Journal of Elementology ISSN 1644-2296

Radkowski A., Radkowska I., Wolski K. 2018.
Effect of silicon foliar application on the functional value of lawns.
J. Elem., 23(4): 1257-1270. DOI: 10.5601/jelem.2017.22.4.1540

RECEIVED: 6 October 2017
ACCEPTED: 25 April 2018

ORIGINAL PAPER

EFFECT OF SILICON FOLIAR APPLICATION ON THE FUNCTIONAL VALUE OF LAWNS*

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Abstract

The research reported below was conducted between 2014 and 2016, at the Prusy Experimental Station of the University of Agriculture in Krakow (50°07′ N, 20°05′ E). An experiment was set up on degraded black earth soil developed from loess, classified as representing very good soil of class 1. The experiment was designed in accordance with the agro-technical recommendations for lawn establishment. A commercial grass seed mixture called ‘Super trawnik’ was used to seed the experimental plots, while silicon in the form of Optysil® was tested as an experimental factor. In three variants of the experiment, three doses of Optysil® were applied: 0.2, 0.5, and 0.8 dm^3 ha^{-1}, with the respective amounts of silicon per hectare equal 18.7 g (variant I), 46.8 g (variant II), and 74.9 g (variant III). Lawn characteristics studied in the experiment were assessed on a 9-point scale. During the growing season, grass was mown 10 to 11 times, to a height of 4 cm. Plants on the plots with the highest dose of silicon (variant III) achieved the highest aesthetic and functional value. Additionally, silicon increased disease resistance of lawn grass. Compared to the control, there was about 12% less Fusarium patch infection and about 18% fewer cases of leaf blight in the plots treated with the highest dose of silicon. Similar satisfactory results were obtained on plots with a dose 0.5 dm^3 ha^{-1} (variant II). In relation to the control, grass in the plots treated with silicon had higher resistance to Fusarium patch (*Microdochium nivale*) and leaf blight (*Drechslera siccans*), denser turf and therefore scored higher lawn ratings.

Keywords: silicon application, grass lawn, turf appearance, overwintering, the structure of the leaf, Fusarium patch (*Microdochium nivale*), leaf blight (*Drechslera siccans - Helminthosporium disease*).

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* This Research was financed by the Ministry of Science and Higher Education of the Republic of Poland.

INTRODUCTION

Lawns are an important element of gardens, urban parks and many public places, where well-kept green areas have decorative and aesthetic values, while mostly playing a functional purpose on grounds intended for recreational activities. In recent years, there has been a significant increase in efforts to make aesthetic improvements in human habitats, for example establishing lawns around residential or commercial premises in order to improve the public image of such places. Grass is the main component of lawn mixtures owing to an immense diversity of its species and varieties, as well as its ability to adapt to changing climatic conditions and different ways of use (Kozłowski et al. 2000, Wolski 2003, Wolski et al. 2015). Grass intended for a lawn should grow slowly after each mowing, forming a dense and even turf, and having high aesthetic quality (Grabowski et al. 2003*a*,*b*, Wolski et al. 2006). The general aesthetic value of a lawn is one of the main attributes in its assessment (Prończuk, Prończuk 1997, Prończuk 2002). This characteristic, together with an assessment of the growth rate, decides about the suitability of a lawn grass species or its variety. In addition, the appearance of a lawn is strongly related to other features, such as grass density or leaf fineness (Prończuk, Prończuk 1997, Prończuk 2002). To establish a lawn, a mixture of several species and varieties of grasses are usually sown, and their selection depends on the purpose of a green area. In a temperate climate, perennial ryegrass (*Lolium perenne* L.) is one of the most common components of lawn mixtures. Lawn varieties of this species thrive well after sowing, having a high turf density and relatively high resistance to trampling (Domański, Golińska 2003). Cultivated plants are exposed to varied, sometimes even extreme, climate conditions as well as abiotic stresses, for example caused by high temperature and drought. These adverse environmental factors restrain the full use of the grass's potential despite the implementation of all the recommended agricultural practice methods. One of the numerous factors affecting the lawn appearance is fertilization. Apart from basic mineral fertilization, fungicides and herbicides, products referred to as plant growth regulators or biostimulants are used increasingly often.

