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COLORING OF LAWNS ESTABLISHED ON THE BASIS OF RED FESCUE, DEPENDING ON APPLICATION OF SUPERABSORBENT AND VARIOUS FERTILIZERS

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Abstract. The aim of this study was to determine the effect of superabsorbent and mineral fertilizers on coloring of lawns. The study was conducted in the years 2002-2004 and included two lawn experiments which were established in the split-block split-plot design with four replications. The experimental unit was a plot with an area of 1 m^2. One experiment involved monoculture lawn turf (pure sowing). The other experiment involved lawn mixtures. Four cultivars of red fescue were cultivated in pure sowing: Adio, Libano, Corail, Simone. The tested mixtures differed in the percentage share of red fescue (20, 40, 60 and 80%). Both monoculture and mixture experiments were conducted on two types of substrates: 1) with the addition of superabsorbent (S), 2) without the addition of superabsorbent (BS). Nutrients necessary for the proper growth and development of grasses and ensuring an attractive lawn appearance were delivered in the form of two mineral fertilizers called Trawovit Komplet and Sierrablen. On the basis of research results, considerable differences were found between the colors of tested red fescue cultivars on a substrate with superabsorbent. The lawn colors among the tested cultivars of red fescue, irrespective on the kind of substrate, changed in the years of the study and on average of the three years of research, cultivar Libano had the most favorable grass green color (7.2^o). Along with an increase in the percentage of red fescue seeds in the mixture, their green color was worsened. Of the tested fertilizers, Sierrablen had a more favorable impact on color improving of monoculture turf, whereas Trawovit Komplet on the mixtures turf. This indicates the varied response of individual species of grasses occurring in the tested mixtures to the applied mineral fertilizers.

Key words: hydrogel, lawn's coloring, red fescue, superabsorbent

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INTRODUCTION

Green areas, that include lawns, enrich the air in oxygen, regulate the water conditions of the given region, retain and neutralize a part of atmospheric pollutions, decrease the strength of wind and hanging of dust, weaken the intensity of noise. They are the place of rest for the elderly people and children plays, the aim of many trips and the Saturday rest for the whole families.

Green has a beneficial effect on both the physical state of people and their mental condition. Moreover, it to some extent satisfies human aesthetic needs. Green is a soothing color and it has a favorable effect on eyesight. A considerably higher disease incidence rate can be observed in people in devastated areas, resulting from direct effect of pollutions, as well as a considerable increase in mental disorders resulted from numerous stresses caused by lack of contact with nature [Stępczak 1997]. Plant color is an important criterion of lawn turf assessment. According to Kozłowski *et al.* [2000], this feature to the largest extent determines the visual aspect of lawns. Due to frequent defoliation and changing meteorological conditions, keeping the stability of color becomes a significant problem. Difficulties in maintaining the proper coloring of lawn turfs under unfavorable moisture conditions and at insufficient content of nutrients in soil can result in a considerable decrease in the lawn attractiveness by the loss of its natural vivid green color. One of the methods for maintaining stability of plant color may be the application of superabsorbents. They are characterized by the ability to absorb water, the sorption of cations, and have an impact on improving physical soil properties. The results of many studies [Bereś and Kałędkowska 1992, Fonteno and Bilderback 1993, Hetman and Martyn 1996, Hetman and Michalak 1997] indicate that superabsorbents provide the optimal moisture conditions. As a result of their action, a negative effect of a long lasting drought, which causes a change in lawn color from green to yellowy-white, is eliminated. The lawn color most desirable by the users is dark green. Lawn grasses have various tones of green depending on the species used, e.g. red fescue or perennial ryegrass.

The aim of this study was to estimate the effect of the superabsorbent and mineral fertilizers on the coloring of lawn turfs established on the basis of red fescue depending on the sorbent applied and the type of fertilizer.

MATERIAL AND METHODS

The study conducted in the years 2002-2004 at the experimental station of the University of Natural Sciences and Humanities in Siedlce (52°16' N; 22°28' E) involved two lawn experiments established in the split-block split-plot design in four replications. The experimental unit was a plot with an area of 1 m^2. One experiment included monoculture lawns (pure sowing), whereas the other involved mixture lawns. Four cultivars of red fescue were grown in pure sowing: Adio, Libano, Corail, Simone. Mixtures differed in the percentage share of red fescue – 20, 40, 60 and 80% (Table 1).

