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EFFECT OF WEATHER ON THE OCCURRENCE OF *PUCCINIA GRAMINIS* SUBSP. *GRAMINICOLA* AND *PUCCINIA CORONATA* F. SP. *LOLII* AT *LOLIUM PERENNE* L. AND *DESCHAMPSIA CAESPITOSA* (L.) P. B.

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Abstract

NOVOTNÁ MONIKA, HLOUCALOVÁ PAVLÍNA, SKLÁDANKA JIŘÍ, POKORNÝ RADOVAN. 2017. Effect of Weather on the Occurrence of *Puccinia Graminis* Subsp. *Graminicola* and *Puccinia Coronata* F. Sp. *Lolii* at *Lolium Perenne* L. and *Deschampsia Caespitosa* (L.) P. B. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis,* 65(1): 0125–0134.

Monitoring of *Puccinia graminis* subsp. *graminicola* and *Puccinia coronata* f. sp. *lolii* was carried out in Plant breeding station called Větrov. The pathogens were estimated on turf grass (*Lolium perenne* L., *Deschampsia caespitosa* (L.) P. B.) from 2009 to 2014. *Puccinia graminis* subsp. *graminicola* was detected in the increased level in 2009 and 2012. The highest amount of mixed infections w as determined in 2014 because of the warmest winter from all monitored years and low precipitations. Significant differences were found out.in the resistance of similar plant materials grown in different fields. Significant effect of weather conditions and supposed effect of different infectious pressure on various fields were reflected in these facts. At evaluated grasses, the highest ($P < 0.05$) occurence of *Puccinia graminis* subsp. *graminicola*. *Lolium perenne* L. was observed and the infection of *Puccinia graminis* subsp. *graminicola* ($P < 0.05$) was determined higher than in *Deschampsia caespitosa* (L.) P. B.

Keywords: *Puccinia* spp.; turf grass; weather; plant pathogen

INTRODUCTION

Puccinia graminis subsp. *graminicola* is heteroecious rust, for which is the intermediate host Berberis vulgaris, and Mahonia. *Puccinia graminis* subsp. *graminicola* is typical stem rust. Although, the symptoms of infestation may also occur on leaf blades and sheaths. During the intensive occurrence in the early stages, it can cause malnutrition of seeds and poor-quality, but mostly the seed yield is not influenced or rather affects the quality of forage from the autumn mowing (Cagas 1997). The symptoms of *Puccinia graminis* subsp. *graminicola* are dark rusty and fuzzy blisters of urediniospores. Later, winter spores appear as dark black and bulging.

Crown rust (caused by *Puccinia coronata* f. sp. *lolii*) is a serious foliar disease of the pasture and turf grass perennial ryegrass (*Lolium perenne*). Previous genetic studies have detected both qualitative and quantitative resistance mechanisms, and the interpretation of the genetic system is complicated by the variation within the sexually reproducing pathogen (Dumsday *et al.* 2003).

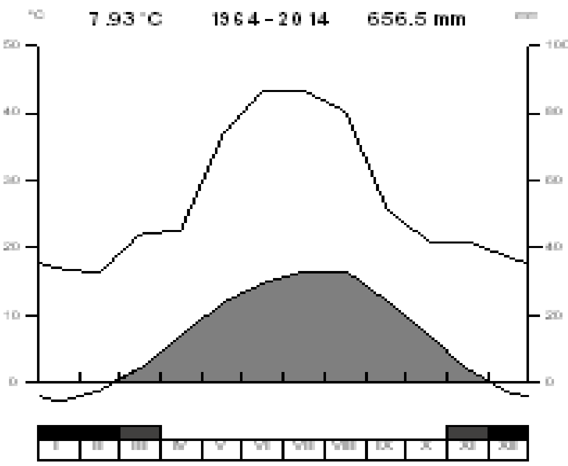
Crown rust (caused by *Puccinia coronata* f. sp. *lolii*) is the most serious foliar disease of the pasture grass of species perennial ryegrass (*Lolium perenne*). Crown rust infection has been reported in almost every zone of cultivation in the temperate regions of both north and south hemispheres (Potter *et al.* 1990). The disease leads to reductions in herbage yield, nutritional quality and palatability for herbivores (Price 1987). Crown rust fungus, *Puccinia coronata* f.sp. *lolii* is an obligate biotrophic pathogen of ryegrasses. (Dracatos *et al.* 2006).

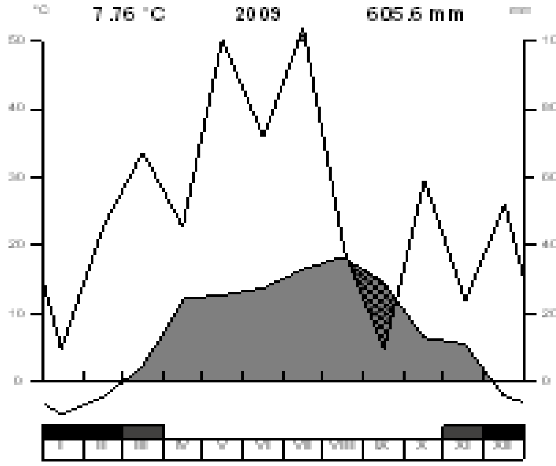
Genus *Puccinia* have been studied thoroughly because of cereals but the grasses were omitted. For this reason, the aim of the work was to precise the identification of particular species of the genus *Puccinia* at selected turf grasses under field conditions, and to evaluate the effects influencing the intensity of the infection.

