

WINTERING OF TURF LAWNS DEPENDING ON THE DEPTH OF PLACING HYDROGEL IN SUBSTRATE AND THE TYPE OF SOIL COVER

Kazimierz Jankowski, Wiesław Czełusciński, Jolanta Jankowska,
Roman Kolczarek

Siedlce University of Natural Sciences and Humanities

Abstract. Using in substrates superabsorbents, also called hydrogels, contributes to considerable savings of water. Lawn turf quality depends largely on frequency of watering, having the effect on financial savings while incurring expenses connected with management of turf lawns. The aim of this study was to assess wintering of different turf lawns depending on the depth of placing hydrogel in the substrate and the type of soil cover. The study was conducted based on two field experiments established in three replications, carried out in the split-plot design. The experimental unit was a plot of an area of 1 m². The treatment of first experiment was a monoculture lawn, where four species of lawn grasses were studied in pure sowing. In the second experiment four designed mixtures of the same grass species were used. In each mixture one grass species was sown as dominant (40%), and the other three species accounted for 20% each: M1 – 40% of perennial ryegrass; M2 – 40% of red fescue; M3 – 40% of Kentucky bluegrass; M4 – 40% of fine bent grass. The following experimental factors were used in each experiment: type of substrate: a) without hydrogel „0” – control; b) with addition of hydrogel placed at a depth of: 5, 10 and 15 cm; soil cover: a) arable soil (P), b) garden peat (T). Monoculture turf of perennial ryegrass and red fescue wintered best. Mixtures with domination of both grass species also were characterized by better wintering. Degree of turf wintering was determined by the type of soil cover; the best wintering, irrespective of the type of lawn, was provided by placing hydrogel in the substrate at a depth of 5 and 10 cm.

Key words: Kentucky bluegrass, monoculture lawn, perennial ryegrass, red fescue

INTRODUCTION

A significant element determining the quality of turf lawns within the space of years is their resistance to wintering conditions. Among grasses quite large differences in

wintering occurs not only between species but also between cultivars of the same species [Prończuk 1998, Grabowski *et al.* 2003, Jankowski *et al.* 2011d]. According to Prończuk [1998], this functional character is of great importance under conditions of Poland, on account of low minus temperatures prevailing in the winter period, long lying snow cover and the effect of fungal diseases, e.g. snow mould, on the lawn sward. According to Prończuk and Prończuk [2009], the occurrence of snow mould is determined by many pathogens with different tolerance to low temperatures. In Poland snow mould is caused mostly by *Microdochium nivale*, but besides *M. nivale*, also fungi of the genus *Typhula* were isolated from grasses infected by this disease [Hoshino *et al.* 2004]. Occurrence of mould on grasses is not so strongly connected with the snow cover as in cereals [Bojarczuk and Bojarczuk 1972]. Many-year growing grasses on the same stand creates favourable conditions for disease to develop, since besides infected plants, also the soil and withered parts of grasses present in the turf can be the source of infection.

Turf lawn quality depends to a large extent on frequent watering and this is an important component of costs connected with turf lawn management [Jankowski *et al.* 2010, 2011a-d]. The use of modern irrigation systems is not a perfect solution. The appliances are usually too expensive and not every farm can afford such investment. Using superabsorbents, also called hydrogels, in substrates contributes to considerable water saving. Therefore the aim of this study was to assess wintering of various turf lawns depending on the depth of placing hydrogel in the substrate and the type of soil cover.

MATERIAL AND METHODS

The experiment was established in 2007 and conducted until 2009 in the area of the experimental facility of the Siedlce University of Natural Sciences and Humanities. The study was carried out based on two field experiments established in three replications, in the split-plot design. The experimental unit was a plot of an area of 1 m².

The treatment of the first experiment was a monoculture lawn (Table 1), where four species of turf grasses were studied in pure sowing.