Silicon is a substance which stimulates the growth and development of plants, while reducing the risk of infestation by pathogens and pests (Fauteux et al. 2005, Ma, Yamaji 2006, Fauteux et al. 2006). Silicon increases the tolerance of plants to drought through their increased absorption of water, which in turn helps to increase their productivity and quality. It reduces the oxidative damage of functional molecules and improves antioxidant properties of plants (Gong et al. 2005). Considering the role of this chemical element, the aim of the study was to assess the effect of foliar application of silicon on the functional value of the 'Super trawnik' grass mixture.

MATERIAL AND METHODS

The research was conducted between 2014 and 2016, in the Experimental Station of the Agricultural University in Prusy near Kraków (50°07′ N, 20°05′ E). It was set up on degraded black earth soil developed from loess and classified as very good soil of class 1 with minor or no physical limitation to use. The chemical properties of the soil were as follows: pH KCl – 7.0, N-total – 2.63 g kg^{-1}, P – 68.54 g kg^{-1}, K – 162.58 g kg^{-1}, and Mg – 44.60 mg kg^{-1}. The experiment, evaluating the mixture of lawn grasses under the brand name 'Super trawnik' was set up in accordance with the agro-technical recommendations for lawn establishment. The composition of the mixture was as follows: perennial ryegrass (*Lolium perenne* L.) – Stadion 12%, Italian ryegrass (*Lolium mulitflorum*) – Maki 30%, tall fescue (*Festuca arundinacea*) – Fawn 20%, red fescue (*Festuca rubra*) – Aniset 25%, and red fescue (*Festuca rubra*) – Reverent 13%. On 8 April 2014, plots of 10 m^2 in size were sown with the mixture of grasses in a dose of 260.0 g m^{-2}. In the first year, the following fertilizers were applied: 65 kg N ha^{-1}, 33 kg P ha^{-1}, and 124.5 kg K ha^{-1}, and afterwards 190 kg N ha^{-1}, 35.2 kg P, 124.5 kg K ha^{-1} applied in the consecutive years. Nitrogen fertilizer was used in the form of ammonium nitrate (34% N), phosphorous as granular triple superphosphate (20.2% P), and potassium as potassium salt (49.8% K). The experimental factor was silicon in the form of Optysil®, applied in three doses: 0.2, 0.5 and 0.8 dm^3 ha^{-1}. The preparation contains 93.6 grams of silicon in a 1 dm^3 of solution, thus the following amounts of silicon were applied: 18.7 g ha^{-1} (variant I), 46.8 g ha^{-1} (variant II), and 74.9 (variant III) g ha^{-1}. In accordance with the Regulation of the Ministry of Agriculture and Rural Development No S-514/15, this fertilizer product is considered to be a mineral growth stimulator, produced by the INTERMAG Ltd. in Olkusz. In our trial, it was administered as foliar spray three times during the growing season, in early April, June, and August. During the growing season, the grass was mown 10 to 11 times to a height of 4 cm. Grass mowing was carried out when the plants were 8 cm high. The mowing frequency and the height of of cut grass were in line with the recommendations of the COBORU for the 'Relax' type grass mixtures (Domański 1992). The weather conditions were generally favourable to the growth and development of plants. During the growing season (April – September), the sum of precipitation was 654.0 mm in 2014, 356.6 mm in 2015, and 338.6 mm in 2016 (Table 1). The average air temperature during the tests was also favourable: 15.9 (2014), 16.3 (2015), and 16.2°C (2016). During persistant periods of dry weather, sprinkler irrigation was started regularly, three times daily, supplying approximately 10 dm^3 m^{-2} (a precipitation dose of 10 mm) of water at a time. The evaluation of the turf lawns was based on the method of Domański (1992), while the visual and functional aspects were assessed using the method of Turgeon (2004). The functional value assessed in the experiment included the following

