europe, open expanses of low grasses became valued among the aristocracy because they allowed a better visibility on the surrounding space (Beard, 1972). The presence of the English lawn highlighted in the early 17th century during the Jacobean period (James VI of Scotland 1603-1625) and after, plays an important role in the setting of the English landscape garden style designed by William Kent and Lancelot Brown (Walpole, 1904). Named 'nature strip', the appearance of the lawn in Australia followed closely after its establishment in North America and parts of Europe (Hogan, 2003). Analyzing the Asian landscape design evolution, in Chinese cities for example, the lawn is still a new landscape feature and directly connected to the process of Westernization and globalization of urban environments, and the first record of a prototype of Chinese lawns 草坪 it was not until the 1960s, found in Fu on the Imperial Garden (Yang et al., 2019).

Studying the benefits of a green area covered with turfgrass in a landscape design proposal, evidence-based research indicates several environmental benefits (Figure 1) that improve our quality-of-life, like functional, recreational and aesthetic components summarize in the following diagram (Beard & Green, 1994). Another aspect of the lawns benefits is that absorbs noise, cool the air, reduce pollution (McKinley, 2005). Also, research result highlights that human exposure to green spaces influence emotional wellbeing, mental and

physical health, by reducing stress, anxiety and depression and improves the cardiovascular and metabolic health, concentration and memory, energy level (Buru et al., 2021; Kwon et al., 2021; Cheng, 2020; Fesharaki et al., 2020; Hitter et al., 2019; Seresinhe et al., 2019; Li, 2018; Cooper Marcus and Sachs, 2014; Hartig et al., 2014; Van Herzele & de Vries, 2012; Gonzales et al., 2011; Sempik et al., 2010).

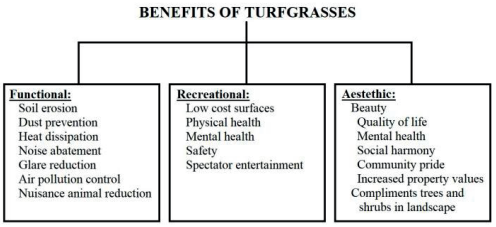

Figure 1. Diagrammatic summary of benefits derived from turfs (Beard & Green, 1994)

In the Romanian landscape architecture design, in accordance with the site dimension and the type of green spaces, technical instructions for design were recommended since 1973, to properly combine each part of the green space, depending on the destination of the landscape (Table 1). Following this recommended proportions, the lawn areas can be integrated in the hole landscape design concept, based on the different landscape units' types and requirements.

Table 1. Characteristic percentages related to the main component parts of the green space units (Negruțiu, 1980)

No.	Green space units	The green surfaces use					
		Vegetation					Other facilities (blue landscape, playground, pergolas) (%)
		Total (%)	Trees and shrubs (%)	Ornamental flowers (%)	Grass, laws (%)	Alley and accesses (%)	
1	Square	60-85	20-60	5-10	30-75	15-20	0-20
2	Allotment garden	40-70	30-60	4-8	32-66	10-20	20-40
3	Park	65-75	30-60	3-5	35-67	10-15	15-20
4	Planting strips	100	20-60	2-5	35-78	-	-
5	Residential green area	90-95	30-60	1-3	37-69	5-10	-
6	Kindergarten - Garden Unit	60-70	50-60	2-3	40-50	10-15	20-25
7	Educational institutions landscapes	45-60	60-70	2-3	30-40	10-15	30-40

In accordance with the green area use and purpose, different turfgrass seed mixtures is made and can be purchased in professional standard products. In many cases, producer's intent to use a mixture with minimum two or three different species having a better ability to adapt to various environmental conditions. To establish the lawn with a proper seed's mixture, several aspects must be considered, like environmental factors as soil type, soil moisture, soil slope, shading, temperature, or land use. Also, the lawn display aspect of the lawn is particularly important, like: color, texture, density. Based on research results, producers and economic agents supply the market with different types of turfgrass seed mixture, for different green areas and landscape types (Table 2).