The experiments – both monoculture and mixture – were conducted in the culture-earth soil of the hortisole type, using two types of substrate: 1) with an addition of the superabsorbent Aqua-gel P4 (S); 2) without an addition of the superabsorbent Aqua-gel P4 (BS). Moderately intensive cultivation was applied in the experiments, (the so-called Relax), i.e. without irrigation, with moderate fertilization. Hydrogels (also often called

agrogels) are the so-called superabsorbents characterizing by an ability to absorb water, the sorption of cations and affecting an improvement in soil physical properties. They are used in various crops, mainly in horticulture. Aqua-gel P4 was applied according to the instruction given on the packaging in a dose of 50 $g \cdot m^{-2}$, mixing it with the top layer of soil at a depth of 5-10 cm.

Table 1. Species-cultivars composition of studied lawn mixtures (own design)
Tabela 1. Skład gatunkowo-odmianowy badanych mieszanek trawnikowych (projekt własny)

Name of mixture Nazwa mieszanki	Species – Gatunek	Share Udział %	Cultivar Odmiana
M1	Red fescue – Kostrzewa czerwona *Festuca rubra*	20	Adio
	Perennial ryegrass – Życica trwała *Lolium perenne*	20	Inka
	Sheep's fescue – Kostrzewa owcza *Festuca ovina*	20	Noni
	Heteroleaf fescue – Kostrzewa różnolistna *Festuca heterophylla*	20	Sawa
	Common bent – Mietlica pospolita *Agrostis tenuis*	20	Niwa
M2	Red fescue – Kostrzewa czerwona *Festuca rubra*	40	Adio
	Perennial ryegrass – Życica trwała *Lolium perenne*	15	Inka
	Sheep's fescue – Kostrzewa owcza *Festuca ovina*	15	Noni
	Heteroleaf fescue – Kostrzewa różnolistna *Festuca heterophylla*	15	Sawa
	Common bent – Mietlica pospolita *Agrostis tenuis*	15	Niwa
M3	Red fescue – Kostrzewa czerwona *Festuca rubra*	60	Adio
	Perennial ryegrass – Życica trwała *Lolium perenne*	10	Inka
	Sheep's fescue – Kostrzewa owcza *Festuca ovina*	10	Noni
	Heteroleaf fescue – Kostrzewa różnolistna *Festuca heterophylla*	10	Sawa
	Common bent – Mietlica pospolita *Agrostis tenuis*	10	Niwa
M4	Red fescue – Kostrzewa czerwona *Festuca rubra*	80	Adio
	Perennial ryegrass – Życica trwała *Lolium perenne*	5	Inka
	Sheep's fescue – Kostrzewa owcza *Festuca ovina*	5	Noni
	Heteroleaf fescue – Kostrzewa różnolistna *Festuca heterophylla*	5	Sawa
	Common bent – Mietlica pospolita *Agrostis tenuis*	5	Niwa

Nutrients necessary for a proper growth and development of grasses and ensuring the attractive lawn appearance were provided in the form of two mineral fertilizers called Trawovit Komplet and Sierrablen. Twice a year (in June and August) the so--called standard fertilizers were applied (Trawovit Komplet) with the following chemical composition: N, P_2O_5 K_2O, MgO, SO_3 CaO, Fe, Zn, Co, Mn, Cu, B, and one a year (in June) a slow-release fertilizer (Sierrablen) was used, with the composition as follows: N, P_2O_5 K_2O, Fe, according to the instruction given on the packaging. Meteorological data from 2002-2004 were obtained from the Hydrological and Meteorological Station in Siedlce (Table 2). The coloring of lawns were assessed in each year of the study (once a month). The assessment was made according to the methods of COBORU [Domański 1992], always by the same person. The 9^o quality scale was used, where 9 means the highest value of the feature.

Table 2. The meteorological conditions from synoptic station in Siedlce
Tabela 2. Warunki meteorologiczne ze stacji synoptycznej w Siedlcach