Table 1

Monthly precipitation and average annual temperature between 2014 and 2016 (Prusy Experimental Station of the University of Agriculture in Krakow)

Month	Precipitation (mm)			Temperature (°C)		
	2014	2015	2016	2014	2015	2016
January	46.1	5.6	21.2	-0.9	1.2	-2.1
February	16.6	19.8	80.6	2.9	1.1	3.9
March	27.7	33.2	34.6	7.2	4.9	4.7
April	43.0	19.4	58.6	11.3	9.1	9.5
May	107.5	101.6	41.4	14.3	13.3	14.5
June	80.1	52.6	59.8	16.7	17.5	18.8
July	183.2	71.8	92.8	20.4	20.6	19.6
August	142.0	41.8	62.0	17.7	22.0	18.5
September	98.2	69.4	24.0	15.2	15.2	16.3
October	38.0	51.4	104.4	9.9	7.9	7.7
November	15.2	53.8	36.2	5.9	5.5	3.8
December	9.0	9.4	19.2	0.9	4.1	0.3
Total	806.6	529.8	634.8	–	–	–
Total April- -September	654.0	356.6	338.6	–	–	–
Average	–	–	–	10.1	10.2	9.6
Average April- -September	–	–	–	15.9	16.3	16.2

parameters: general appearance (Ao), turf density (Z), colour (K), overwintering (P), and susceptibility to disease (Pch). Identification keys and graphic rating scales were used to identify plant diseases. The results of the observations were set out using a 9-point scale, on which each lawn feature was assigned a relative score from 1 to 9, with 9 indicating the highest and 1 the lowest value (Domański 1992). In each year of the experiment, the effect of foliar fertilization on the chlorophyll content was studied. The leaf greenness index values were determined on the upper leaves with a Chlorophyll Meter Minolta SPAD 502DL (Minolta, Osaka, Japan). The measurements were taken on every plot, using thirty fully developed leaves. The Kjeldahl method was used to determine the total nitrogen content in plant samples, while the content of P, K, Ca, Mg, Na, Cu, Mn, Fe and Zn was measured with inductively coupled plasma atomic emission spectroscopy (ICP-AES). The results were processed statistically in a Statistica 12 program, and the Duncan's test served to determine the significance of the differences between means.

RESULTS AND DISCUSSION

One of the most important approaches to an assessment of the value of a lawn is by estimating its appearance, as this is among the most significant contributors to the quality of turf in both compositional and aesthetic terms (Domański 1992). In our experiment, the biggest differences between appearance scores assigned were observed in summer, with the variation coefficient at 20.5% (Table 2). Depending on a dose of silicon and year of the study, the appearance scores ranged from 5.0 to 8.2°. Application of Optysil® in the first year of the experiment significantly ($p \leq 0.05$) influenced the aesthetic value of lawns. Plants on the plots with higher doses of silicon (variants II and III) were assigned significantly higher scores ($p \leq 0.05$) than the control plot grass. Jankowski et al. (2010) report that the aesthetic appearance of lawns particularly depends on the amount of precipitation in individual months of the growing period. Thus it can be assumed that silicon in the present experiment eliminated some of the effects of stressful conditions, leading to the satisfying results obtained on the Optysil® treated plots. By taking part in the creation of mechanical or physical barriers in cell walls and intercellular spaces inside cells, silicon diminishes plants' demand for water and it limits water loss due to evaporation (Grenda, Skowrońska 2004). Our comparisons of the appearance of lawns in different seasons resulted in assigning the highest scores in spring (the three-year average score was 7.6°), slightly lower in spring (7.3°), and the lowest in summer (6.1°). According to Domański (1992), appearance scores can be considered significantly different from each other when differences between means are higher than 0.5. The study of Starczewski and Affek-Starczewska (2011) showed that the appearance values in consecutive months of plant growth ranged, on average, from 6.1 points in May to 7.5 points in October. Another feature assessed in our experiment was grass cover throughout the growing season. This is a measure of the durability of the species making up the turf and a measure of their adaptation to habitat conditions. The more leaf blades cover the soil, the higher the score. In the experiment, the scores for this characteristic ranged from 6.7° to 8.3°. It was noted that the control plot together with the plot treated with 18.7 g Si ha^{-1} (variant I) had the worst turf. Variants II and III had a significantly higher turf quality ($p \leq 0.05$) in relation to the control. Depending on the time of year, the best density of grass was observed in autumn (7.6°) and the worst in spring (7.3°). Grass density is one of the most important criteria in evaluating lawns, and it largely depends on atmospheric conditions. In their experiments with a variety of species, Jankowski at al. (2012) found that grass density in lawns varied considerably in different seasons. In the present experiment, the best grass density was in the summer of the first year (8.7°), and in the autumn in the second year (7.4°). In addition, on the basis of the average annual values, it was concluded that turf was in a better condition in summer and autumn than in spring. Simi-