Table 2. Turfgrass seed mixture (Dumitraș et al., 2008; Iliescu, 2008; Negruțiu, 1980)

Lawn for leisure			
Sandy soils	Heavy soils	Shaded areas	Sunny areas
40% *Lolium perenne*	45% *Lolium perenne*	35% *Lolium perenne*	40% *Lolium perenne*
50% *Festuca rubra*	40% *Festuca rubra*	35% *Festuca rubra*	30% *Festuca rubra*
10% *Festuca ovina*	15% *Poa pratensis*	15% *Poa nemoralis*	30% *Festuca ovina*
		15% *Poa trivialis*	
Sport field			
Sandy soils	Heavy soils	Shaded areas	
40% *Lolium perenne*	50% *Lolium perenne*	30% *Lolium perenne*	
20% *Festuca rubra*	25% *Festuca rubra*	40% *Festuca rubra*	
20% *Festuca arundinaceae*	15% *Festuca arundinaceae*	20% *Festuca arundinaceae*	
20% *Festuca ovina*	10% *Festuca ovina*	10% *Poa pratensis*	
English lawn			
Sandy soils	Heavy soils	Shaded areas	
20% *Lolium perenne*	20% *Lolium perenne*	60% *Festuca rubra*	
70% *Festuca rubra*	65% *Festuca rubra*	20% *Poa nemoralis*	
10% *Poa pratensis*	15% *Poa pratensis*	20% *Poa trivialis*	
Ornamental lawn			
Sandy soils		Heavy soils	
75% *Festuca rubra*		50% *Festuca rubra*	
25% *Agrostis tenuis*		30% *Agrostis tenuis*	
		20% *Festuca ovina*	
Lawn for road slopes, dams etc.			
Sandy soils	Heavy soils	Shaded areas	Sunny areas
50% *Festuca arundinacea*	50% *Festuca rubra*	50% *Lolium perenne*	60% *Poa pratensis*
25% *Bromus inermis*	40% *Festuca ovina*	30% *Bromus inermis*	35% *Festuca rubra*
25% *Dactylis glomerata*	10% *Poa pratensis*	20% *Poa pratensis*	5% *Agrostis tenuis*
Rustic lawn			
40% *Lolium perenne*			
50% *Festuca pratensis*			
5% *Poa pratensis*			
5% *Poa pratensis*			

MATERIALS AND METHODS

The present research study was carried out Institute of Advanced Horticultural Research of Transylvania (I.C.H.A.T) from the University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, to test the germination of several turfgrass seed mixture available on the Romanian market in the spring of 2020. There were selected eight different turfgrass seed mixtures (M), considered experimental variants:

M1 - LANDSCAPER PRO FINESS: 40% *Lolium perenne*, 40% *Festuca rubra rubra*, 10% *Festuca rubra duriuscula*, 10% *Festuca rubra trichophylla*;

M2 - TURFLINE DLF: 80% *Lolium perenne*, 20% *Festuca rubra rubra*;

M3 - LANDSCAPER PRO PERFORMANCE: 20% *Lolium perenne*, 50% *Festuca rubra*, 20% *Festuca rubra trichophylla*, 10% *Poa pratensis*;

M4 - GEBRAUHSRASEN SCHATTENRASEN: 5% *Agrostis capillaris*, 20% *Festuca trachyphylla*, 45% *Festuca rubra*, 15% *Lolium perenne*, 10% *Poa pratensis*, 5% *Poa nemoralis*;

M5 - TURFLINE ECO LAWN: 35% *Lolium perenne*, 5% *Poa pratensis*, 12% *Festuca rubra trichophylla*, 45% *Festuca rubra rubra*, 3% *Trifolium repens*;

M6 - TURFLINE DLK SUNSHINE: 25% *Lolium perenne*, 45% *Festuca arundinacea*, 20% *Festuca rubra rubra*, 10% *Poa pratensis* ;

M7 - LANDSCAPER PRO RAPID: 75% *Lolium perenne*, 15% *Festuca rubra rubra*, 10% *Poa pratensis*;

M8 - LANDSCAPER PRO SUN&SHADE: 25% *Lolium perenne*, 30% *Festuca rubra rubra*, 15% *Festuca rubra commutate*, 30% *Festuca rubra trichophylla*.