MATERIALS AND METHODS

Characteristics of Plant Breeding Station called Větrov

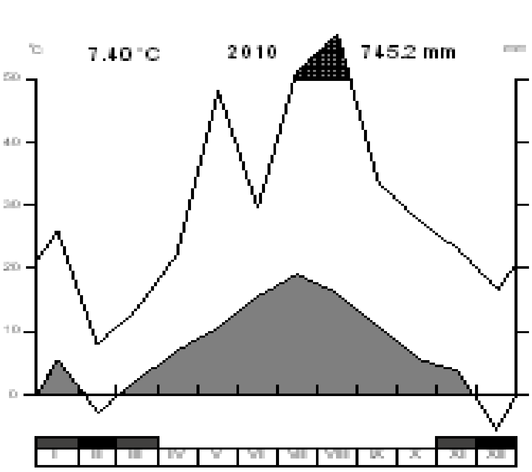
Sampling of research material was carried out at four locations at the Plant Breeding Station called Větrov (49.5172314N, 14.4680278E), (Skalnice, Za Borovíčkem, Mezi pahorky, Pod porodnicí). Skalnice plot is located at an altitude of 600 m. a.s.l. Za Borovíčkem plot is located at an altitude of 630 m a.s.l. Mezi pahorky plot is at an altitude of 560 m a.s.l. Pod porodnicí plot is at an altitude of 590 m a.s.l. Climate-diagrams according to Walter (1957), referring last fifty years (1964–2014), are seen in the Fig 1. The climate of this plot is characterized by climate-diagrams for particular years from 2009 to 2014 shown in the Fig. 2–6. The data were obtained from the measurements carried out in climatological station called Nadějkov.

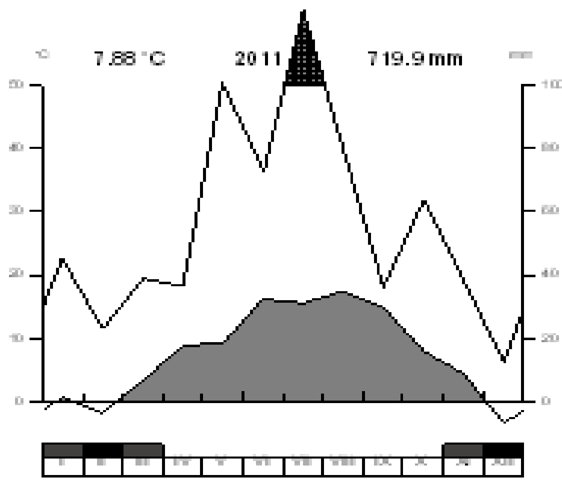




1: *Climate-diagram referring fifty years (1964–2014)*

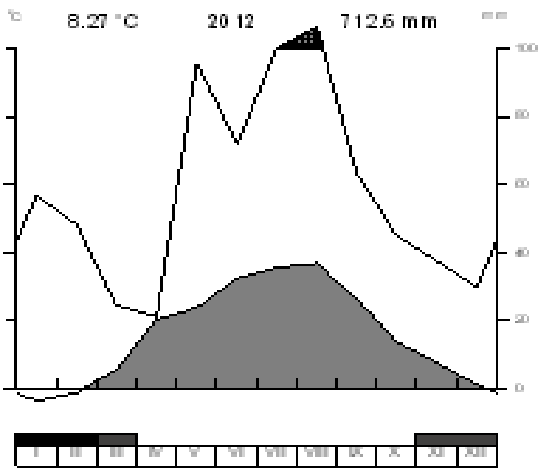
2: *Climate-diagram referring year of 2009*