Table 1. Monocultures of grasses used in the experiment
Tabela 1. Monokultury traw zastosowane w doświadczeniu

Marker Oznaczenie	Grass species Gatunek trawy	Cultivar Odmiana	Seeding rate Ilość wysiewu g·m ⁻²
G 1	perennial ryegrass – życica trwała	Inka	15.0
G 2	red fescue – kostrzewa czerwona	Nil	6.0
G 3	Kentucky bluegrass – wiechlina łąkowa	Alicja	6.5
G 4	fine bent grass – mietlica pospolita	Tolena	2.5

In the second experiment, four designed mixtures of the same grass species were used. In each mixture sowing one grass species as dominant (40%) was applied, whereas the other three species accounted for 20% each: M 1 – 40% of perennial ryegrass, M 2 – 40% of red fescue, M 3 – 40% of Kentucky bluegrass, M 4 – 40% of fine bent grass.

In each experiment the following research factors were applied:

- type of the substrate: a) without hydrogel “0” – the control, b) with the addition of hydrogel placed at depths: 5, 10, 15 cm,
- soil cover: a) arable soil (P), b) garden peat (T).

After marking experimental plots, hydrogel was applied in an amount of $50 \text{ g} \cdot \text{m}^{-2}$ at the top layer of soil at depths of 5, 10 and 15 cm. Seeds were sown at the end of April 2007. After sowing the seeds of grasses, the soil surface was randomly covered with a thin layer of garden peat or arable soil. In the production years, turf lawns were fertilized with Florovit supplying nitrogen in an amount of $120 \text{ kg} \cdot \text{ha}^{-1}$ per year.

The assessment of some functional characters of turf grasses, such as wintering, was made in growing periods in the year of the study (2007-2009) [Domański 1992, Prończuk 1993]. The 9° scale was used, where 9 denoted the best value of the character. Assessment of functional characters was made once a year (at the beginning of April).

The experiments were carried out in soil classified into the division of anthropogenic soils, the order of culture earth soils, the type of horticols, formed from slightly loamy sand. This soil has an alkaline reaction, a high content of magnesium ($8,4 \text{ Mg} \cdot 100 \text{ g}^{-1}$) and phosphorus ($39,6 \text{ P} \cdot 100 \text{ g}^{-1}$), and a low content of potassium ($15,8 \text{ K} \cdot 100 \text{ g}^{-1}$).

Meteorological data from the winter periods of the years 2007-2009 show that the most difficult conditions for turf lawn wintering occurred at the turn of 2008 and 2009 (Table 2). In that period the mean air temperature amounted to $-0,6^{\circ}\text{C}$, whereas in the previous year – $1,1^{\circ}\text{C}$. The total precipitation in winter was more favorable also in the first year of the study (23.1 mm) than in the second (19.2 mm).

Table 2. Meteorological conditions in winter 2007-2009

Tabela 2. Warunki meteorologiczne w okresie zimy w latach 2007-2009

Year Rok	Monthly mean air temperature Średnie miesięczne temperatury powietrza °C				Mean December-March Średnia grudzień – marzec
	January styczeń	February luty	March marzec	December grudzień	
2007				-0.3	–
2008	-0.4	2.1	3.1	0.6	1.1
2009	-3.2	-1.3	1.5	–	-0.7
Mean from many years Średnia z wielolecia 1960-2003	-3.5	-2.4	1.5	-1.5	-3.0
Total precipitation – Sumy opadów atmosferycznych, mm					
2007				12.4	–
2008	34.4	10.4	35.0	20.2	23.1
2009	8.3	7.7	40.4	–	19.2
Mean from many years Średnia z wielolecia 1960-2003	25.2	22.6	26.4	32.8	26.8

The results of the study were subject to the statistical analysis, with the use of the analysis of variance. For significant sources of variability (factors and interactions) detailed comparison of means was made using Tukey's test, at the significance level $P \leq 0.5$ [Wójcik and Ludański 1989].

RESULTS

The wintertime is of particular importance for the life of plants. According to Prończuk and Zagdańska [1993], under conditions of Poland it is essential due to prevailing low temperatures, lying snow cover and the effect of fungal diseases on the lawn sward.