Table 2

Scores for main lawn properties (1–9), three-year means and standard error

Variant of silicon dose (g ha^{-1})	Lawn appearance (Ao)			Turf density (Z)			Overwintering (P)
	spring	summer	autumn	spring	summer	autumn	
Control (0)	6.0 (±0.53)^{c}	5.0 (±0.51)^{b}	7.0 ±0.75)^{b}	6.7 (±0.70)^{b}	7.0 ±0.76)^{b}	7.0 ±0.81)^{b}	6.5 (±0.85)^{b}
I (18.7)	7.2 (±0.72)^{b}	5.2(±0.55)^{b}	7.2 (±0.82)^{b}	7.1 (±0.84)^{b}	7.2 ±0.82)^{b}	7.4 (±0.92)^{b}	6.7 (±0.83)^{b}
II (46.8)	7.8 (±0.78)^{a}	6.3 (±0.58)^{ab}	7.8 (±0.76)^{a}	7.5 (±0.88)^{a}	7.6 (±0.87)^{a}	7.8 (±0.94)^{a}	6.9 (±0.91)^{a}
III (74.9)	8.1 (±0.84)^{a}	7.7 (±0.74)^{a}	8.2 (±0.85)^{a}	7.8 (±0.92)^{a}	8.0 (±0.94)^{a}	8.3 (±1.04)^{a}	7.4 (±0.94)^{a}
Standard deviation	0.9	1.2	0.6	0.5	0.4	0.6	0.4
Variation coefficient (V%)	12.8	20.5	7.3	6.6	6.0	7.3	5.6

a, *b*, *c* – letters denote significantly different values in columns ($p \leq 0.05$)

larly, Grabowski at al. (1999) found that grass density is largely dependent on the time of year. Overwintering scores determined by comparing the ground cover by living grass blades before winter, at the end of the growing season and in spring a week after the growing started ranged from 6.5° to 7.4°. Plants on the plots with higher doses of silicon (variants II and III) had significantly higher scores ($p \leq 0.05$) in relation to plants on the control plots. Studies have shown that silicon strengthens cell walls of plants, making them more resistant to adverse conditions, including low temperature (Ma, Yamaji 2006). It has been proven that silicon has a positive effect on tissue regeneration after frost damage of ornamental plants (Falkowski, Matysiak 2008). By analyzing the colour of leaves, one of the specific features of a lawn, the highest scores were assigned to plants on plots with higher doses of silicon (Table 3). Many scientific studies confirm the beneficial effect

Table 3

Scores for minor lawn properties (1–9), three-year means and standard error

Variant of silicon dose (g ha^{-1})	Leaf colour in autumn (K)	Leaf structure (fineness) (S)	Susceptibility to diseases	
			Microdochium nivale	*Drechslera siccans*
Control (0)	6.0 (±0.54)^b	6.0 (±0.59)^b	7.5 (±0.65)^b	7.5 (±0.74)^b
I (18.7)	7.2 (±0.66)^b	6.2 (±0.68)^b	8.2 (±0.82)^b	8.0 (±0.80)^b
II (46.8)	7.4 (±0.68)^a	6.5 (±0.67)^a	8.5 (±0.84)^a	9.0 (±0.00)^a
III (74.9)	7.7 (±0.72)^a	7.0 (±0.54)^a	8.8 (±0.87)^a	9.0 (±0.00)^a
Standard deviation	0.7	0.4	0.6	0.8
Variation coefficient V%)	10.5	6.8	6.7	9.0