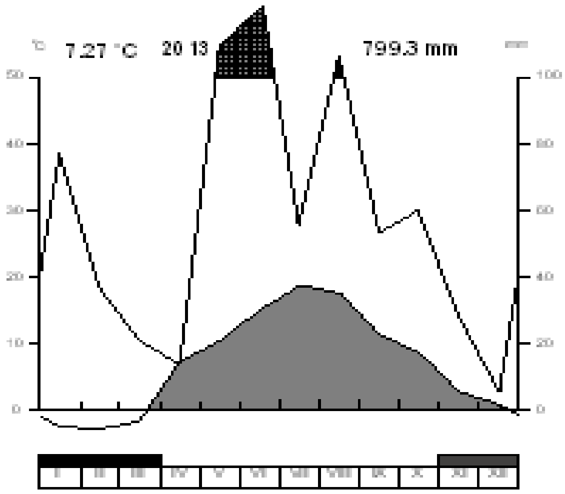




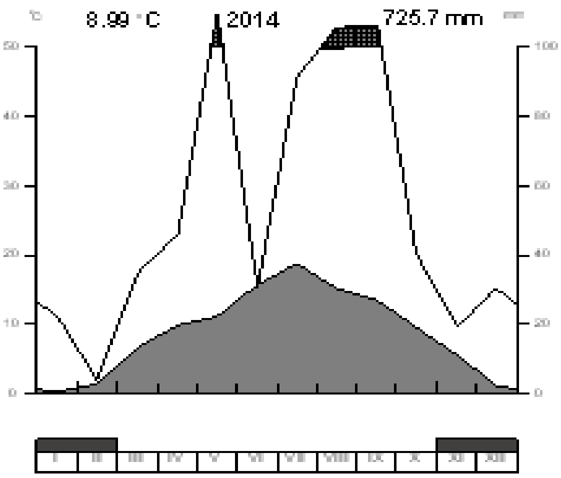
3: *Climate-diagram referring year of 2010*

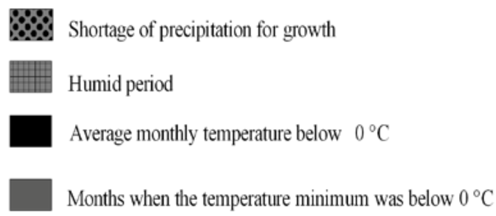
4: *Climate-diagram referring year of 2011*





5: *Climate-diagram referring year of 2012*
6: *Climate-diagram referring year of 2013*





7: *Climate-diagram referring year of 2014*

I: *Average monthly values of humidity*

Years/ months in %	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
2009	91.3	91.7	86.3	63.3	81.7	80.3	79.0	70.7	78.3	88.0	87.0	91.3
2010	92.7	88.3	77.0	70.0	85.0	75.3	70.3	81.3	84.3	83.0	92.3	92.7
2011	92.3	84.0	69.7	67.4	85.6	76.6	80.6	79.0	80.1	85.6	92.1	90.4
2012	87.1	92.3	84.0	69.7	84.7	85.6	76.6	80.6	79.0	80.1	85.6	92.1
2013	94.5	91.9	84.0	78.3	86.4	80.0	69.7	72.4	84.7	85.1	92.1	87.0
2014	90.1	81.8	66.7	70.5	76.0	62.6	68.6	77.1	85.2	89.8	92.7	88.3

Characteristics of the experimental material

Special experiments were not set up for the purpose of the research. All observations (from 2009 to 2014) were conducted on plant material in breeding nurseries of the Plant Breeding Station called Větrov plot. The characteristics of the observed material are listed below.

Jv SO/06 – KL/08 a KL/10

World assortment of lawn varieties of perennial ryegrass was founded in 2006 in the selection of plots. In 2009, selected genotypes were subcloned and planted in clonal nurseries called Pod porodnicí. Ten clones were planted from each variety (23 varieties such as Bargold, Liolympic, Greenflash, Greenway, Nikita, Jessica, Nikolin, Bareuro, Lorettanov, Lorina, Greenfair, Bellini, Margarita, Philip Conrad, Marieta, Ponderosa, Patrick, Tapiola, Romance, Leon, Henrieta, Cleopatra). The evaluated plants were subcloned in 2010 and planted in a new clonal nursery called Skalnice. From all 23 varieties, 40 of the healthiest clones were also planted in Skalnice.

Jv SO/10 – VP/10

The assortment of varieties of *Lolium perenne,* to which 5 local varieties (Doton, Filip, Honzík, Jakub Vojta), 2 domestic selections, and 7 foreign varieties (Barmarga, Altesse, 8RA236, Bargold, Bareuro, Bordorado, Barblack) were included. The experiment was founded on selected plots on the area called Za Borovíčkem in 2010.

Jv F1/08 – VP/09

Selected clones of the first crossing generation of selected genotypes of *Lolium perenne* from SO/06. Healthy genotypes (Nikita x Greenway, Nikita x Action, Barvites x Margarita, Margarita x Bareuro, Evita x Bellini) were used in crossings. The experiment was established on the selected plots on the area called Velké pole in 2009.

Jv SO/09 – VP/09

The assortment of varieties of *Lolium perenne* L., in which four Dutch varieties (Barlennium, Bartwingo, Barminton, Barsandra) and one domestic variety (Vojta) as control one were included. The experiment was established on the selected plots on the area called Skalnice in 2009.

Mt PF/04 – KL/08

The ecotypes of *Deschampsia caespitosa* (L.) P. B., coming from wild flora and collected from the Karpaty mountains, have been continuously selected against rust. In KL/08, the genotypes, which repeatedly showed higher resistance to rust, were included. The experiment was established on the selected plots on the area called Pod Porodnicí in 2008.