No significant differences were found in wintering of monocultures of perennial ryegrass and red fescue (6.8°) (Table 3).

Table 3. Wintering of monoculture turf lawns (in 9° scale) depending on the type of substrate and soil cover (mean from 2008-2009)

Tabela 3. Przezimowanie monokulturowych muraw trawnikowych (w skali 9°) w zależności od rodzaju podłoża i okrywy glebowej (średnia z lat 2008-2009)

Year Rok	Depth of hydrogel application (B) Głębokość podania hydrożelu (B) cm	Type of soil cover – Rodzaj okrywy glebowej (C)								Mean Średnia
		arable soil – gleba uprawna				peat – torf				
		grass species – gatunek trawy (A)								
		G1	G2	G3	G4	G1	G2	G3	G4	
2008	control – kontrola	7.0	7.0	5.0	5.7	7.0	7.0	5.0	5.7	6.2
	-5	7.0	7.0	5.0	7.0	7.0	7.0	5.0	7.0	6.4
	-10	7.0	7.0	5.0	6.3	7.0	7.0	5.0	6.3	6.3
	-15	5.7	5.7	5.7	5.7	5.7	5.0	5.7	5.7	5.6
Mean in 2008 Średnia w roku 2008		6.7	6.7	5.2	6.2	6.7	6.5	5.2	6.2	6.1
2009	control – kontrola	7.0	7.0	5.0	7.0	7.0	7.0	5.0	7.0	6.4
	-5	7.0	7.0	5.0	7.0	7.0	7.0	5.0	7.0	6.4
	-10	7.0	7.0	5.0	7.0	7.0	7.0	5.0	7.0	6.4
	-15	7.0	7.0	5.0	7.0	7.0	7.0	5.0	7.0	6.4
Mean in 2009 Średnia w roku 2009		7.0	7.0	5.0	7.0	7.0	7.0	5.0	7.0	6.4
Mean from Średnia w latach 2008-2009	control – kontrola	7.0	7.0	5.0	6.3	7.0	7.0	5.0	6.3	6.3
	-5	7.0	7.0	5.0	7.0	7.0	7.0	5.0	7.0	6.4
	-10	7.0	7.0	5.0	6.7	7.0	7.0	5.0	6.7	6.4
	-15	6.3	6.3	5.3	6.3	6.3	6.0	5.3	6.3	6.0
Mean – Średnia		6.8	6.8	5.1	6.6	6.8	6.8	5.1	6.6	6.3
LSD _{0.05} – NIR _{0.05} for – dla:										
monoculture – monokultury (A)			0.23		interaction – interakcji:					
GUH (B)			0.25		A × B			0.92		
type of soil cover – rodzaju okrywy (C)			ns – ni		C × A			1.49		
year of study – roku badań (D)			ns – ni		A × D			0.32		
					C × D			0.45		

ns – ni – non-significant differences – różnice nieistotne

Under conditions of the Siedlce Upland, those two monocultures wintered best among the studied lawns. In the study by Jankowski *et al.* [1999], conducted in the same area but in different years, mixtures containing more than 50% seeds of red fescue showed very good wintering. Also under conditions of the Olsztyn Lake District, mixtures with 50 and 60% of red fescue seeds wintered well [Grabowski *et al.* 2003]. However, different data are presented by Prończuk *et al.* [2003], who reported that in the mixture with a high proportion (67%) of red fescue there was the highest infection

with snow mould, which resulted in significantly worse wintering. Similar results were obtained by Kwietniewski [2006]. In the present study, the monoculture of Kentucky bluegrass wintered the most poorly (5.1°), showing significant differences between the other monoculture lawns. Irrespective of the kind of monoculture, the lawns on treatments with a depth of placing hydrogel of 5 cm (6.5°) wintered the best, and those with a depth of 15 cm (6.1°) the worst. In the study by Jankowski *et al.* [2011d], in turn, it was shown that hydrogel used in the soil substrate reduced the degree of wintering of lawn mixtures, since it could stimulate the plant growth in autumn and delay the process of their hardening.