Month – Miesiąc	2002	2003	2004	Mean from Średnia z wielolecia 1960-2003
Mean monthly air temperature – Średnia miesięczna temperatura powietrza, °C				
April – Kwiecień	8.5	6.7	7.7	7.5
May – Maj	16.7	15.3	11.5	13.3
June – Czerwiec	16.9	16.9	15.2	16.2
July – Lipiec	20.8	19.8	17.4	17.8
August – Sierpień	20.0	18.2	18.7	17.2
September – Wrzesień	12.8	13.2	13.0	12.7
October – Październik	7.1	5.1	9.9	7.8
Mean April – October Średnia kwiecień – październik	14.7	13.6	13.3	13.2
Annual mean – Średnia roczna	9.1	7.7	7.9	7.4
Total precipitation – Suma opadów atmosferycznych, mm				
April – Kwiecień	10.8	26.1	36.4	36.1
May – Maj	24.2	32.0	81.6	53.0
June – Czerwiec	75.1	61.7	45.2	72.7
July – Lipiec	58.6	44.5	53.5	69.6
August – Sierpień	32.2	62.2	69.3	62.1
September – Wrzesień	31.9	36.5	17.5	62.4
October – Październik	59.2	44.0	32.2	37.7
Mean April – October Średnia kwiecień – październik	292	307	336	384
Annual mean – Średnia roczna	466	424	518	529

Numerical notation of colors was assigned to the verbal expressions, according to the catalogue RHS Colour Chart [Gąbka 2010]:

Color – Kolor	Catalogue number – Numer katalogowy
1 – yellowy-green – żółtozielony	144 A, B, C, D
2 – olive green – oliwkowy	138 A, B, C, D I 137 A, B, C, D
3 – bright green – jasnozielony	134 A, B, C, D
4 – green-grey – zielonoszary	133 A, B, C, D
5 – vivid green – intensywny zielony	132 A, B, C, D
6 – green – zielony	131 A, B, C, D
7 – grass green – zielona trawa	135 A, B, C, D
8 – brown-green – brązowozielony	136 A, B, C, D
9 – emerald – szmaragdowy	127 A, B, C, D

The results obtained were subjected to 3-factorial analysis of variance using the random model (synthesis from the years), and for significant sources of variability, a detailed comparison of means with Tukey's test was made at the significance level $P \leq 0.05$ [Trętowski and Wójcik 1991].

RESULTS

On the basis of the obtained results, a considerable variety in coloring of the tested cultivars of red fescue was observed, particularly on the substrate with the super--absorbent (Table 3). The lawns with the Libano cultivar had the most intensive color (from grass green to brown), especially in the first and second year of the study. On the plots without an addition of Aqua-gel P4 the Corail cultivar presented the best results in respect of this feature. An addition of superabsorbent to the substrate affected an improvement in coloring of the cultivars Adio, Libano and Simone.

Table 3. Coloring of lawns both for monocultures and for mixtures depending on the kind of substrate (in 9° scale)

Tabela 3. Kolorystyka muraw trawnikowych monokulturowych i mieszankowych w zależności od rodzaju podłoża (w skali 9°)

Cultivar Odmiana	2002		2003		2004		Mean Średnia
	BS	S	BS	S	BS	S	
Adio	7.1	7.5	7.8	8.2	5.4	5.9	7.0
Libano	7.3	7.4	8.3	8.4	5.6	6.1	7.2
Corail	7.2	7.0	8.4	8.2	6.3	6.1	7.1
Simone	7.2	7.2	7.8	7.9	5.7	6.3	7.0
Mean – Średnia	7.2	7.3	8.1	8.2	5.8	6.1	7.1
$LSD_{0.05}$ – $NIR_{0.05}$ for – dla:							
sorbent – sorbentu		ns – ni					
years – lat		0.80					
M1	6.4	7.5	8.1	8.2	5.4	5.1	6.9
M2	6.4	7.1	8.2	8.4	5.4	5.1	6.8
M3	6.8	7.1	7.7	7.9	5.4	4.8	6.7
M4	6.1	6.7	7.2	7.7	5.0	5.0	6.3
Mean – Średnia	6.4	7.1	7.8	8.1	5.3	5.0	6.6
$LSD_{0.05}$ – $NIR_{0.05}$ for – dla:							
mixtures – mieszanek		0.57					
sorbent – sorbentu		0.51					
years – lat		0.36					

M1-M4 – for explanations see Table 1 – objaśnienia w tabeli 1
S – with the addition of superabsorbent – z dodatkiem superabsorbentu
BS – without the addition of superabsorbent – bez dodatku superabsorbentu
ns – ni – non-significant difference – różnica nieistotna

The analysis of coloring of the tested lawn mixtures (Table 3) indicated that irrespective of the substrate applied, the highest score (6.9°) – with grass green color of leaves – was obtained by mixture M1 with a proportion of 20% seeds of red fescue and a slightly lower by mixture M2. Only in the case of mixture M4, an addition of Aqua--gel P4 to the substrate resulted in an increase in color intensity from green to grass green, particularly in the first two years of the study.