Mt I1/06 – KL/08

The first generation of tufted hairgrass (*Deschampsia caespitosa*) after selfing clones of PF/04 was grown. The experiment was established on the selected plots on the area called Pod Porodnicí in 2008.

Mt PF/08 – VP/08 a VP/10

The ecotypes of tufted hairgrass (*Deschampsia caespitosa*) were collected from the wild flora in the Alps and in South Bohemia. The experiment was established on the selected plots on the area called Pod Porodnicí in 2008. In 2010, selected genotypes were subcloned and planted in the selective plots on the area called Mezi Pahorky.

Mt SO/07 – KL/08

In the assortment of tufted hairgrass (*Deschampsia caespitosa*), the varieties of subcloned genotypes of Dutch varieties (Barbitosa, 6DC 302) were included. The experiment was established in a clonal nursery on the area called Mezi Pahorky in 2008.

Mt SO/08 – VP/09

The assortment of varieties of tufted hairgrass (*Deschampsia caespitosa*), in which two Dutch varieties (Barcampsia, Barbitosa) and one domestic variety (Kometa) as control one were included. The experiment was established in selective plots on the area called Pod Porodnicí in 2009.

Mt SO/08 – APT/09

In this experiment, the same variety of tufted hairgrass (*Deschampsia caespitosa* (L.) P.B. were used as in the previous experiment (Mt SO/08 – VP/09). In this case, it was the agrotechnical experiment founded on the area called Pod Porodnicí in 2009.

Sampling

The samples of *Lolium perenne* L. and *Deschampsia caespitosa* (L.) P.B. (leaves and stems) were taken during growing season from 2009 to 2014. Selected genotypes of grasses were used for the dermination of *Puccinia species*. The samples were taken at irregular intervals (from June to October) in the dependence of the infectious intensity of rust fungi in particular years. The samples were collected regardless of the frequency of infection. Ten samplings were performed per year. Collected plants were showing the signs of rust fungi structures. Removed parts of plants (leaves and stems) were placed into paper bags. Collected material was directly used for the determination of the pathogen species. In succeeding years, rust infections were found out in the range from 1 to 9, in which 1 = more than 75 % of foliage covered with rust, 2 = 75 % of rust cover, 3 = 60 % of rust cover, 4 = 40 % of rust cover, 5 = 25 % of rust cover, 6 = 10 % of rust cover, 7 = 5 % of rust cover, 8 = trace of rust, 9 = no rust. The samples, that were assessed in the scale from 8 to 1, were microscopically detected for the determination of P. G., P. C., P. G. + P. C. and the number of samples was given in tables II. and III. As a representative sample, 40 plants were used.

Microscopic diagnostics

For the determination of pathogens, microscopic diagnostics was proved. Teliospore and urediospore were observed (Knoz and Opravilová 1992). Plants were collected, when the infection of *Puccinia graminis* subsp. *graminicola, Puccinia coronata* f. sp. *lolii* and mixed infection were determined. Based on the findings, the intensity of the infection and the differences between pathogens were calculated using STATISTICA Version 10.0. Statistical significance was determined by multi-factor analysis of ANOVA variance (species, year) and subsequent testing by Scheffe's test.

RESULTS

In 2009, most of the samples were infected by *Puccinia graminis* subsp. *graminicola* (75 % of the samples) (Tab II.). The samples were collected in July 2009 and compared with samples taken in September of 2009. A combined infection (3 %) was determined in the samples. Most samples were infected by *Puccinia graminis* subsp. *graminicola* in 2010. The samples were taken at the end of September in 2010 in a lower number than in summer sampling. Only 3 % of samples were infected by *Puccinia coronata* f. sp. *lolii*. In 2011, most of the samples were detected without the infection from both sampling in August and September. The samples were found out the most ($P < 0.05$) infected by *Puccinia graminis* subsp. *graminicola* in the plant material in 2011 (Fig. 8). From the infected material in August of 2011, the samples were determined the most infected by *Puccinia graminis* subsp. *graminicola*. Due to low temperatures, *Puccinia graminis* subsp. *graminicola* did not occur in September of 2011. In June of 2012, 40 % of the samples were infected by *Puccinia graminis* subsp. *graminicola* (Tab. II). In August 2012, the intensity of infection by *Puccinia graminis* subsp. *graminicola* was found out from medium to high. In 2012, *Puccinia graminis* subsp. *graminicola* prevailed in the samples taken in June and August. *Puccinia coronata* f. sp. *lolii* occurred only in the sampling in September of 2012, when contributed the weather with altering rain (63.1 mm) and the optimum temperatures (13.2 °C) to the occurrence. In 2013, most of the samples were infected by *Puccinia graminis* subsp. *graminicola* in 62 % of cases. *Puccinia coronata* f. sp. *lolii* was found out in 20 % of samples. The lowest number of samples was free of infection. The sampling was proved in June, July, August and September of 2013. In 2014, most plants were infected by *Puccinia graminis* subsp. *graminicola*. The lowest number of samples was infected by a combination of *Puccinia graminis* subsp. *graminicola* and *Puccinia coronata* f. sp. *lolii*. In 2014, the sampling was proved in August, September and October.