The statistical analysis showed a significant interaction of the kind of monoculture and the type of soil cover. The studied lawn monocultures, particularly those of perennial ryegrass and red fescue, wintered to the same degree (7°) on the control plots and at placing hydrogel at depths of 5 and 10 cm. The application of soil cover did not cause significant differences in wintering of monoculture lawns. However, a significant interaction of soil cover and the kind of monoculture lawn was indicated.

In the present study of mixture lawns (Table 4) variability of wintering values was indicated depending on the applied mixture and the type of substrate. Of the studied mixtures, M1 with predominance of perennial ryegrass and M2 with predominance of red fescue – grown with hydrogel were characterized by the best wintering (above 8°). According to some authors [Prończuk and Zagdańska 1993, Vargas 1994], perennial ryegrass is classified into grass species most susceptible to snow mould. However, in the study by Kwietniewski [2006], concerning wintering of sheep's fescue cultivars and its mixtures, no significant differences were found in wintering of those lawns. Of the studied mixtures, lawn M3 with predominance of Kentucky bluegrass wintered most poorly (6.3°).

Taking into consideration the depth of placing hydrogel, it was found that irrespective of the kind of mixture, the lawns where hydrogel was placed at a depth of 10 cm (8.2°) were characterized by the significantly best wintering. According to other results [Jankowski *et al.* 2011a-d] hydrogel placed in the soil substrate did not have a substantial effect on infection of turf lawns with snow mould. The present study indicated a significant interaction for the kind of mixture and the type of substrate.

According to Dąbrowski and Pawluśkiewicz [2011], an extremely essential element in establishing lawns is preparation of the substrate with a definite abundance of basic nutrients, appropriate porosity and permeability [Jeznach 2002, Pawluśkiewicz 2009]. On home lawns it is possible to use organic substance (peat, compost) for enriching the substrate. The most commonly used components at building the structural layer of turf lawns is sand with addition of native soil or peat [Wysocki 2002, Wolski *et al.* 2006]. Considering the type of soil cover, in the present study no significant differences in values of wintering of mixture lawns were observed between the covers applied. Nevertheless, a significant interaction was found for the type of soil cover and the lawn mixtures used was found. Taking into account the production years (Fig. 1), it was found that the climatic conditions prevailing in the wintertime had a higher negative effect on monoculture lawns than on mixture ones. Significantly better wintering was shown in the studied lawns, both monoculture (6.3°) and mixture (7.5°) during the winter 2009. Higher wintering value of mixture lawns indicates their higher resistance to the climatic conditions of the Siedlce Upland than of the studied monoculture lawns.

Table 4. Wintering of mixture turf lawns (in 9° scale) depending on the type of substrate and soil cover (mean from 2008-2009)

Tabela 4. Przewimowanie mieszkankowych muraw trawnikowych (w skali 9°) w zależności od rodzaju podłoża i okrywy glebowej (średnia z lat 2008-2009)