The experiment was organized in randomizes blocks, with 3 repetition/each turfgrass seed mixture (100 seed/plastic containers), measured before sowing to determine the thousand seeds weight (TSW, g) and were sown after in plastic containers (195 x 125 x 75 mm) filled with rehydrated peat. The seeds were placed over the substrate, without being covered. Using a growing chamber - Ekochl 700, the controlled environment for the following 14 days was provided with 12 hours of photoperiod with day/night conditions of 15/10°C air-temperature and 55/75% relative humidity (Mollard & Naeth, 2014; Serpe et al., 2006). During the study, 7 days after the sowing the germinative energy (%) and after 14 days germinative faculty (%) were measured.

The obtained results from the present experience were statistically analysed using Duncan test and Fisher's Least Significance Difference to measure the differences between the eight turfgrass seed mixtures.

RESULTS AND DISCUSSIONS

Results regarding the seed germination of the eight turfgrass seed mixtures, to determine the best and fast germination percentage, in controlled conditions, using biometric observation and measurement were made on the important characteristics of the seedling, like thousand seeds weight, germinative energy and germinative faculty presented in the next tables (Tables 3, 4 and 5).

Table 3. Thousand seeds weight (TSW)

code	Mean (g)	±SD	±SE	Duncan	Diff.	Diff. %	LSD significance
M1	1.15	0.01	0.01	c	0.02	101.6	n.s.
M2	1.43	0.02	0.01	d	**0.30**	126.3	**
M3	1.00	0.16	0.09	bc	-0.14	88.0	n.s.
M4	0.77	0.08	0.05	a	**-0.36**	67.9	000
M5	0.93	0.11	0.06	ab	**-0.20**	82.2	0
M6	1.15	0.08	0.05	c	0.02	101.4	n.s.
M7	1.57	0.13	0.07	d	**0.44**	138.5	***
M8	1.07	0.08	0.05	bc	-0.07	94.1	n.s.
Average	**1.132**				0	100	Control
Note: ±SD – standard deviation, ±SE – standard error of mean							LSD (p 0.05) 0.18
LSD significance p>0.05, (n.s.), p<0.05 (- 0/ + *), p<0.01 (- 00/+ **), p<0.001 (- 000/ + ***)							LSD (p 0.01) 0.25
Duncan test – differences between values followed by at least one common letter are n.s. at p<0.05							LSD (p 0.001) 0.35

Maximum thousand seeds weight value (Table 3) was registered by M7 - LANDSCAPER PRO RAPID (1.57 g.), and lowest by M4 - GEBRAUHSRASEN SCHATTENRASEN (0.77 g). The average thousand seeds weight for all eight variants was 1.13 g. Based on Duncan test, thousand seeds weight of M7 was significantly different superior to M1, M3, M4, M5, M6, M8. TSW of M4 was significantly different inferior to M1, M2, M3, M6, M7, M8 Thousand seeds weight of M1 was significantly different superior from M4, and significantly different inferior from M7, M2. There were no significant differences in thousand seeds weight between M3, M5 and M8. Also, thousand seeds weight was not significantly different between

M1, M6, M3 and M8. Based on Fisher's least significant different test was determined that thousand seeds weight of was M2 and M7 was significantly higher than the average for the eight variants. By comparison, the thousand seeds weight for M4 and M5 was significantly lower than the average for the eight variants.

Table 4. Germinative energy (%)

Experimental code	Mean (%)	±SD	±SE	Duncan	Diff.	Diff. %	LSD significance
M1	11.60	2.46	1.42	b	0.65	105.9	n.s.
M2	18.67	3.78	2.18	c	7.71	170.4	**
M3	4.83	3.12	1.80	a	-6.12	44.1	0
M4	1.50	0.82	0.47	a	-9.45	13.7	00
M5	6.80	1.54	0.89	ab	-4.15	62.1	n.s.
M6	4.30	0.20	0.12	a	-6.65	39.3	0
M7	28.00	4.54	2.62	d	17.05	255.6	***
M8	11.93	3.96	2.28	b	0.98	108.9	n.s.
Average	**10.954**				0	100	**Control**

Note: ±SD – standard deviation, ±SE – standard error of mean
LSD significance $p>0.05$, (n.s.), $p<0.05$ (- 0/ + *), $p<0.01$ (- 00/+ **), $p<0.001$ (- 000/ + ***)
Duncan test – differences between values followed by at least one common letter are n.s. at $p<0.05$

LSD (p 0.05) 5.39
LSD (p 0.01) 7.47
LSD (p 0.001) 10.38

According to the germinative energy (Table 4), the highest percentage was registered by M7 - LANDSCAPER PRO RAPID (28.00%), and lowest by M4 - GEBRAUHSRASEN SCHATTENRASEN (1.50%) after 7 days from the sowing. During period of testing the germinative energy, the first seedlings could be observed at M5 (TURFLINE ECO LAWN) at day four (Figure 2).