a, *b* – letters denote significantly different values in columns ($p \leq 0,05$)

of silicon on the chlorophyll content in leaves. Ranganathan et al. (2006) found a higher concentration of chlorophyll in rice leaves. Similar results were obtained in studies on other plant species (Wang, Li 2009, Gao et al. 2011). Gong et al. (2005) found that the use of silicon in a period of drought increased the amount of photosynthetic pigments and soluble proteins in plants. It can therefore be suspected that higher leaf colour scores on plots where silicon was applied obtained in the present experiment were a result of the higher concentration of chlorophyll. The level of chlorophyll in leaves showed significant variation depending on the amount of silicon applied (Table 4). Compared to the control, grass on plots with higher doses of silicon, i.e. 46.8 g and 74.9 g ha^{-1}, contained significantly higher amounts of chlorophyll ($p \leq 0.05$). It was noted that the chlorophyll content depended on the time of year, namely the highest values were recorded in autumn, and the smallest occurred in summer. The scores for individual features compose an overall assessment of a lawn. The lawn functional value (*Wum*) is the

Table 4

Effect of silicon on the leaf greenness index (three-year means and standard error)

Variant of silicon dose (g ha^{-1})	Leaf greenness index		
	spring	summer	autumn
Control (0)	23.2 (±1.12)^{ab}	14.3 (±0.74)^{b}	25.3 (±1.21)^{b}
I (18.7)	23.4 (±1.42)^{ab}	14.5 (±0.65)^{ab}	25.9 (±1.47)^{ab}
II (46.8)	24.3 (±1.65)^{a}	15.3 (±0.52)^{a}	26.3 (±1.54)^{ab}
III (74.9)	24.8 (±1.34)^{a}	15.6 (±0.72)^{a}	27.2 (±1.42)^{a}
Standard deviation	0.7	0.6	0.8
Variation coefficient (V%)	3.1	4.2	3.0

a, *b* – letters denote significantly different values in columns ($p \leq 0.05$)

average of the scores of all basic features of a lawn on a measurement day. *Wum* is a composite indicator which enables us to make a rapid comparison of the state of a turf in several locations (Wolski et al. 2015).

$$Wum = 0.34Ao + 0.33Z + 0.33K,$$

where: Ao – general appearance, Z – grass density, K – grass colour.

Making analysis of a lawn's appearance (Ao), grass density (Z), and grass colour (K) according to the COBORU methodology resembles and can be compared to lawn assessments conducted in line with the UEFA and FIFA methods. By adopting the *Wum* indicator to lawn evaluation, it was demonstrated that the lawns achieved an average *Wum* value of 7.11° (good to very good turf) throughout the experiment. Comparing the seasons, the functional value of the turf, expressed with the *Wum* indicator (Table 5),

Table 5

Wum: lawn functional value (three-year means and standard error)

Variant of silicon dose (g ha^{-1})	*Wum*		
	spring	summer	autumn
Control (0)	6.23 (±0.32)^{bc}	5.73 (±0.35)^{c}	7.07 (±0.48)^{c}
I (18.7)	7.17 (±0.41)^{ab}	5.93 (±0.44)^{b}	7.30 (±0.52)^{b}
II (46.8)	7.57 (±0.46)^{a}	6.73 (±0.47)^{ab}	7.73 (±0.54)^{ab}
III (74.9)	7.87 (±0.48)^{a}	7.77 (±0.52)^{a}	8.20 (±0.57)^{a}
Standard deviation	0.71	0.93	0.50
Variation coefficient (V%)	9.89	14.18	6.61

a, b, *c* – letters denote significantly different values in columns ($p \leq 0.05$)

