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EFFECT OF *Puccinia graminis ssp.* Pers. INFECTION ON THE MACROELEMENTS' CONTENT IN SELECTED GRASS SPECIES

WPŁYW PORAŻENIA *Puccinia graminis ssp.* Pers. NA ZAWARTOŚĆ MAKROELEMENTÓW U NIEKTÓRYCH GATUNKÓW TRAW

Summary: The investigations were conducted in the years 2002–2004 in the Floriculture Station in Skrzeszowice near Krakow (altitude of 220 m). In the experimental object designed by the split-splot method in four replicants, four grass species were taken into account *i.e.*: *Festuca pratensis* cultivar Skawa, *Festuca rubra* cultivar Brudzyńska, *Phleum pratense* cultivar Skald and *Poa pratensis* cultivar Eska 46. Among all examined species, uninfected and infected with stalk rust (*Puccinia graminis*) plants were selected. The level of infection determined in a 9-degree scale amounted to 5^o, 4^o, 6^o and 2^o, respectively. The aim of this work was to determine the infection influence on the macroelements' content in selected grass species.

Uninfected plants were characterised with the highest total protein content: from 8 % for *Phleum pratense* to 27 % for *Poa pratensis*, phosphorus: from 13 % (*Phleum pratense*) to 36 % (*Festuca pratensis, Poa pratensis*) and potasium: from 9 % (*Festuca rubra*) to 70 % (*Poa pratensis*) than infected plants. On the other hand, infected species were richer in calcium, magnesium and sodium by 34–48 %, 11–20 % and 19–148 %, respectively.

Keywords: *Festuca pratensis*, *Festuca rubra, Phleum pratense, Poa pratensis, Puccinia graminis*, macroelements' content

Grass flora can be attacked by many pathogens, for example by fungi. The greatest damages are observed in genetically homogeneous, monoculture growings, which are susceptible to the attack of specialized pathogens [1]. Seed grasses are are an example of such cultivations. There is insufficient knowledge of grass diseases in cultivations intended for seeds. Labruyere [2] states, that wide-ranging investigations need to be done to answer the question what disease is the most dangerous and needs to be taken into consideration in the cultivation program. Welty and Barker [3] reported, that almost all

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seed grass species can be infected with *Puccinia graminis* ssp. Pers., and this pathogen is considered to be of the greatest economic importance.

The aim of the presented work was to estimate an effect of *Puccinia graminis* infection on the macroelements' content in four grass species *i.e.*: *Festuca pratensis*, *Festuca rubra*, *Phleum pratense* and *Poa pratensis* cultivated for seeds.

