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REACTION OF LAWN GRASSES CULTIVARS OF GENUS *Festuca* ON WATER DEFICITS AND THE SOD REGENERATION LEVEL BASED ON MORPHOMETRIC ROOT EXPERIMENTS*

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Abstract. The research carried out under greenhouse and field conditions involved three species and eight cultivars representing genus *Festuca* (*F. arundinacea*, *F. rubra*, *F. ovina*). The research results showed that semi-drought reduces the weight and the length of roots less considerably than of their aboveground parts. The research of the sod regeneration level showed that the process is species-specific. The lowest tolerance to semi-drought is observed for *F. rubra* cultivars, while those most resistant to drying-off are *F. ovina* cultivars. The grasses which, after the period of semi-drought, regenerated the sod most considerably were *F. ovina* cultivars. The coefficient of correlation calculated showed that for the grasses evaluated, depending on the species, under greenhouse and field conditions, the morphological characteristics of roots (weight and length) are a good indicator of the reactions of the grasses investigated to the process of sod drying-off and regeneration. The results of research reported in the greenhouse experiment, especially for *F. rubra*, are confirmed in the field conditions.

Key words: aboveground part weight, root length, root massiveness, soil drought, underground part weight

INTRODUCTION

Lawns are objects with high landscape and aesthetic values. Selection of species and cultivars, which have an effect on their quality and durability, takes place based on morphological and biological characteristics. Also plant requirements in respect of environmental conditions are of considerable importance. Mutual relation system of

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biotic and abiotic factors determines plant development. An essential element of grass defense against unfavorable environmental factors is morphological and anatomical adaptation which involves the root systems and aboveground parts [Kukielska 1974, Carrow *et al*. 1996, Stetson and Sullivan 1999, Chaves *et al*. 2003]. Adaptations of plants for periodical water deficits in soil and their regenerative abilities are of particular importance. The role of the root system in immune mechanisms is less known in comparison with the importance of aboveground organs, and structural changes (qualitative and quantitative) of grass roots subjected to water stress have not been fully explained yet.

The most common species used on lawns include grasses of the genus *Festuca*. Among them tall fescue is worthy of note (*F. arundinacea* Schreb.), which tolerates conditions of water deficit thanks to formation of a deep and strongly developed root system [Stuczyńska and Stuczyński 1993, Wilman *et al*. 1998]. A valuable species which is commonly used in lawn mixtures is red fescue (*F. rubra* L.), and particularly its short-creeping cultivars, resistant to water deficit [Żyłka *et al*. 2001]. Another important species on lawns is sheep's fescue (*F. ovina* L.), which is characterized by the xeromorphic structure of leaves, and develops roots mainly in the uppermost soil layers. It shows little water requirement, and in spite of generating a relatively low aboveground weight it achieves a high degree of sod cover [Golińska 2002].

The aim of this study was to find an answer to the question whether the root system, and especially the weight and length of roots, can be a good indicator of grass reaction to water deficits and the process of sod regeneration after the period of drought already at the initial stage of growth. For comparison, two parallel experiments were carried out, one under greenhouse conditions (with young plants) and the second under field conditions (with three-year old plants).

MATERIAL AND METHODS

The study was carried out in 2010 in the IHAR Botanical Garden in Bydgoszcz. In the experiment eight lawn cultivars were evaluated, belonging to three grass species of the genus fescue (*Festuca*):

– tall fescue (*F. arundinacea*), cultivars Rahela, Tarmena,
– red fescue (*F. rubra*), cultivars Rapsodia, Dark, Nimba, Adio,
– sheep's fescue (*F. ovina*), cultivars Mimi, Noni.

The evaluation of morphological structure of root systems was conducted based on the greenhouse and field experiments. In the greenhouse experiment, grasses grew for four months in cuvettes of 480 × 560 × 90 mm (an area of 0.268 m^2). For two months the cuvettes were placed in a cold frame and sprinkled with water every 2-3 days, depending on the amount and frequency of precipitation. According to the methods proposed by Żurek [2006] after that time plants in the cuvettes were subjected to the process of "simulated drought" for a period of 26 days. To do that, the cuvettes were transferred to a greenhouse and placed under an angle of 40° from the substrate. After this time, the cuvettes were placed again on an even surface, watered and the optimal moisture level was dale kept in the substrate (35-40% volumetric humidity).