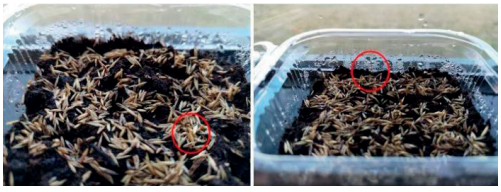

Figure 2. First seedlings registered in day four at M5 turfgrass mixtures, original

The average of the germinative energy for all eight variants was 10.954%. Analyzing the Duncan test results, it can be noticed that the germinative energy of M7 was significantly different superior to all other variants (M1, M2, M3, M4, M5, M6, M8). Germinative energy of the variants M3, M4 and M6 were significantly different inferior to V1, V2, V7, V8. There were no significant differences between germinative energy of variants M3, M4, M5, M6. Also, germinative energy was not significantly different between M1, M5 and M8. Considering the obtained date, Fisher's least significant different test was determined that germinative energy of was M2 and M7 was significantly higher than the average for the eight variants. Comparing the data, the germinative energy for M3, M4 and M6 was significantly lower than the average for the eight variants (Robins et al., 2020; Charif et al., 2019; Jones, 2013; Miller et al., 2013; Serpe et al., 2006; McKinley, 2005).

Table 5. Germinative faculty (%)

Experimental code	Mean (%)	±SD	±SE	Duncan	Diff.	Diff. %	LSD significance
M1	37.57	6.43	3.71	bc	-1.46	96.3	n.s.
M2	45.00	11.67	6.74	cd	5.97	115.3	n.s.
M3	28.50	16.15	9.32	bc	-10.53	73.0	n.s.
M4	6.43	3.03	1.75	a	-32.59	16.5	00
M5	43.80	10.04	5.80	cd	4.77	112.2	n.s.
M6	22.77	8.29	4.79	ab	-16.26	58.3	n.s.
M7	66.87	9.46	5.46	e	27.84	171.3	**
M8	61.27	10.46	6.04	de	22.24	157.0	*
Average	**39.025**				0	100	**Control**

Note: ±SD – standard deviation, ±SE – standard error of mean
LSD significance $p>0.05$, (n.s.), $p<0.05$ (- 0/ + *), $p<0.01$ (- 00/+ **), $p<0.001$ (- 000/ + ***)
Duncan test – differences between values followed by at least one common letter are n.s. at $p<0.05$

LSD (p 5%) 18.05
LSD (p 1%) 25.02
LSD (p 0.1%) 34.76

Analyzing the germinative faculty (Table 5), the highest percentage was registered by M7 - LANDSCAPER PRO RAPID (66.87%), and lowest by M4 - GEBRAUHSRASEN SCHATTENRASEN (6.43%) after 14 days from the sowing. The average of the germinative faculty for all eight variants was 39.025%. Based on Duncan test, germinative faculty of M7 was significantly different superior to M1, M2, M3, M4, M5, M6 (Figure 3).

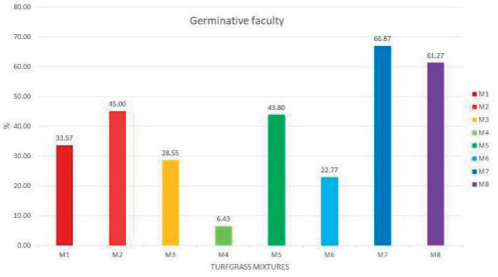

Figure 3. Compared result regarding the germinative faculty at eight different turfgrass mixtures, original

Germinative faculty of M4 was significantly different inferior to M1, M2, M3, M5, M7, M8. The germinative faculty was not significantly different between M1, M2, M3 and M5. Also, the germinative faculty was not significantly different between M4 and M6. Based on Fisher's least significant different test was

determined that germinative faculty of M7 (Figure 4) and M8 was significantly higher than the average for the eight variants. By comparison, the germinative faculty for M4 was significantly lower than the average for the eight variants.