In 2009, most of the samples were infected by *Puccinia graminis* subsp. *graminicola* (67 % samples). The intensity of infection was found out in a high level (Tab. III) and the lowest number of samples was free of infection. *Puccinia graminis* subsp. *graminicola* was occurred in 662 cases. *Puccinia coronata* f. sp. *lolii* was determined nearly absent (6 %). In September 2010, the average temperature was about 10.6 °C *with 67.9 mm of precipitation, which could also affect the low* occurrence of *Puccinia coronata* f. sp. *lolii*. In 2011, most of the samples were unidentified (40 %) therefore the intensity of infection was found out low. *Puccinia graminis* subsp. *graminicola* occurred in 20 % of samples of *Deschampsia caespitosa* (L.) P.B., as it was detected in *Lolium perenne*. The lowest number of samples was determined with combined infections (*Puccinia graminis* + *Puccinia coronata*). In 2012, 44 % of samples were infested by *Puccinia graminis* subsp. *graminicola*. *Puccinia coronata* f. sp. *lolii,* detected in 22 % of plants. Temperatures and precipitation were acceptable for the occurrence of both pathogens in 2012. In 2013, *Puccinia graminis* subsp. *graminicola*

II: *Monitoring of Puccinia graminis subsp. graminicola and Puccinia coronata f. sp. lolii and Lolium perenne L. in Plant breeding station called Větrov from 2009 to 2014*

Year of detection	Unit	P. graminis	P. coronata	*P. g. + P. c.*	Unidentified
2009	%	75 %	7 %	3 %	15 %
	number	1135	106	45	227
2010	%	62 %	3 %	7 %	28 %
	number	843	41	95	380
2011	%	20 %	15 %	5 %	60 %
	number	197	148	49	592
2012	%	90 %	2 %	4 %	4 %
	number	1121	25	50	50
2013	%	63 %	21 %	2 %	14 %
	number	495	165	16	109
2014	%	48 %	26 %	11 %	15 %
	number	673	364	154	210

III: *Detection of Puccinia graminis subsp. graminicola and Puccinia coronata f. sp. lolii.at Deschampsia caespitosa (L.) P.B. in Plant breeding station called Větrov from 2009 to 2014*

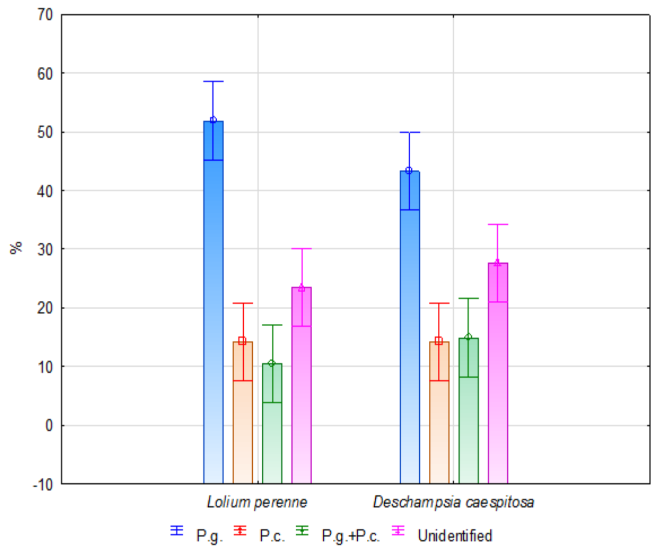
(L.) P.B.					
Year of detection	**Unit**	**P. graminis**	**P. coronata**	*P. g. + P. c.*	**Unidentified**
2009	%	67 %	16 %	9 %	8 %
	number	662	158	89	79
2010	%	58 %	6 %	24 %	12 %
	number	359	37	149	74
2011	%	20 %	30 %	10 %	40 %
	number	70	105	35	140
2012	%	44 %	22 %	14 %	20 %
	number	384	192	122	175
2013	%	72 %	8 %	6 %	14 %
	number	363	40	30	71
2014	%	70 %	5 %	8 %	17 %
	number	319	23	36	78

prevailed (72 %). *Puccinia coronata* f. sp. *lolii* was found out only in 40 samples. The lowest number of samples was found out with combined infection in 2013. In 2014, *Puccinia graminis* subsp. *graminicola* was observed in 70 % ($P < 0.05$) of samples (Fig. 8). *Puccinia coronata* f. sp. *lolii* occurred in 5 % of samples. 17 % of samples were found out unidentified.