Mean values of color from the production years (Table 3) prove that the tested cultivars of red fescue were characterized by a similar color intensity assessed to be within the range 7.0-7.2°. By contrast, a significant differentiation of coloring was observed among the sown lawn mixtures. Mixtures with a smaller percentage of red fescue seeds (M1 and M2) were characterized by a significantly better coloring (grass green) than mixture M4 with 80% of this grass species, with green color (6.3°).

The superabsorbent applied in the substrate (Table 4) only to a small extent affected an improvement in coloring of both monoculture and mixture lawns. The color of leaves belongs to the features which are of utmost importance in the assessment of usefulness of lawn grasses species and cultivars for carpet lawns, golf courses and sports pitches. However, color stability during the growing period and grass sensitivity to changes in color under the influence of stress factors are more valuable traits [Prończuk 1994].

Table 4. Coloring of studied lawns (in 9^o scale) depending on kind of substrate and months (mean for 2002-2004)

Tabela 4. Kolorystyka badanych muraw trawnikowych (w skali 9^o) w zależności od rodzaju podłoża i miesięcy (średnia z lat 2002-2004)

Month – Miesiąc	BS	S	Mean – Średnia
	Monoculture – Monokultura		
May – Maj	7.1	7.4	7.2
June – Czerwiec	7.4	7.4	7.4
July – Lipiec	7.6	6.3	7.0
August – Sierpień	7.2	7.0	7.1
September – Wrzesień	6.9	7.0	6.9
October – Październik	6.2	6.6	6.4
Mean – Średnia	6.9	7.1	7.0
$LSD_{0.05}$ – $NIR_{0,05}$ for – dla:			
months – miesięcy	0.65		
	Mixture – Mieszanka		
May – Maj	7.0	6.5	6.7
June – Czerwiec	7.3	7.2	7.2
July – Lipiec	6.2	7.1	6.7
August – Sierpień	6.1	6.4	6.2
September – Wrzesień	6.7	7.0	6.8
October – Październik	6.3	6.5	6.4
Mean – Średnia	6.5	6.8	6.6
$LSD_{0.05}$ – $NIR_{0,05}$ for – dla:			
months – miesięcy	0.75		
interaction – interakcji:			
sorbent × month – sorbent × miesiąc	1.07		

The results obtained prove that the color of leaves of red fescue cultivars and mixtures of lawn grasses changed both in the production years (Table 3) and in the months of the growing period (Table 4). Varietal lawns of red fescue had the most intensive grass green coloring from May to August. The mean values of color in this months were within the range 7.0-7.4°. When comparing the results of color intensity of grass leaves from individual years of the study (Table 3), it was shown that the leaf color of varietal turfs of red fescue (brown-green) was significantly more favorable in all the months of 2003 in comparison with 2004 or 2002. Analogically, lawn mixtures were characterized by significantly the most intensive color in 2003. Mixture turfs were most intensively green in June (on average 7.2^o). On average in the years, the intensity of coloring of lawn mixtures depended inversely proportionally on the percentage share of red fescue. Along with an increasing percentage of red fescue seeds in the mixture from 20 to 80% the intensity of coloring of those mixtures decreased.

In the present study, the lawn color was also largely dependent on the meteorological conditions (Table 2). The results obtained indicate that more favorable weather conditions in 2003 had an effect on more intensive and more desirable color of lawns. The intensity of green color of leaf blades of lawn turfs in 2003 was to a large extend affected by the most even distribution of precipitation during the growing period.

According to Rutkowska and Hempel [1986] maintaining the vivid green color of leaves during the whole growing period and prolonging the stability of lawn green color until the late autumn is determined by the proper mineral fertilization. In the own study (Fig. 1) a significantly better effect of fertilizer Sierrablen on the color of monoculture turfs was observed as compared with Trawovit Komplet, whereas the coloring of mixture lawns was statistically significantly determined by Trawovit Komplet. In the literature concerning lawn turfs there are few studies on the assessment of their coloring. Consequently, it is difficult to relate the results of the present study to other authors.