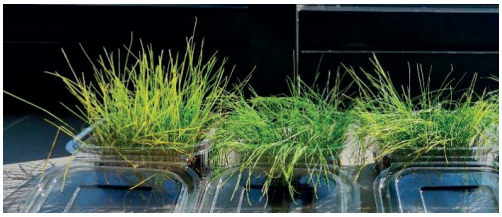

Figure 4. The highest germination was registered at M7 turfgrass mixtures, original

Turfgrass mixtures and blends are more resilient to environmental factors such as abiotic and biotic stress. The characteristics of a mixture and blend is given by the species and cultivars it contains and their proportion. A study on five turfgrass species showed these have different germination characteristics, with *Lolium perenne* displaying fast and high germination rate while *Poa pratens* presenting both slow germination at low rate. The species *Festuca arundinacea*, *Agrostis stolonifera* and *Pennisetum clandestinum* presented intermediate germination parameters compared with the two species mentioned above (Charif et al., 2019). A study conducted on eight turfgrass mixtures subject to low-input and two mowing conditions, has put in evidence a heterogenous response across variants, with tall fescue blend performing the best (Millller et al., 2013). Furthermore, another research has demonstrated that perennial wheatgrasses have a better performance in mixture with traditional turfgrass species (*Festuca brevipila, Poa pratensis*), resulting in a higher coverage and density than monoculture (Robins & Bushman, 2020).

CONCLUSIONS AND RECOMMENDATIONS

Based on the germination results can be observed that in the case of the seed mixtures of M2 (LANDSCAPER PRO PERFORMANCE) and M7 (LANDSCAPER PRO RAPID) a significantly higher thousand seeds weight was associated with significantly higher germinative energy. But only for M7 (LANDSCAPER PRO RAPID) the significantly higher thousand seeds weight was associated both with higher germinative energy and faculty, then this mixture can be recommended for grassed green areas in landscape constructions, based on the results of this study. This association between higher seed mass and higher germinative energy and faculty can be explained by the fact that larger seeds have larger foods reserves (more endosperm) for the growing embryo. The lowest performance regarding germinative energy and faculty was registered by M4 (GEBRAUHSRASEN SCHATTENRASEN), that also presented significantly lower thousands seeds weight compared to the average of all eight variants and this poor performance of M4 can be associated with smaller seeds with less nutrient reserves for the growing embryo. Thus, for landscape construction and maintenance services (or groundskeeping), green area and lawn can have an increase functional and aesthetic role by using professional seed mixture with a fast germination, but also with a high germinative faculty.

ACKNOWLEDGEMENTS

This work was supported by Advanced Horticultural Research Institute of Transylvania, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Authors are thankful to the students from Faculty of Horticulture UASVM Cluj-Napoca that were involved in this study.

REFERENCES

Beard, J. B. (1972). Turfgrass: Science and culture. *Prentice Hall PTR.*

Beard, J. B., & Green, R. L. (1994). The role of turfgrasses in environmental protection and their benefits to humans. *Journal of Environmental Quality*, 23(3), 452-460.

Bormann, F. H., Balmori, D., Geballe, G. T., & Geballe, G. T. (2001). Redesigning the American lawn: a search for environmental harmony. *Yale University Press.*

Buru, T., Kállay, É., Cantor, M., Papuc, I. (2021) The Investigation of the Relationship Between Exposure to Nature and Emotional Well-Being. A Theoretical Review. In: Moga L., Șoimoșan T.M. (eds)

Environmental and Human Impact of Buildings. Springer Tracts in Civil Engineering. *Springer, Cham*. https://doi.org/10.1007/978-3-030-57418-5_4

Charif, K., Mzabri, I., Chetouani M., Khamou L., Boukroute A., Kouddane N., Berrichi A. (2019). Germination of some turfgrass species used in the green spaces in eastern Morocco. M*aterials Today: Proceedings,* 13(3), 713-719. https://doi.org/10.1016/j.matpr.2019.04.032

Cheng, M. (2020). Are people happier with larger green space? A study of greenness and happiness in urban China. *Journal of Chinese Economic and Business Studies*, 18(2), 183-201.

Cooper Marcus, C., Sachs, N. A. (2014) Therapeutic landscapes: an evidence-based approach to designing healing gardens and restorative outdoor spaces, vol 1, *John Wiley & Sons.*

Dongmei, X. U. (2009). Characteristics of Ornamental Grass and Its Application in Landscape [J]. *Jiangxi Forestry Science and Technology*, 1.