The experiment was carried out in three replications for each cultivar. Samples were collected from each cuvette at three points: after the second month of grass growth (in June) – the initial state, after the simulated drought (in July) and after the period of regeneration (in August). A ring sampler was used (a set for soil sample collection NNS made by Eijkelkamp with an area of 19.6 cm^2 and a volume of 176.6 cm^3). Roots from collected samples were rinsed out under a stream of water on 0.6-,0.4 mm mesh sieves. Larger organic and mineral impurities were removed by hand using tweezers. The aboveground weight was cut once a month at a height of 2 cm, and after each date of soil sample collection the part which constituted sod (to 2 cm) was added. The obtained aboveground and underground biomass was dried at 60°C, until the air-dry weight was obtained.

At the same time, observations of the same grass cultivars growing on micro-plots of 0.5 × 0.5 m established in 2007 were carried out under field conditions. Roots to a depth of 9 cm were collected from the plots at the same dates as in the greenhouse experiment. During the growing season the lawns were cut six times. The biomass obtained was handled in the same way as in the greenhouse experiment.

In both experiments the root length was measured using the computer program RadixNova, which is used for the quantitative analysis of root scans. In this program, calculations are made using the so-called non-statistical method, involving the detailed analysis of the course of pixels making axes of individual branches. The root length was calculated based on the picture analysis [Moraczewski 2008].

Based on the results obtained, the ration of root dry weight to aboveground dry weight – the K:N index, was calculated, which expresses root productivity and the ratio of the root weight to their length – root massiveness index [Sołtysik 1997].

The field experiment was established in a lessive soil with an average content of nutrients and the mechanical composition whit a predomination of light loam with the content of silt and clay of 20%. The greenhouse experiment was conducted on a substrate established on the basis of compost humus, peat and sand, which were mixed in equal proportions.

One-factorial analysis of variance was made for the studied parameters. To assess the significance of differences between the treatments Tukey's test was applied for $P \leq 0.05$, whereas to find similarities in the course of growth reaction in plants from greenhouse and field cultivation – the correlation analysis of the same features.

Growing period during the experiment, that is from April to September 2010, should be classified as a very differentiated in respect of the weather conditions. July was particularly hot, when the mean air temperature amounted to 22.1°C and was by 3°C higher than the long-term mean. In the other months mean air temperatures were similar and by about 0.2-1.8°C lower or higher than the means from the long-term period. In respect of precipitation the evaluated growth period belonged to those very wet, and the total precipitation amounted to 420.7 mm and was by 34% higher than the long-term mean (312 mm). The very wet months were May (103.7 mm) and August (120.3 mm). Dry months, in turn, were June, with precipitation only of 13.1 mm (29.8% of the mean from the long-term period) and July – 84.6 mm (88.6% of the mean from the long-term period). In July rainfalls occurred after practically dry period from the 10th to 31th July 2010.

RESULTS AND DISCUSSION

Analysis of morphological features of grasses in the greenhouse experiment was preceded by analyses of substrate moisture in the cuvettes. Before starting the experiment of the "simulated drought", analysis of the substrate in the cuvettes did not show significant differences between the treatments. The humidity values observed were situated above field water capacity (pF = 2.0) and were on average 35-40% (volumetric humidity). As a result of the high temperature which occurred in July (the process of sod drying off), a very fast transferring of water to the bottom parts of the cuvettes was observed during this experiment. This caused that as fast as after 3 days of the test the difference between the moisture at the bottom part of the cuvette (0-10 cm) and at the top part (above 50 cm) for individual treatments was on average 25%. Decrease in moisture to the permanent wilting point (9%) at the top parts of the cuvettes (above 50 cm) occurred in treatments with red fescue after 11 days, with tall fescue after 12 days and with sheep's fescue after13 days of the experiment. The manifestation of this process was rapid wilting of leaves and their drying off. On average, the number of days after which the soil moisture under sod at the bottom of the cuvette (0-10 cm) decreased to the permanent wilting point (9%) was for tall fescue 19 days, for red fescue – 18 days and for sheep's fescue – 21 days.

As a result of subjecting young plants to the process of simulated drought, a high difference of their reaction to changes in substrate moisture was observed, which was related to both the structure of aboveground and underground parts (Table 1).