Materials and methods

The investigations were conducted in the years 2002–2004 in the Floriculture Station in Skrzeszowice near Krakow (altitude of 220 m) on the degraded humus made from loess. The soil chemical characteristics were as follows: pH_{KCl} – 7.2 and contents of assmilable: P – 54, K – 127 and Mg – 48 g · kg^{-1}. In the experimental object designed by the split-splot method in four replicants (fields of 1×10 m^2 area), four grass species were taken into account *i.e.*: *Festuca pratensis* cultivar Skawa, *Festuca rubra* cultivar Brudzyńska, *Phleum pratense* cultivar Skald and *Poa pratensis* cultivar Eska 46. The field before the seed sowing was carefully prepared in the autumn 2001. Triple superphosphate was used as a phosporous fertilizer in the amount of 31 kg P · ha^{-1} and potassium salts (potassium fertilizer) in the amount of 83 kg K · ha^{-1}. In the early spring of 2002 presowing nitrogen fertilization (ammonium nitrate(V)) was applied in a dose of 20 kg N per ha. The second dose of nitrogen fertilizer was used at the beginning of the May in the amount of 50 kg N · ha^{-1}. During the sowing year no sowing material was collected but some cultivations works were done on a seed plantation. After the cultivation mowing, preparing plantation for the winter period, phosphorous and potassium fertilizers were applied in the same amounts as in a previous year. In the years of full utilization nitrogen fertilization was done in the same manner as in the year of sowing and weeds were controled with Chwastox extra 300 SL in the amount of 1.2 dm^3 · ha^{-1} in the stage of tillering of seedlings and after harvesting with Starane 250 SL in a dose of 1.2 dm^3 · ha^{-1}. Investigated species were 3-times per vegetation period subjected to the evaluation of wholesomeness and every time green mass samples from the area of 1 m^2 were collected. Plant pathogens were analyzed in laboratory on artificial culture medium (PDA). Samples containing 40 specimens of an infected grass were placed onto the agar medium. Fungi species were identified basing on plant pathology keys and monographs [4]. Among all investigated species, plants uninfected and infected with *Puccinia graminis* were divided. Degree of infection in the 9-points scale for the particular species amounted to: for *Festuca pratensis* 5^o (30–50 %), for *Festuca rubra* 4^o (60–75 %), for *Phleum pratense* 6^o (20–30 %) and for *Poa pratensis* 2^o (85–95 %). Established points of the scale describe following degrees of infection: 9^o (0 %) – describes the most agriculturally advantageous state (total resistance), whereas 1^o (100 %) – describes agriculturally the worst state (total susceptibility) [4]. After drying and milling, in weighted mean plant samples total nitrogen content was estimated using Kjeldahl method. Then the samples after dry mineralization in a muffle kiln in 450 ^oC [5] were subjected to the atomic absorption spectral (AAS) determination for phosphorous, potassium, calcium, magnesium and sodium.

Annual average rainfall during the investigated period (2002–2004) ranged from 435 to 783 mm. However, average rainfall for the growth period (IV–IX), varied in the range of 295–567 mm. Annual average temperature for all investigated years amounted to 6.5–8.4 ^{o}C, and for the April–September periods it fluctuated within the range 12.8–13.7 ^{o}C.

Obtained data were subjected to analysis of variance (ANOVA). The means were contrasted and the differences analysed using the Duncan range test, then the least significant difference (LSD) was found.

In this work the average results for the three years of full utilization are presented.

Results and discussion

Uninfected plants were characterised with a higher level of total nitrogen, phosphorous and potassium content than plants infected with *Puccinia graminis*, regardless the level of infection. The nitrogen content varied from 8 % for *Phleum pratense* (the least infected – 20–30 %) to 27 % for *Poa pratensis* (the most infected – 85–95 %). *Phleum pratense* was characterised with the lowest diversification in phosphorous content between uninfected and infected plants (13 %), whereas the highest difference (36 %) was found for *Festuca pratensis* and *Poa pratensis*. It is worth to stress that the degree of infection for *Festuca pratensis* amounted to 5.0 points. The level of potassium in either infected or healthy plants varied from 9 % for *Festuca rubra* (4^{o}) to 70 % for *Poa pratensis* (2^{o}).

Regardless the intensity of infection, grasses infected with *Puccinia graminis* in comparison with uninfected ones were richer in calcium (from 34 % for *Phleum pratense* to 85 % for *Festuca rubra*), magnesium (from 11 % for *Poa pratensis* to 20 % for *Festuca pratensis*) and sodium (from 19 % for *Poa pratensis* to 148 % for *Festuca pratensis*). The lower level of disproportion in calcium, magnesium and sodium content was found for species of a high degree of infection (*Poa pratensis* and *Festuca rubra*) than for uninfected plants.

Table 1

Macroelements' content [g · kg^{-1} d.m.]