Year Rok	Depth of hydrogel application Głębokość podania hydrożelu (B) cm	Type of soil cover – Rodzaj okrywy glebowej (C)								Mean Średnia
		arable soil – gleba uprawna				peat – torf				
		type of mixture – rodzaj mieszanki (A)								
		M1	M2	M3	M4	M1	M2	M3	M4	
2008	control – kontrola	7.0	7.0	5.0	5.0	7.0	7.0	5.0	5.0	6.0
	-5	9.0	9.0	7.0	7.0	9.0	9.0	7.0	7.0	8.0
	-10	9.0	9.0	7.0	7.0	9.0	9.0	7.0	7.0	8.0
	-15	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Mean in 2008 Średnia w roku 2008		8.0	8.0	6.5	6.5	8.0	8.0	6.5	6.5	7.3
2009	control – kontrola	7.0	7.0	5.0	7.0	7.0	7.0	5.0	7.0	6.5
	-5	9.0	9.0	5.0	7.7	9.0	9.0	5.0	7.0	7.6
	-10	9.0	9.0	7.0	9.0	9.0	9.0	7.0	9.0	8.5
	-15	9.0	9.0	7.0	9.0	9.0	9.0	7.0	9.0	8.5
Mean in 2009 Średnia w roku 2009		8.5	8.5	6.0	8.2	8.5	8.5	6.0	8.0	7.8
Mean from Średnia w latach 2008-2009	control – kontrola	7.0	7.0	5.0	6.0	7.0	7.0	5.0	6.0	6.3
	-5	9.0	9.0	6.0	7.3	9.0	9.0	6.0	7.0	7.8
	-10	9.0	9.0	7.0	8.0	9.0	9.0	7.0	8.0	8.3
	-15	8.0	8.0	7.0	8.0	8.0	8.0	7.0	8.0	7.8
Mean – Średnia		8.3	8.3	6.3	7.3	8.3	8.3	6.3	7.3	7.5
LSD _{0.05} – NIR _{0.05} for – dla:										
mixture – mieszanki (A)			0.93		interaction – interakcji:					
GUH (B)			0.43		A × B			0.82		
type of soil cover – rodzaju okrywy (C)			ns – ni		C × A			0.87		
year of study – roku badań (D)			ns – ni		A × D			0.08		
					C × D			0.15		

ns – ni – non-significant differences – różnice nieistotne

Also the rate and type of fertilization has a large effect on the wintering of turf lawns. In the fertilizer applied in this study (Florovit) all the turf lawns were provided with 120 kg N·ha⁻¹ of the annual rate of nitrogen. In fertilizing lawns this rate is not too high, although nitrogen has a favourable effect on all qualitative characters of lawns.

Fertilization with high nitrogen rates may sometimes deteriorate the state of a lawn [Prończuk and Prończuk 2009]. It causes, among other things, more shallow rooting of grasses [Sullivan *et al.* 2000]. It affects accumulation of large amounts of withered leaves in the turf [Turner and Hummel 1992], and in consequence, it can result in higher amounts of spores of dangerous fungal pathogens accumulating there, also including those inducing snow mould [Parry *et al.* 1995]. Intensive fertilization with nitrogen stimulates the plant growth in autumn and delays the process of hardening, and because of that it decreases an ability to accumulate in roots carbohydrates necessary to survive winter [Arsovoll and Larsen 1977]. However, both the lack and the excess of nitrogen may affect the occurrence of grass diseases. Grasses growing at a low fertilization level are susceptible to rusts (*Puccinia* spp.) and red thread (*Laetisaria fuciformis*), whereas

those fertilized with high rates are more often infected by snow mould (*M. nivale*), Rhizoctonia diseases (*Rhizoctonia* spp) and others [Smiley *et al.* 1992].

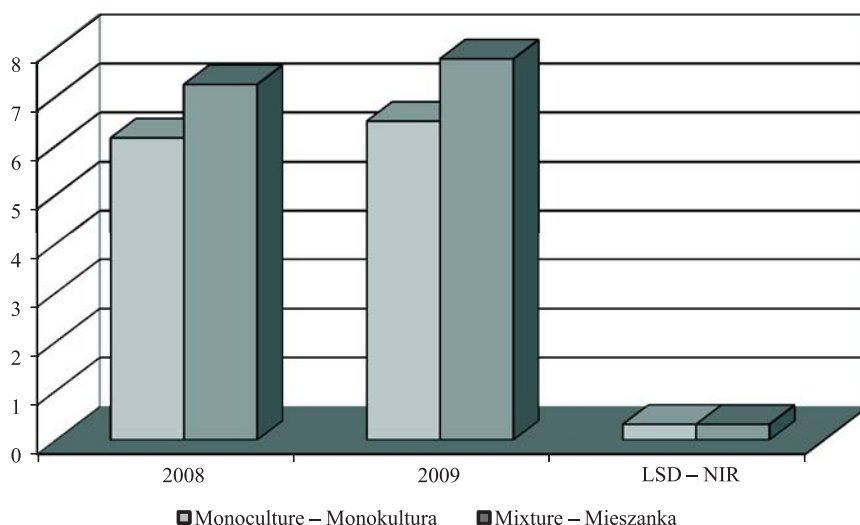


Fig. 1. Wintering of turf lawns (in 9° scale) depending on the type of lawn in 2008- 2009