In the case of tall fescue and red fescue cultivars, changes in size of the aboveground weight turned out to be much more drastic than in relation to the root weight. In the initial growth period of young plants of tall fescue, the weight of aboveground part predominated, but due to the process of drying off and its weakened regeneration, finally both plant parts of this species cultivars almost balanced out. In June in red fescue it was observed that the weight of the aboveground and underground parts of the studied cultivars was similar. Due to the rapid increase in the weight of aboveground part and a relatively smaller growth in the weight of roots, they achieved a large predominance in the structure of young plants. This type of plant reaction would indicate the presence of evolutionarily formed adaptation mechanisms for periodical water shortage [Greco and Cavagnaro 2003]. Change in the above proportion makes it possible to reduce water loss through reduction in the transpiration area and increase in the water absorbing area [Chaves *et al*. 2003, Żurek 2006]. In sheep's fescue cultivars proportions between both parts of several months' plants remained constant, with the predomination of the aboveground part, at the significantly smallest K:N ration in all the course of the experiment.

Changes in the root weight of young plants were accompanied by a reduction in the total root length. In June the mean total length of roots on all the treatments was almost 8 thousand meters. After the end of drying off stage, this value decreased to 6 thousand meters and after a month of regeneration it underwent further decrease – to 5 thousand meters. Irrespective of the stage of the experiment, the totally longest roots were formed by the cultivar Tarmena (*Fa*). The smallest reduction in the root length between June and August was observed in the case of the cultivars Rahela (*Fa*) and Noni (*Fo*) – a decrease in root length by 30 and 22.3%, respectively.

Table 1. Biometrical features of fescue cultivars (*Festuca* ssp.) in greenhouse experiment
Tabela 1. Cechy biometryczne odmian kostrzewy (*Festuca* ssp.) w doświadczeniu prowadzonym w szklarni

Species/cultivar Gatunek/odmiana	Dry weight – Sucha masa $kg \cdot m^2$ underground part (K) części podziemnej (K)	above-ground part (N) części nadziemnej (N)	K:N	Whole root length in uppermost soil layer Łączna długość korzeni w powierzchniowej warstwie gleby m ($m^2 \cdot 0{,}9$ m)	Root massiveness index Wskaźnik masywności korzeni $g \cdot m^{-1}$
Initial stage (June) – Stan początkowy (czerwiec)					
Fa Rahela	0.13 bc	0.17 b	0.76 bc	7 083 b	0.018
Fa Tarmena	0.19 a	0.24 a	0.79 bc	10 668a	0.018
Fr Adio	0.15 ab	0.15 b	1.00 ab	7 253 b	0.021
Fr Dark	0.14 ab	0.13 b	1.08 ab	7 774 b	0.018
Fr Nimba	0.16 ab	0.14 b	1.14 a	7 823 b	0.020
Fr Rapsodia	0.15 ab	0.16 b	0.94 abc	8 504 b	0.018
Fo Mimi	0.09 c	0.14 b	0.64 c	7 603 b	0.012
Fo Noni	0.08 c	0.14 b	0.62 c	6 700 b	0.012
Mean – Średnia	0.14	0.16	0.87	7 926	0.017
$LSD_{0.05}$ – $NIR_{0,05}$	0.05	0.05	0.33	2 152	ns – ni
Stage of drying-off (July) – Etap zasuszania (lipiec)					
Fa Rahela	0.12 bc	0.11 ab	1.25 a	6 962 abc	0.017
Fa Tarmena	0.16 a	0.14 a	1.14 a	8 611 a	0.019
Fr Adio	0.10 cd	0.08 b	1.25 a	5 169 bcd	0.019
Fr Dark	0.10 cd	0.07 b	1.43 a	5 023 cd	0.020
Fr Nimba	0.13 b	0.09 b	1.44 a	6 049 abcd	0.021
Fr Rapsodia	0.11 bcd	0.09 b	1.22 a	7 881 ab	0.014
Fo Mimi	0.09 de	0.14 a	0.64 bc	5 376 bcd	0.017
Fo Noni	0.07 e	0.14 a	0.50 c	3 313 d	0.021
Mean – Średnia	0.11	0.11	1.09	6 048	0.018
$LSD_{0.05}$ – $NIR_{0,05}$	0.03	0.05	0.46	2 764	ns – ni
Stage of regeneration (August) – Etap regeneracji (sierpień)					
Fa Rahela	0.11 bc	0.10 c	1.10 bc	4 959 abc	0.022
Fa Tarmena	0.13 ab	0.11 c	1.18 b	6 772 a	0.019
Fr Adio	0.08 d	0.09 c	0.89 bcd	3 392 c	0.024
Fr Dark	0.08 d	0.10 c	0.80 cd	4 220 bc	0.019
Fr Nimba	0.08 d	0.09 c	0.89 bcd	4 534 bc	0.018
Fr Rapsodia	0.14 a	0.09 c	1.56 a	5 933 ab	0.023
Fo Mimi	0.11 bc	0.19 b	0.58 de	5 267 abc	0.021
Fo Noni	0.09 cd	0.26 a	0.35 e	5 205 abc	0.018
Mean – Średnia	0.10	0.13	0.92	5 035	0.020
$LSD_{0.05}$ – $NIR_{0,05}$	0.03	0.05	0.36	2 111	ns – ni

means of biometrical features with the same letters are not significantly different ($P \leq 0.05$) – średnie cech biometrycznych oznaczone tymi samymi literami nie różnią się istotnie ($P \leq 0{,}05$)
ns – ni – non-significant differences – różnice nieistotne