Dumitraș, A., Zaharia, D., Singureanu, V., Sabo, G. (2008). Principii generale de proiectare și amenajare a spațiilor verzi. *Ed. AcademicPress.*

Fesharaki, S. F. H., Behrouz, A., Yang, J., Wohn, D. Y., & Cha, M. (2020). Green space and happiness of developed countries. In 2020 IEEE International Conference on Big Data and Smart Computing (BigComp) (pp. 247-250). *IEEE*.

Gonzalez, M. T., Hartig, T., Patil, G. G., Martinsen, E. W., & Kirkevold, M. (2011). A prospective study of existential issues in therapeutic horticulture for clinical depression. I*ssues in Mental Health Nursing*, 32(1), 73-81.

Haq, S. M. A. (2015). Urban green spaces and an integrative approach to sustainable environment. Urban Ecology: *Strategies for Green*.

Hartig, T., Mitchell, R., De Vries, S., & Frumkin, H. (2014). Nature and health. *Annual review of public health*, 35, 207-228.

Hitter, T., Kallay, E., Ștefan, R., Buta, E., Chiorean, S., Cantor, M., Papuc, I. (2019). The Effect of Therapeutic Horticulture on Depression and Kynurenine Pathways. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, 47(3), 804-812.

Hogan, T. (2003). Nature Strip': Australian suburbia and the enculturation of nature. *Thesis Eleven*, 74(1), 54-75.

Iliescu, A. F. (2008). Arhitectură peisageră. *Ed. Ceres.*

Jenkins, V. (2015). The lawn: A history of an American obsession. *Smithsonian Institution.*

Jones, M. (2013). The grass crop: the physiological basis of production. *Springer Science & Business Media.*

Kwon, O. H., Hong, I., Yang, J., Wohn, D. Y., Jung, W. S., & Cha, M. (2021). Urban green space and happiness in developed countries. *arXiv preprint arXiv*:2101.00807.

Li Q (2018) Shinrin-Yoku: the art and science of forest bathing. *Penguin UK.*

McKinley, M. D. (2005). Ortho's All about lawns. *Ortho Books.*

Miller, D., Mugaas, R. J., Meyer, M. H, Watkins, E. (2013). Performance of low-maintenance turfgrass mixtures and blends. *HortTechnology*, 23(5), 610-612. https://doi.org/10.21273/HORTTECH.23.5.610

Mollard, F. P., & Naeth, M. A. (2014). Photoinhibition of germination in grass seed–implications for prairie revegetation. *Journal of environmental management*, 142, 1-9.

Negruțiu, F. (1980). Spații verzi. *Ed. Didactică și pedagogică*

Robins, G. J., Bushman, B. S. (2020). Turfgrass performance of perennial wheatgrass species when grown as monocultures and mixtures. *Agronomy Journal,* 112(5), 3567-3578. https://doi.org/10.1002/agj2.20346

Sempik, J., Hine, R., & Wilcox, D. (Eds.). (2010). Green Care: A Conceptual Framework: a Report of the Working Group on Health Benefits of Green Care. *Loughborough University.*

Seresinhe, C. I., Preis, T., MacKerron, G., & Moat, H. S. (2019). Happiness is greater in more scenic locations. *Scientific reports,* 9(1), 1-11.

Serpe, M. D., Orm, J. M., Barkes, T., & Rosentreter, R. (2006). Germination and seed water status of four grasses on moss-dominated biological soil crusts from arid lands. *Plant ecology*, 185(1), 163-178.

Steinberg, T. (2006). American green: The obsessive quest for the perfect lawn. *WW Norton & Company.*

Teyssot, G. (1999). The American Lawn. Princeton *Architectural Press.*

Van Herzele, A., & de Vries, S. (2012). Linking green space to health: A comparative study of two urban neighbourhoods in Ghent, Belgium. *Population and Environment*, 34(2), 171-193.

Walpole, H. (1904). Essay on modern gardening. *Kirgate Press.*

Yang, F., Ignatieva, M., Larsson, A., Xiu, N., & Zhang, S. (2019). Historical development and practices of lawns in China. *Environment and History*, 25(1), 23-54.