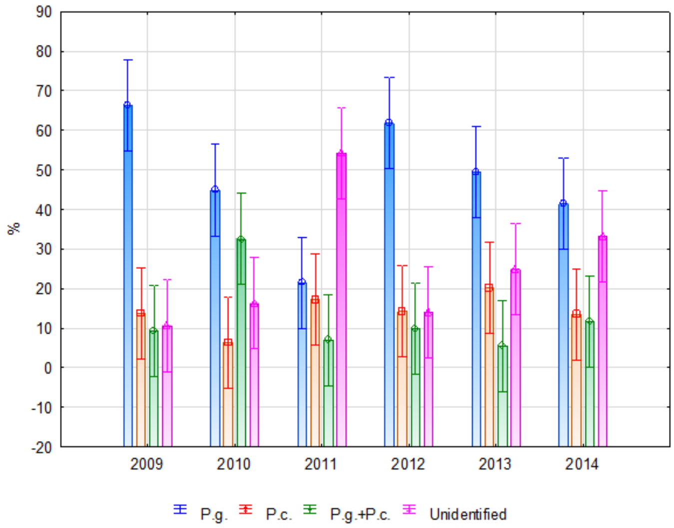
Puccinia graminis subsp. *graminicola* dominated on *Lolium perenne* L. more than on *Deschampsia caespitosa* (L.) P.B. ($P < 0.05$). *Puccinia graminis* subsp. *graminicola* prevailed from all monitored pathogens (Fig. 8). The lowest number of samples was infected by a combined infection ($P < 0.05$). *Deschampsia caespitosa* (L.) P.B. proved to have the samples of *Puccinia coronata* f. sp. *lolii* and also a combined infection.

In *Lolium perenne* L. And *Deschampsia caespitosa* (L.) P.B.,the share of *Puccinia graminis* subsp. *graminicola* was the highest ($P < 0.05$). *Lolium perenne* L. was infected more ($P < 0.05$) by *Puccinia graminis* subsp. *graminicola* than *Deschampsia caespitosa* (L.) P.B. (Fig. 8). The number of leaves of individual species infected by *Puccinia coronata* f. sp. *lolii*, resp. infected by both of rusts (*Puccinia graminis* subsp. *graminicola* and *Puccinia coronata* f. sp. *lolii*), was detected similar.

Puccinia graminis subsp. *graminicola* prevailed in the year of 2009. Contrarily, the infection by this pathogen was found out lower in 2011($P < 0.05$). Unidentified samples were prevalent in 2011 (Fig. 9). The share of *Puccinia coronata* f. sp. *lolii* was detected similar in each year. A combined infection was predominated in 2010 ($P < 0.05$).



8: *Percentages of Puccinia graminis, Puccinia coronata, Puccinia graminis + Puccinia coronata, unidentified at Lolium perenne and Deschampsia caespitosa in all years of monitoring (from 2009 to 2014)*
P.g. – *Puccinia graminis*, P.c. – *Puccinia coronata*, P.g.+P.c. – *Puccinia graminis + Puccinia coronata*



9: *Percentages of Puccinia graminis, Puccinia coronata, Puccinia graminis + Puccinia coronata, unidentified in different years (from 2009 to 2014)*
P.g. – *Puccinia graminis*, P.c. – *Puccinia coronata*, P.g. + P.c. – *Puccinia graminis + Puccinia coronata*

DISCUSSION

Existing papers are primarily concerned on the occurrence of rust on field crops. However, rust may cause significant problems at turf grass. An important function of turf grass can be aesthetics. Nowadays, the aesthetic function is seriously threatened with the occurrence of rust but also the fact that diseases weaken the plants and can generally deteriorate the appearance of turf grass. Current knowledge about the occurrence of rust may be affected by changing climate. The assessment of ornamental turf grass in the context of weather condition during particular years represents quality of this work.

In 2009 and 2011, the highest humidity was detected in January and the lowest one in April. In 2010, the highest humidity was detected in January and December 2010 and the lowest one in April 2010. In 2012, the highest humidity was detected in February 2012 and the lowest one in April 2012. In 2013, the highest humidity was detected in January 2013 and the lowest one in August 2013. In 2014, the highest humidity was detected in January 2014, and the lowest on in June 2014 (Tab. I).