Analysis of variance did not reveal the significance of differences between values of root massiveness index of young plants. However, comparison means for measuring dates (respectively: 0.017, 0.018 and 0.020 $g \cdot m^{-1}$) suggests that in the process of drying off and later regeneration mainly small roots died. Monitoring of the process of drying off in the experiment allowed the observation that provoked stress introduced a large variability of reaction in young grass cultivars regarded as well tolerance for periodical moisture deficits.

Three years' field cultivation made it possible to reveal differences resulting from belonging to different species, which were weakly expressed in the greenhouse experiment (Table 2). On average in most cultivars after one month from the end of simulated drought they did not regenerated either the root system or the aboveground part to the state from before drying off. In comparison with the state from June, at the end of August the weight and length of roots of young plants in the greenhouse experiment were smaller by 28.6 and 36.5%, respectively, and in field cultivation – by 37.9 and 53.5%. At the same time losses in the aboveground weight were not so great and on average they amounted to 18.7% (in the greenhouse experiment) and 16.7% (in the field).

In tall fescue cultivars the significantly smallest total root length, combined with the greatest massiveness, is observed at all stages of the experiment. It may be supposed that tall fescue forms a different root system than the other evaluated species. This would also explain changes in relation between the weight of underground and aboveground parts of those plants – a decrease in the root weight during the experiment in total by 39.0% was accompanied by over 25% increase in the weight of aboveground part. Since in the greenhouse experiment a fifty per cent loss in the aboveground part weight was recorded in cultivars of the species under discussion, correlation coefficients for the K:N ration of tall fescue cultivars are negative and they indicate different relationships between body parts in young and three-year-old plants. However, in both experiments the cultivar Tarmena was characterized by a large root weight, and the correlation coefficient $r = 0.999$ (Table 3) shows a very large similarity of reaction in this respect to changes in soil moisture in plants at different ages.

In both experiments all red fescue cultivars were characterized by a very big total root length. The mean root length of three-year-old plants of this species observed in June reached up to 21 thousand meters in the studied soil layer. However, during the experiments a considerable reduction in root length and weight was recorded. In the greenhouse experiment, a decrease in the total root length between June and August was 42.3%, and in field cultivation as much as 51.2%. At the stage of drying off red fescue cultivars showed also a significant decrease in the weight of aboveground part. Correlations revealed for those cultivars are strong and often statistically significant, and they indicate sensitiveness of red fescue to changes in substrate moisture, revealing already in young plants.

Both young and three-year-old plants of sheep's fescue cultivars were characterized by predomination of the aboveground part over the underground part. In June their root system, at the significantly smallest root weight, was at the same time strongly expanded. Although sheep's fescue cultivars are characterized by a considerably weaker negative reaction to a period of long drought in comparison of the other species, during measurements made in August it was found that the total length of roots in young plants decreased in relation to the state from the beginning of the experiment – in young plants by 26.8%, and in three-year-old – by as much as 52.7%. This was accompanied by 67% increase in the root massiveness index in the greenhouse experiment and more than twofold – in the field experiment. This means that also in sheep fescue, which is resistant to drought, severe drying off of the substrate results in a noticeable dying of small roots.