was the highest in autumn, reaching 7.57° (very good turf), while in summer it was the lowest with 6.54° (good turf), and in spring it was 7.21 (good turf). The lowest average value of this characteristic was reported for the control lawn in summer (5.73°). Throughout the experiment, plants from the control plot scored the lowest *Wum*. Plots with higher doses of silicon (variants II and III) had a significantly higher value ($p \leq 0.05$) of *Wum* in relation to the control plants. The experiment showed that application of silicon positively affected the resistance of grass to Fusarium patch (*Microdochium nivale*) and leaf blight caused by *Drechslera siccans*. The largest number of plants infected by both pathogens was on the control plot. Beneficial effects of silicon on plant resistance against many pathogens have been confirmed in many studies (Fauteux et al. 2005, 2006, Ma, Yamaji 2006). Silicon deficiency in plants makes them more susceptible to insect invasions, fungal diseases and other pathogens, all of which adversely affect the yield and quality of the crop (Ahmad et al. 2013). Rodgers-Gray and Shaw (2004) showed that application of silicon to wheat limited the presence of powdery mildew (*Blumeria graminis*), septoria (*Phaeosphaeria nodorum* and *Mycosphaerella graminicola*), and eyespot (*Oculimacula yallundae*). The beneficial effects of silicon application on rice has been shown in relation to stalk rot (*Leptosphaeria salvinii*), rice blast (*Magnaporthe grisea*), fusarium wilt (*Fusarium*), tan spot (*Cochliobolus miyabeanus*), melting seedlings (*Thanatephorus cucumeris*) and leaf spot (*Monographella nivalis*) (Savant et al. 1997). Fawe et al. (2001), but also Ma and Yamaji (2006), argue that silicon application strengthens plant defence mechanisms, for example by the more intensive accumulation of lignin, phenolic compounds and phytoalexins. Fauteux et al. (2005) underline the fact that silicon not only participates in the structural and physiological processes, but it also affects the resistance of plants to fungal pathogens. Research into the epidermal cells showed that silicon application stimulated plants' defensive system by the production of phenolic compounds, callose or methylaconitate (phytoalexin) (Bélanger et al. 2003, Rémus-Borel et al. 2009). Guével et al. (2007) found that foliar application of silicon reduces infection by real mildew (*Erysiphe graminis*), although they did not explain the mechanism of this action. In addition, experiments have shown that silicon application inhibits the development of powdery mildew on cucumbers, with an increased activity of such enzymes as catalase, peroxidase and lactate dehydrogenase (Hu, Zhu 2008). Prończuk and Prończuk (1997) report that grass disease strongly weakens plants in winter and may further delay the start of the growing season in susceptible varieties. In the present experiment, the weighted average content of macronutrients in grass was determined (2014-2016). Depending on a dose of silicon, the mineral content in lawn mixtures varied in the range of: 3.49-3.83 g N, 2.71-3.02 g P, 22.46-25.22 g K, 3.93-4.22 g Ca, 1.78-1.94 g Mg and 0.44-0.48 Na g kg^{-1} DM (Table 6). The findings presented in Table 6 show large differences in the content of macronutrients in lawn grass mixtures, the greatest variation being recorded in the case of K (V=5.20%), and the smallest one for Ca

Table 6

Effect of silicon on the macroelement content (g kg^{-1} DM) in plants (three-year means and standard error)

Variant of silicon dose (g ha^{-1})	Macroelement content (g kg^{-1} DM)					
	N	P	K	Ca	Mg	Na
Control (0)	3.49 (±0.26)^{b}	2.71(±0.15)^{b}	22.46 (±1.26)^{b}	3.93 (±0.32)^{b}	1.78 (±0.14)^{b}	0.44 (±0.03)^{b}
I (18.7)	3.53 (±0.19)^{b}	2.84 (±0.23)^{b}	22.84 (±1.13)^{b}	4.08 (±0.35)^{b}	1.82 (±0.15)^{b}	0.45 (±0.04)^{b}
II (46.8)	3.68 (±0.31)^{ab}	2.82 (±0.26)^{b}	23.42 (±1.44)^{b}	4.10 (±0.27)^{b}	1.86 (±0.15)^{b}	0.46 (±0.05)^{a}b
III (74.9)	3.83 (±0.28)^{a}	3.02 (±0.32)^{a}	25.22 (±1.38)^{a}	4.22 (±0.31)^{a}	1.94 (±0.16)^{a}	0.48 (±0.05)^{a}
Standard deviation	0.16	0.13	1.22	0.12	0.07	0.02
Variation coefficient (V%)	4.27	4.51	5.20	2.91	3.69	3.73

a, *b* – letters denote significantly different values in columns ($p \leq 0,05$)