Rys. 1. Przechimowanie muraw trawnikowych (w skali 9°) w zależności od rodzaju murawy w latach 2008-2009

CONCLUSIONS

1. Wintering of the studied turf lawns depended on the species composition of lawns; mixture lawns were characterized by better wintering than monoculture.

2. Of the monoculture lawns, the lawn of perennial ryegrass and the lawn of red fescue were characterized by the best wintering. Similarly, mixtures with domination of those species were distinguished by better wintering.

3. A degree of lawn wintering was determined by the type of soil substrate; best wintering, irrespective of the type of lawn, was provided by placing hydrogel in the substrate at a depth of 5 and 10 cm.

4. The type of used soil cover of grass seeds (arable soil or garden peat) did not affect the wintering of the studied turf lawns.

REFERENCES

- Arsovoll K., Larsen A., 1977. Effect of nitrogen, phosphorus and potassium on resistance to snow mould fungi and freezing tolerance in *Phleum pratense*. *Meld. Norg. LandbrHøgsk* 56(29), 1-30.
- Bojarczuk M., Bojarczuk J., 1972. Badania nad etiologią pleśni śniegowej oraz odpornością odmian, rodów i linii żyta i pszenicy ozimej na tę chorobę [Study of etiology of snow mould and resistance of cultivars, breeds and lines of rye and winter wheat to this disease]. *Hod. Roś. Aklim. Nas.* 16/5, 413-427 [in Polish].