Table 2. Biometrical features of fescue cultivars (*Festuca* ssp.) in field experiment
Tabela 2. Cechy biometryczne odmian kostrzewy (*Festuca* ssp.) w doświadczeniu polowym

Species/ cultivar Gatunek/odmiana	Dry weight – Sucha masa kg·m^2		K:N	Whole root length in uppermost soil layer Łączna długość korzeni w powierzchniowej warstwie gleby m (m^2·0,9 m)	Root massiveness index Wskaźnik masywności korzeni g·m^{-1}
	undergroud part (K) części podziemnej (K)	above-ground part (N) części nadziemnej (N)			
Initial stage (June) – Stan początkowy (czerwiec)					
Fa Rahela	1.30 b	0.94 ab	1.38 bcd	11 878 c	0.109 a
Fa Tarmena	1.36 ab	0.55 e	2.47 a	11 041 c	0.133 a
Fr Adio	1.18 bc	0.80 abcd	1.47 bc	18 894 b	0.062 b
Fr Dark	1.25 bc	0.77 bcd	1.62 b	19 401 b	0.064 b
Fr Nimba	1.00 cd	0.63 de	1.59 bc	19 905 b	0.050 b
Fr Rapsodia	1.56 a	0.70 cde	2.23 a	25 437 a	0.061 b
Fo Mimi	0.68 e	0.98 a	0.69 d	21 622 ab	0.032 b
Fo Noni	0.92 de	0.86 abc	1.07 cd	19 339 b	0.048 b
Mean – Średnia	1.16	0.78	1.56	18 440	0.070
$LSD_{0.05}$ – $NIR_{0,05}$	0.25	0.20	0.53	5 422	0.035
Stage of drying-off (July) – Etap zasuszania (lipiec)					
Fa Rahela	0.92 b	0.87 b	1.06 cd	7 934 cd	0.116 b
Fa Tarmena	1.13 a	0.83 b	1.36 c	5 868 d	0.193 a
Fr Adio	0.85 b	0.35 c	2.43 b	9 660 bcd	0.088 bc
Fr Dark	1.17 a	0.38 c	3.08 a	11 688 abc	0.100 bc
Fr Nimba	0.81 b	0.37 c	2.19 b	16 567 a	0.049 c
Fr Rapsodia	1.25 a	0.44 c	2.84 a	15 287 ab	0.082 bc
Fo Mimi	0.80 b	1.01 a	0.79 d	13 182 abc	0.061 c
Fo Noni	0.83 b	0.87 b	0.95 d	10 553 bcd	0.079 bc
Mean – Średnia	0.98	0.64	1.84	12 717	0.096
$LSD_{0.05}$ – $NIR_{0,05}$	0.17	0.14	0.41	5 652	0.057
Stage of regeneration (August) – Etap regeneracji (sierpień)					
Fa Rahela	0.67 ab	0.94 b	0.71 b	6 682	0.100
Fa Tarmena	0.95 a	0.92 b	1.03 b	8 350	0.114
Fr Adio	0.49 b	0.29 e	1.69 a	8 073	0.061
Fr Dark	0.54 b	0.30 e	1.80 a	7 914	0.068
Fr Nimba	0.73 ab	0.44 d	1.66 a	10 026	0.073
Fr Rapsodia	0.67 ab	0.32 e	2.09 a	8 225	0.081
Fo Mimi	0.75 ab	1.10 a	0.68 b	9 038	0.083
Fo Noni	0.95 a	0.85 c	1.11 b	10 336	0.092
Mean – Średnia	0.72	0.65	1.35	8 580	0.084
$LSD_{0.05}$ – $NIR_{0,05}$	0.29	0.05	0.51	ns – ni	ns – ni

means of biometrical features with the same letters are not significantly different ($P \leq 0.05$) – średnie cech biometrycznych oznaczone tymi samymi literami nie różnią się istotnie ($P \leq 0,05$)
ns – ni – non-significant differences – różnice nieistotne

These observations are confirmed by the results of earlier studies [Kukielska 1974, Grzesiak 1998, 2002, Lipińska 2005], indicating that soil drought causes a decrease in root size and inhibiting growth of the aboveground weight, which results in changing relationships between the plant parts.

According to methodological assumptions of the study, observation of young plants of three fescue species in short stages, lasting only one months, of extremely different conditions of substrate moisture, exposing plants to deep stress, should give the answer whether their reaction is connected with predispositions of the species or cultivar.

Comparison of reactions of fescue species and cultivars to changes in soil moisture under greenhouse and field conditions is well supported by the correlation analysis of the results of both experiments (Table 3). Although development of young plants depends to a great extent on the environmental conditions, it is determined genetically. It is also possible that morphological characteristics are reflected in successive growth stages [Gibson 2009]. It was found that changes in structure of young plants of selected red fescue cultivars were identical to the changes observed in three-year-old plants in the total length of the root system. By contrast, varietal differences were revealed in the case of tall and sheep's fescue. As regards sheep's fescue, the indicator feature for the reaction to periodical drought for the cultivar Mimi is the size of the aboveground weight, and for the cultivar Noni – the weight of the root system. Growth reaction of young plants of the cultivar Tarmena (*Fa*), both in respect of the structure of aboveground and underground parts, was very similar to that observed in the plants grown in field, whereas reactions of the cultivar Rahela (*Fa*) recorded in both experiments are so different that it is impossible to distinguish the morphological feature which can be indicator for the purpose in question.