The movement of clouds proves a seasonal character in our area. Static type of layering clouds occurs from October to March. Dynamic type with cumulus cloud prevails from April to September. Relative humidity ranges from 60 % to 80 % in the annual average. Respectively, the value of global radiation should be slightly increased and due to increase in temperature, relative humidity shall be reduced. This trend is probably to intensify further, thus in the long term, these changes can already be considered as significant. The declines in summer precipitation, the increases in summer temperatures together with decreases in the relative humidity and higher values of global solar radiation can be considered as the main cause to increase the evaporation, and generally the increasing risks of drought. In the future, the risk of water loss in the soil can increase, thereby to reduce the moisture content (a critical deficit may happen at the height of summer and early autumn, when sampling is carried out). Trends of relative humidity, cloud covering, sunshine, altitude and duration of snow are consistent and correspond to the trends in temperature and its amplitudes. Winter, spring and summer are characterized by lengthening the duration of sunshine, decreasing cloud cover and the decreases in relative humidity. Contrarily in the autumn, when temperature and its day amplitude are decreased, we can see the shortening of sunlight duration, and the increase in cloud cover and relative humidity. The average days with snow cover in altitudes up to 600 meters a.s.l. have decreased by 15 % in last 20 years compared to usual number of days in the middle of the last century (shorten age of the season for 12 days). In higher altitudes, the decrease was roughly halved. The maximum of snow cover has decreased by 25 % in the lower altitudes, and by up to 305 % at higher altitudes. Total amounts of new snow show similar trends. All these climatic changes affect the occurrence of the genus *Puccinia spp. Puccinia graminis* subsp. *graminicola*, which is the most demanding on the temperature. The temperature optimum for the infection ranges from 15 to 20 °C. Pfender *et al.* (1999) detected that 97 % of samples were fallen down after 72 hours of observations in low temperatures (< 0 °C) from surviving of uredispores of *Puccinia graminis* subsp. *graminicola*. The extensive damage to wheat is detected in warmer regions of Central and Eastern Europe, Slovak Republic, Hungary, the Balkans and other places, where under favourable conditions, the inoculum (summer spores – urediospores) of stem rust can spread to the Czech Republic (Hanzalová *et al.* 2008). The results from 2009 showed that high intensity of infestation was probably caused by warmer and drier year. In the summer 2009, there were very favourable conditions for the occurrence of rust fungi at *Deschampsia caespitosa* (L.) P.B. The temperature was found out higher by 1.93 °C compared to long term average and the precipitation amount was detected below the average in August 2009. August of 2009 was found out the strongest month from 2009. The beginning of June in 2009 was marked by an intense storm activity. In the third decade of June in 2009, thunderstorms progressed through our territory frontal systems from the northeast. They were associated with heavy precipitation and strong winds occurred virtually across all the country. They were the most effective in northern Moravia and southern Bohemia. September of 2009 was extremely warm and dry. In mid-September 2009, clouds were increasing, there was strong wind and fog persisted till noon. Thus, sampling was carried out only till half of September in 2009. BRAUN (1982) stated that stem rust and crown rust are the most common pathogens of *Lolium perenne* L. In Turkey, the occurrence of *Puccinia graminis* f. sp. *tritici* was observed from 2007 to 2008. In 2007, *Puccinia graminis* f. sp. *tritici* was detected in 43 % of samples of wheat and 25 % was found out in 2008. The occurrence was affected by rainfall, which was lower by 16 % in 2007 and by 9 % in 2008 compared to the long-term average precipitation (Mert *et al.* 2012). Our study confirmed that the most samples of *Lolium perenne* L. and *Deschampsia caespitosa* (L.) P.B. were infected with *Puccinia graminis* subsp. *graminicola* in June of 2010, when the temperature increased by 2.7 °C above the long-term average. Tall fescue is susceptible to the infection by certain populations of P. *graminis* subsp. *graminicola* (Urban 1967), which include the host range from orchard grass (*Dactylis glomerata* L.) and ryegrass (*Lolium spp.*). Stem rust can cause severe yield losses up to 40 %, in seed crops. Stem rust severity and damage are generally more severe in the first-year of tall fescue seed fields than in older established stands (Pfender *et al.* 2001).

The intensity of thunderstorm activity associated with torrential downpours and hail were recorded in July and August of 2010. In July 2010, humidity was detected the lowest. In the infectious plants, *Puccinia coronata* f. sp. *lolii*. Prevailed because of the optimal temperature in autumn of 2011. The occurrence of *Puccinia coronata* f. sp. *lolii* was the most common in late summer. In 2009 and 2010, there were not suitable conditions for the occurrence of *Puccinia coronata* f. sp. *lolii*. Chapman *et al.* (2012) states *Puccinia* spp. causes the economic loss on seed crops especially at *Lolium perenne* L. In perennial ryegrass (*Lolium perenne*) and tall fescue grown for seed, stem rust, caused by *Puccinia graminis* subsp. *graminicola*, is economically the most important disease in major seed production areas of the United States (Welty and Azevedo 1984). Teliospores of crown rust, produced in late summer, remain in dormancy over winter and germinate in the spring. In the southern US states, they persist winter in the phase of urediospores at sown oats from the autumn to winter (Simons 1970). *Puccinia coronata* infections have been reported in almost every area of crop production in moderate regions of both northern and southern hemispheres. The disease leads to a reduction in yields of herbs and grasses, nutritional quality, and tastiness of forage for herbivores (Leonard *et al.* 2004). Schubiger *et al.* (2010) observed *Puccinia coronata* f. sp. *lolii* as the most severe disease in *Lolium perenne* L. *Puccinia coronata* f. sp. *lolii* was observed in 61 % of plants from the areas of Perugia (Italy) in the south of Europe, Boelshoj (Denmark) in the north of Europe, Loughgall (Northern Ireland), western France, up to Poland and the Czech Republic. Schubiger *et al.* (2010) observed the occurrence of rust on *Lolium perenne* L. in Italy and found out the first occurrence in June and the most frequent occurrence in August. In our observations, most samples for detection were collected in August of 2009, when rainfall was lower by 41.4 mm, compared to long-term precipitation average. Small number of samples was taken in August of 2010, when the highest value of above-average rainfall (difference to long-term precipitation average was by 61 mm) was recorded. Losses of seed yield of perennial ryegrass were detected up to 98 % due to stem rust damage (Pfender 2009). *Puccinia graminis* subsp. *graminicola* was observed the most spread in June probably due to the optimum temperature for reproduction, as the average temperature in June of 2012 was +16 °C. In Israel, *Puccinia coronata* f.sp. *avenae* P. Syd. & Syd. regularly infects oats from December to April. Teliospores are produced from April or May. During the hot Mediterranean summers, they are in dormancy and basidiospores germinate during the winter rainy season (Kolmer 2005). Roscher *et al.* (2007) reports that both pathogens produce sporangia, which can be seen especially in late summer and autumn. In our monitoring, combined infections (*Puccinia graminis* + *Puccinia coronata*) were the most frequent at *Deschampsia caespitosa* (L.) P.B. in 2010. Potter *et al.* (1990) states that the strongest occurrence of urediospores of rust fungi appears annually after seed harvest in the autumn. Věchet (1995) reported that *Puccinia graminis* is the most demanding on temperature from 15 to 20 °C, which is the optimum for the infection. July was the hottest month (18.7 °C) from 2013, collected samples were detected the most affected by *Puccinia graminis* subsp. *graminicola* and *Puccinia coronata* f. sp. *lolii*. In June 2013, the intensity of infestation was found out low due to intense of rainfall. In 2014, an extraordinarily early and strong occurrence of yellow rust in Western Europe, as opposed to *Puccinia graminis* subsp. *graminicola* and *Puccinia coronata* f. sp. *lolii*, which occurred at the end of summer. The intensity of the infection was low due to intense rainfall in October and due to low temperature in August and September of 2014.