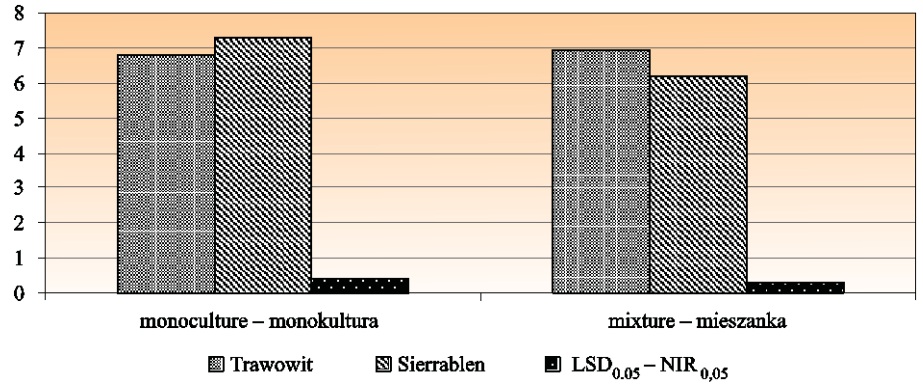

Fig. 1. Lawn coloring (in 9° scale) depending on the kind of fertilizer
Rys. 1. Kolorystyka muraw trawnikowych (w skali 9°) w zależności od rodzaju nawozu

CONCLUSIONS

1. The lawn coloring of the tested cultivars of red fescue, irrespectively of the type of substrate (with or without the superabsorbent) changed in the years of the study. On average from the three years of the study, the monoculture lawn of the cultivar Libano was characterized with the most favorable grass green color.

2. In two out of the three years of the study, leaf blades of mixtures cultivated on the substrate with the superabsorbent had more green coloring.

3. Along with an increase in the percentage of red fescue seeds in the mixture their green coloring worsened, it changed from the intensively dark green to the lighter color with a tone of yellow.

4. Of the tested fertilizers, Sierrablen had a more favorable effect on an improvement in coloring of monoculture lawns, and Trawovit Komplet – on mixture lawns, which indicates a diversified response of individual species of grasses occurring in the tested mixtures to the mineral fertilizers applied.

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KOLORYSTYKA MURAW TRAWNIKOWYCH ZAŁOŻONYCH NA BAZIE KOSTRZEWY CZERWONEJ W ZALEŻNOŚCI OD STOSOWANIA SUPERABSORBENTU ORAZ ZRÓŻNICOWANYCH NAWOZÓW

Streszczenie. Celem badań było określenie wpływu superabsorbentu i nawozów mineralnych na kolorystykę muraw trawnikowych. Badania prowadzone w latach 2002--2004 obejmowały dwa doświadczenia trawnikowe założone w układzie split-blok split--plot w czterech powtórzeniach. Jednostką doświadczalną było poletko o powierzchni 1 m^2. Jedno doświadczenie dotyczyło muraw jednogatunkowych (siew czysty), natomiast drugie obejmowało murawy mieszankowe. W siewie czystym uprawiano cztery odmiany kostrzewy czerwonej: Adio, Libano, Corail, Simone. Badane mieszanki różniły się procentowym udziałem 20, 40, 60 i 80% kostrzewy czerwonej. Doświadczenie jednogatunkowe i mieszankowe prowadzono na dwóch rodzajach podłoża: 1) z dodatkiem superabsorbentu (S), 2) bez dodatku superabsorbentu (BS). Składniki pokarmowe niezbędne do prawidłowego wzrostu i rozwoju traw, a także gwarantujące atrakcyjny wygląd trawnika dostarczono w postaci dwóch nawozów mineralnych o nazwie Trawovit Komplet oraz Sierrablen. Na podstawie uzyskanych wyników badań stwierdzono znaczne

zróżnicowanie kolorystyki badanych odmian kostrzewy czerwonej na podłożu z superabsorbentem. Kolorystyka muraw badanych odmian kostrzewy czerwonej, niezależnie od rodzaju podłoża, zmieniała się w latach badań. Średnio z trzech lat badań najkorzystniejszą trawiastozieloną barwą (7,2^{o}) cechowała się odmiana Libano. W miarę zwiększania się procentowego udziału nasion kostrzewy czerwonej w mieszance zielone zabarwienie ulegało pogorszeniu. Z badanych nawozów korzystniejszy wpływ na poprawę kolorystki muraw jednogatunkowych miał nawóz Sierrablen, a muraw mieszankowych – Trawovit Komplet, co świadczy o zróżnicowanej reakcji poszczególnych gatunków traw występujących w badanych mieszankach na zastosowane nawozy mineralne.

Słowa kluczowe: kolorystyka trawników, kostrzewa czerwona, superabsorbent

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