Table 3. Correlation coefficients between the same morphological characters of grasses in the greenhouse and field experiment
Tabela 3. Współczynniki korelacji między tymi samymi cechami morfologicznymi traw w doświadczeniu szklarniowym i polowym

Species/ cultivar Gatunek/ odmiana	Dry weight of above-ground part Sucha masa części nadziemnej	Dry weight of undergroud part Sucha masa części podziemnej	K:N	Whole root length Łączna długość korzeni	Root massiveness index Wskaźnik masywności korzeni
Fa Rahela	0.575	0.922	-0.804	0.733	**-0.966**
Fa Tarmena	**-0.999**	**0.999**	-0.944	0.386	0.440
Fr Adio	0.925	**0.966**	0.858	**0.949**	-0.888
Fr Dark	0.611	0.858	0.785	**0.993**	0.934
Fr Nimba	**0.992**	0.885	0.835	**0.956**	**-0.969**
Fr Rapsodia	0.852	-0.178	-0.162	**0.978**	0.048
Fo Mimi	**0.986**	0.216	0.310	0.894	**0.994**
Fo Noni	-0.656	**0.978**	-0.048	0.775	0.886

significance of the correlation coefficient for $P \leq 0.05$ – istotność współczynnika korelacji dla $P \leq 0,05$

Irrespective of the experimental treatment and differentiated morphological reactions of the selected cultivars, the common feature of the compared fescues was a similar direction of changes after a temporal drying off of the substrate: strong reduction in the size of the root system, expressed mainly by dying of small roots.

Conducting studies at the early stage of growth can be useful in testing grasses in respect of their reaction to drought and regeneration abilities. However, due to variability of those reactions in individual species, and even cultivars, a possibility of conducting such a study as initial for each cultivar should be suggested.

CONCLUSIONS

1. Greenhouse study of grass reaction to drought using diagonal surfaces well reflects the dynamics of grass growth and their reaction to the stress factor and regeneration abilities of sod.

2. Soil drought affects mainly a heavy reduction in the aboveground weight and, to a less degree, the weight and length of grass roots. Those changes mostly refer to red fescue cultivars. Sheep's fescue cultivars proved to be the most resistant to soil drought.

3. Study of the sod regeneration degree showed that that process is determined not only by species but also varietal predispositions. Grasses which after a period of drought regenerated the sod to the greatest degree were sheep's fescue cultivars.

4. Greenhouse and field experiments indicate that determination of the root weight and length is a good indicator of plant reactions to the process of drying off and regeneration. This relationship was proved mainly for red fescue cultivars.

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REAKCJA ODMIAN TRAW GAZONOWYCH Z RODZAJU *Festuca* NA NIEDOBORY WODY I STOPIEŃ REGENERACJI DARNI W OPARCIU O BADANIA MORFOMETRYCZNE KORZENI

Streszczenie. Badania prowadzono w warunkach szklarniowych i polowych na trzech gatunkach i ośmiu odmianach traw z rodzaju *Festuca* (*F. arundinacea* Schreb., *F. rubra* L., *F. ovina* L.). W doświadczeniach oceniano reakcję traw na suszę glebową oraz ich predyspozycje do regeneracji darni po okresie zasychania. Uzyskane rezultaty wykazały, że susza wpływa w mniejszym stopniu na redukcję masy i długości korzeni niż części nadziemnych roślin, a o stopniu regeneracji darni decydują predyspozycje gatunkowe. Najmniejszą tolerancję na suszę wykazują odmiany *Festuca rubra*, a najbardziej odporne są odmiany *Festuca ovina*. Te ostatnie także po okresie suszy w największym stopniu zregenerowały darń. Współczynniki korelacji wskazują, że dla ocenianych traw zależnie od gatunku w warunkach szklarniowych i polowych cechy morfologiczne korzeni (masa i długość) są dobrym wyznacznikiem reakcji badanych traw na proces zasuszania i regeneracji darni. Rezultaty badań uzyskane w doświadczeniu szklarniowym, szczególnie dla *Festuca rubra* znajdują potwierdzenie w warunkach polowych.

Słowa kluczowe: długość korzeni, masa części nadziemnej, masa części podziemnej, masywność korzeni, susza glebowa

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