Specification		Crude N	P	K	Ca	Mg	Na
Festuca pratensis	A	35.8	2.71	22.4	6.85	1.50	1.54
	B	39.5	3.32	29.5	3.78	1.25	0.62
Festuca rubra	A	15.8	2.22	12.3	3.94	0.87	2.12
	B	19.4	3.02	25.7	2.13	0.75	1.16
Phleum pratense	A	31.4	2.82	25.4	4.77	0.95	0.90
	B	33.9	3.19	27.9	3.56	0.85	0.57
Poa pratensis	A	16.3	1.58	10.2	2.88	0.68	0.69
	B	20.7	2.15	17.3	2.14	0.61	0.58
LSD $_{(0.05)}$		4.25	0.61	2.04	2.78	n.s.	0.68

A – infected plants; B – uninfected plants

Damages caused by fungi had a quantitative as well as qualitative effect on changes in mineral composition. Study of Welling and Nordestgaard [6] indicate a great importance of fungi which are responsible for leaves damages, because they limit assimilation and as a result decrease the seed yield in the following year. Among all mineral components, phosphorous and potassium play special role positively influencing the concentration of some dyes *i.e.* chlorophyll and carotene [7]. Moreover, presence of potassium in plants have an effect on the forming of quantitative rates of other elements, what can be fully confirmed by results presented in this work. High potassium contents in grass flora usually decrease the level of sodium and magnesium and change calcium concentration as well. In plants calcium plays some role in nitrogen metabolism but its excessive amounts results in accelerated ageing process visible as decreased chlorophyll content. This element acts as a regulator of mineral salts intake and influences the transpiration process [7]. Moreover, mutual relationship between magnesium and calcium seems to be important here. Both the elements compete for carrier molecules transporting them across a cell membrane. In our experiment the higher content of magnesium observed in the affected plants cannot be easily explained. It is known that *Puccinia graminis*, growing through infected plant tissues, do not releases toxins, so would not cause an excessive discharge of this element out of the plant cells, which is observed for infections by other pathogens. In that case for affected plants the higher magnesium content would be observed if compared with healthy ones. In the analyzed plant material the reported difference of magnesium content between infected and healthy plants did not occur to be significant statistically, while similar effects for the other macroelements did.

Conclusions

1. Healthy plants were characterised with higher contents of total nitrogen, phosphorous and potassium than infected plants.
2. The greatest disproportion between uninfected and infected flora in the total nitrogen, phosphorous and potassium content was found for *Poa pratensis,* species infected with *Puccinia graminis* in 85–95 %.
3. Plants infected with *Puccinia graminis,* in relation to the healthy ones, regardless the degree of infection, contained more calcium, magnesium and sodium, even so the difference in magnesium content was not significant statistically.

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S t r e s z c z e n i e

Badania przeprowadzono w latach 2002–2004 na terenie Stacji Hodowli Roślin w Skrzeszowicach pod Krakowem (220 m n.p.m.). W doświadczeniu założonym metodą losowanych bloków w czterech powtórzeniach, uwzględniono cztery gatunki traw *Festuca pratensis* odmiana Skawa, *Festuca rubra* odmiana Brudzyńska, *Phleum pratense* odmiana Skald oraz *Poa pratensis* odmiana Eska 46. Spośród badanych gatunków wydzielono rośliny zdrowe i porażone przez rdzę źdźbłową (*Puccinia graminis*), przy czym stopień porażenia w skali 9 stopniowej, wynosił odpowiednio 5º, 4º, 6º i 2º. Niniejsza praca miała na celu określenie wpływu porażenia na zawartość makroelementów u wybranych gatunków traw.

Rośliny zdrowe charakteryzowały się większą zawartością azotu ogólnego od 8 % u *Phleum pratense* do 27 % u *Poa pratensis*, fosforu od 13 % (*Phleum pratense*) do 36 % (*Festuca pratensis, Poa pratensis*) i potasu od 9 % (*Festuca rubra*) do 70 % (*Poa pratensis*) niż rośliny porażone. Gatunki zainfekowane były bardziej zasobne w wapń o 34–85 %, magnez o 11–20 % oraz w sód o 19–148 %.

Słowa kluczowe: *Festuca pratensis*, *Festuca rubra, Phleum pratense, Poa pratensis, Puccinia graminis*, zawartość makroelementów