Due to warm spring in 2014, there were suitable conditions for the development of rust fungi until fall with lower precipitation. The number of tillers was reduced in a population as a result of the infection with crown rust. Increased rates of tiller death due to the pathogen occurred throughout the population age-range and were the most detected in the youngest tillers. Population changes were evident from following infection and continued to be apparent in the following spring. The disease caused the alterations in sward age structure leading to a higher proportion of older tillers in more rust-damaged treatments and to a decrease in the weight of the produced herbage. It is concluded that rust infection of a sward may lead to changes in population structure with long-term yield effects or to the immediate direct yield reductions, which are commonly reported. The significance of these results to the ecological and agronomic balance of grassland is discussed (Plummer *et al.* 1990).

CONCLUSION

Puccinia graminis subsp. *graminicola* and *Puccinia coronata* f. sp. *lolii* at *Lolium perenne* and *Deschampsia caespitosa* were accurately found out, and the effects of their intensity were evaluated. Individual tested grass species differed significantly from the susceptibility to both rust fungi. *Lolium perenne* was the most infected grass where most samples of *Lolium perenne* were collected to determine the pathogen. *Deschampsia caespitosa* was strongly infected as well. *Puccinia graminis* subsp. *graminicola* was also found out similarly as in the case of *Lolium perenne*. The occurrence of *Puccinia coronata* f. sp. *lolii* was found out significantly lower in 2010 than in 2009. In the summer and autumn of 2009, temperatures were slightly above the average, which promoted the development of rust until late autumn. Contrarily, the below-average temperature probably prevented from the development of *Puccinia coronata* f. sp. *lolii* in autumn of 2010. Only laboratory and greenhouse tests can eliminate the impact of climate changes. *Puccinia coronata* f. sp. *lolii* prevailed in the infected plants in 2011 due to warmer autumn. In 2012, temperatures in late summer differed significantly because the conditions were not detected favourable for germination of teliospores of *Puccinia coronata* f. sp. *lolii*. Therefore, the presence was determined as minimal in the samples. Due to rainy weather and low temperatures in October 2012, another sampling was not carried out.

In June of 2013, the intensity of infestation was detected low due to the intense rainfall. In 2014, *Puccinia graminis* subsp. *graminicola* was monitored in most samples. Due to warmer spring of 2014, there were suitable conditions for the development of rust until autumn due to lower rainfall. There were observed significant differences in resistance of similar materials grown in different fields. It is confirmed by significant effect of microclimate conditions and probably also by the impact of different infection pressure on individual plots (affecting neighbouring crops etc.). The results of turf grass experiments showed that the selection of genotypes of *Lolium perenne* with reduced rust infestation is positively reflected not only in improved health but also in a better overall appearance of progenies of selected plants. Thus, the effectiveness of selection has been confirmed. Highly susceptible genotypes, which could serve as the infectious material in planned greenhouse tests of rust resistance, were selected as the tested materials. At the same time, there has been managed preliminary identification of genotypes relatively resistant to various rust fungi. If their resistance is confirmed in the following period, they may be able to be used as donors of resistance in breeding and as resistant standards in the tests.

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