(V=2.91%). It was observed that silicon applied in the highest dose resulted in a significant increase in the content of N, P, K, Ca, Mg and Na in grass. The lower doses increased the content of these nutrients too, but not statistically significantly. Table 7 shows the weighted average content of trace elements throughout the entire period of the study (2014-2016). The content of those chemical elements in grass varied depending on fertilizer, with fluctuations in the following ranges: 7.80-8.36 mg Cu, 53.32-55.24 mg Mn, 101.52-107.42 mg Fe, 72.02-74.46 Zn mg kg^{-1} DM. The highest variation in the trace element content was recorded for Cu (V = 3.09%), and the smallest appeared for Zn (V=1.38%). By analyzing the content of microelements in lawn grass mixtures on plots treated with silicon, it was found that only an application of the highest dose significantly increased the content of Cu and Fe. In the case of Mn and Zn, differences were not statistically significant. Sacala (2009) claims that the positive effect of silicon application may result from a better and more efficient regulation of osmosis, improved water balance of plants, reduced transpiration losses, and an adequate supply of necessary components. Silicon application also limits toxic ion intake and improves the functioning of antioxidant mechanisms. Kurdali et al. (2013) found that it increases the amount of nitrogen fixed from the air (% Ndfa), by 51% during drought, and by 47% in optimal conditions. Mali and Aery (2008) point out that the beneficial effect of silicon on nitrogen fixation may be associated with a higher content of leghemoglobin, a hemoprotein binding oxygen in the roots of legumes. Thus, application of silicon stimulates the development of plants and results in a lawn attaining a high aesthetic value, high content of nutrients and high resistance to fungal diseases.

Table 7

Effect of silicon on the microelement content (g kg^{-1} DM) in plants (three-year means and standard error)

Variant of silicon dose (g ha^{-1})	Microelement content (mg kg^{-1} DM)			
	Cu	Mn	Fe	Zn
Control (0)	7.80 (±0.62)^{b}	53.32 (±4.34)^{a}	101.52 (±8.14)^{b}	72.02 (±4.85)^{a}
I (18.7)	7.88 (±0.64)^{b}	54.45 (±4.42)^{a}	102.20 (±8.30)^{b}	72.86 (±5.44)^{a}
II (46.8)	8.04 (±0.65)^{b}	55.00 (±4.12)^{a}	104.32 (±8.42)^{ab}	73.14 (±5.64)^{a}
III (74.9)	8.36 (±0.67)^{a}	55.24 (±4.25)^{a}	107.42 (±8.54)^{a}	74.46 (±5.36)^{a}
Standard deviation	0.25	0.85	2.65	1.01
Variation coefficient (V %)	3.09	1.57	2.55	1.38

a, *b* – letters denote significantly different values in columns ($p \leq 0,05$)

CONCLUSIONS

1. Plants on plots with the highest dose of silicon (variant III) had the highest aesthetic and functional value. As early as in the first year, higher doses of silicon applied in the experiment positively affected the aesthetic value of lawns.

2. Silicon application limited the occurrence of plant diseases. Compared to plants from the control, Fusarium patch infection of the grass on silicon-treated plots decreased by about 12% and leaf blight occurrence fell by about 18%.

3. Application of higher doses of silicon resulted in a significant increase in the content of N, P, K, Ca, Mg, Na, Cu and Fe in the mixture of grasses.

4. Based on the findings, it is advisable to use silicon in higher doses (variant III) to improve the aesthetic value of a lawn.

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