- Domański P., 1992. System badań i oceny traw gazonowych w Polsce [System of research and assessment of turf grasses in Poland]. Biul. IHAR 183, 251-263 [in Polish].
- Dąbrowski P., Pawluśkiewicz B., 2011. Wpływ warstwy wierzchniej podłoża o różnej zawartości piasku na rozwój wybranych gazonowych odmian *Lolium perenne* L. [Effect of top layer of substrate with different sand content on development of some turf cultivars of *Lolium perenne* L.]. Przegl. Nauk. 51, 27-35 [in Polish].
- Hoshino T., Prończuk M., Kiriaki M., Yumoto I., 2004. Effect of temperature on the production of sclerotia by the psychrotrophic fungus in Poland. Czech Mycology 56(1-2), 113-120.
- Grabowski K., Grzegorzczak S., Kwietniewski H., 2003. Ocena przydatności gatunków i odmian traw gazonowych na trawniki rekreacyjne w warunkach Pojezierza Olsztyńskiego [Assessment of usefulness of turf grass species and cultivars for recreation lawns under conditions of the Olsztyn Lake District]. Biul. IHAR 225, 295-302 [in Polish].
- Jankowski K., Ciepiela G., Jodełka J., Kolczarek R., 1999. Analiza porównawcza mieszanek gazonowych uprawianych w warunkach Podlasia [Comparative analysis of turf mixtures grown under conditions of Podlasie]. Fol. Univ. Agric. Stetin, Agricultura 75, 133-140 [in Polish].
- Jankowski K., Czełuściński W., Jankowska J., 2011a. Wpływ rodzaju hydrożelu i rodzaju nawozu mineralnego na zadarnienie muraw trawnikowych o zróżnicowanym udziale życicy trwałej [Effect of the type of hydrogel and the mineral fertilizer on turf compactness of turf lawns with different proportions of perennial ryegrass]. Fol. Pom. Univ. Tech. Stetin., Agricultura 286(18), 13-32 [in Polish].
- Jankowski K., Czełuściński W., Jankowska J., Ciepiela G.A., 2010. Wpływ hydrożelu na początkowy rozwój muraw trawnikowych oraz estetykę ich w latach użytkowania [Effect of hydrogel on initial growth of turf lawns and aesthetics of their utilization]. J. Res. Appl. Agric. Eng. 55(2), 36-41.
- Jankowski K., Czełuściński W., Jankowska J., Sosnowski J., 2011b. Wpływ hydrożelu oraz różnych rodzajów nawozów na tempo odrostu runi trawników założonych na bazie życicy trwałej [Effect of hydrogel and different types of fertilizers on the turf regrowth rate of lawns established based on perennial ryegrass]. Woda, środowisko, obszary wiejskie 11(34), 73-82 [in Polish].
- Jankowski K., Sosnowski J., Jankowska J., 2011c. Effect of hydrogel and different types of fertilizers on the number of turf shoots in lawns created by monocultures of red fescue (*Festuca rubra* L.) Cultivars and its mixtures. Acta Agrobotanica 64(3), 109-118.
- Jankowski K., Tkaczuk C., Jankowska J., Czełuściński W., 2011d. Ocena przezimowania oraz stopnia porażenia pleśnią śniegową muraw trawnikowych w zależności od zastosowanego hydrożelu i rodzaju nawozu [Assessment of wintering and degree of infection with snow mould of turf lawns depending on applied hydrogen and type of fertilizer]. Fragma. Agron. 28(2), 26-34 [in Polish].
- Jeznach J., 2002. Przyrodnicze i techniczne problemy odwodnienia terenów rekreacyjnych i sportowych [Natural and technical problems of dewatering of recreation and sports areas]. Prz. Nauk. Inż. Kształ. Środ. XI(24), 50-60 [in Polish].
- Kwietniewski H., 2006. Walory użytkowe odmian gazonowych *Festuca ovina* wysiewanych w siewie czystym i mieszanek na trawnikach ozdobnych [Commercial values of turf cultivars of *Festuca ovina* sown in pure stand and in mixtures on decorative lawns]. Ann. Univ. Mariae Curie-Skłodowska, Sec. E, Agricultura 61, 389-396 [in Polish].
- Parry D.W., Rezanoor H.N., Pettitt T.R., Hare M.C., Nicholson P., 1995. Analysis of *Microbotinum niraie* isolates from wheat in UK during 1993. Ann. Appl. Biol. 126, 449-455.
- Pawluśkiewicz B., 2009. Analiza możliwości wykorzystania odmian traw do poprawy powierzchni trawiastych na obszarach zurbanizowanych [Analysis of possibilities for using grass species to improve grassy areas in urbanized regions]. Wyd. SGGW Warszawa.
- Prończuk M., 1998. Choroby traw i ich zapobieganie na trawniku [Grass diseases and their prevention on the lawn]. Mat. Konf. Miasto – ogród – sto lat rozwoju idei, Wrocław – Taragra' 98, Dolnośl. Wyd. Nauk., 65- 70 [in Polish].

- Prończuk M., Laudański Z., Prończuk S., 2003. Porównanie gatunków i odmian *Festuca ssp.* w wieloletnim użytkowaniu trawnikowym [Comparison of species and cultivars of *Festuca ssp.* in many-year lawn utilization]. Biul. IHAR 225, 239-257 [in Polish].
- Prończuk M., Prończuk S., 2009. Występowanie pleśni na życicy trwałej (*Lolium perenne* L.) w zależności od warunków świetlnych i intensywności pielęgnacji trawników [Occurrence of mould on perennial ryegrass depending on light conditions and lawn cultivation intensity]. Acta Agrobot. 58(2), 381-394 [in Polish].
- Prończuk M., Zagdańska B., 1993. Effect of *Microdochium nivale* and low temperature on winter survival of perennial ryegrass. Phytopathology 138, 1-8.
- Prończuk S., 1993. System oceny traw gazonowych [Assessment systems of turf grasses]. Biul. IHAR, 127-130 [in Polish].
- Smiley R.W., Dernoedon P.H., Clarc B.B., 1992. Compendium of turf grass diseases. The American Phytopath. Society Minnesota.
- Sullivan W.M., Jang. Z., Hull R., 2000. Root morphology and its relationship with nitrate uptake in Kentucky Bluegrass. Crop Sci. 40, 765-772.
- Turner T.R., Humel N.W., 1992. Nutritional requirements and fertilization. [In:] Turf – grass. Waddington R.N. et al. (eds), Agronomy Monograph 32, 385-440.
- Wolski K., Kotecki A., Spiak Z., Chodak T., Bujak H., 2006. Ocena wstępna możliwości wykorzystania kilkunastu gatunków traw w stabilizacji skarp obwałowań składowiska „żelazny most” w Rudnej [Initial assessment of possibilities for using several grass species in stabilizing escarpments of the “iron bridge” landfill in Rudna]. Zesz. Nauk. UP we Wrocławiu, Rolnictwo, 54, 293-298 [in Polish].
- Wójcik A.R., Laudański Z., 1989. Planowanie i wnioskowanie statystyczne w doświadczałnictwie [Planning and statistical concluding in experimental work]. PWN Warszawa [in Polish].
- Wysocki Cz., 2002. Przyrodniczo-techniczne uwarunkowania w opracowaniach projektowych trawników sportowych [Natural and technical determinants in design projects of sports lawns]. Prz. Nauk. Inż. Kształ. Środ. 1(24), 34-42 [in Polish].
- Vargas J.M., 1994. Management of turf grass diseases. Lewis Pub. CRC Press Inc.

PRZEZIMOWANIE MURAW TRAWNIKOWYCH W ZALEŻNOŚCI OD GŁĘBOKOŚCI UMIESZCZENIA HYDROŻELU W PODŁOŻU ORAZ RODZAJU OKRYWY GLEBOWEJ

Streszczenie. Zastosowanie w podłożach superabsorbentów, zwanych także hydrożelami, przyczynia się do znacznej oszczędności wody. Jakość muraw trawnikowych zależy w dużym stopniu od częstotliwości podlewania, mającej wpływ na oszczędności pod względem finansowym przy realizacji wydatków związanych z utrzymaniem muraw trawnikowych. Celem badań była ocena przezimowania różnych muraw trawnikowych w zależności od głębokości umieszczenia hydrożelu w podłożu i rodzaju okrywy glebowej. Badania realizowano w oparciu o dwa doświadczenia polowe założone w trzech powtórzeniach, prowadzone w układzie split-plot. Jednostką doświadczalną było poletko o powierzchni 1 m². Obiekt pierwszego doświadczenia stanowił trawnik monokulturowy, gdzie w siewie czystym badano cztery gatunki traw gazonowych. W drugim doświadczeniu użyto czterech zaprojektowanych mieszanek tych samych gatunków traw. W każdej mieszance zastosowano wysiew jednego gatunku trawy jako dominującego (40%), pozostałe trzy gatunki stanowiły po 20%: M1 – życica trwała 40%; M2 – kostrzewa czerwona 40%; M3 – wiechlina łąkowa 40%; M4 – mietlica pospolita 40%. W każdym z doświadczeń zastosowano następujące czynniki badawcze: rodzaj podłoża: a) bez hydrożelu „0” – kontrola; b) z dodatkiem hydrożelu umieszczonego na głębokości: 5, 10 i 15 cm; okrywa glebowa: a) gleba uprawna (P), b) torf ogrodniczy (T). Najlepiej zimowała murawa

monokulturowa życicy trwałej i kostrzewy czerwonej. Mieszanki z dominacją obu gatunków traw wyróżniały się także lepszym przezimowaniem. Na stopień przezimowania muraw wpływał rodzaj podłoża glebowego; najlepsze przezimowanie, niezależnie od rodzaju murawy, zapewniało umieszczenie hydrożelu w podłożu na głębokości 5 i 10 cm.

Słowa kluczowe: kostrzewa czerwona, trawnik monokulturowy, wiechlina łąkowa, życica trwała

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