NITROGEN CONTENT IN PLANT TISSUE AND VISUAL QUALITY ASSESSMENT OF THREE TURFGRASS MIXTURES INFLUENCED BY DIFFERENTIATED FERTILIZATION

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Abstract

Lawns are established with perennial grass species and varieties mixed in different proportions, to create various types of turfgrass mixtures that meet certain requirements of utilisation or can adapt to specific climatic conditions such as excessive drought or strong shading. In our study were analyzed the nitrogen content in plant tissue and visual quality of three different turf mixtures under the influence of differentiated fertilization and the pedoclimatic conditions in the NE region of Romania. The first mixture (M1) was composed of *Festuca arundinacea* 80% + *Lolium perenne* 10% + *Poa pratensis* 10%. The second mixture (M2) consisted of three varieties of *Lolium perenne* mixed in equal proportions. The third mixture (M3) was composed of *Festuca rubra* 60% + *Lolium perenne* 20% + *Festuca ovina duriusculla* 10% + *Poa pratensis* 10%. Three types of fertilizers were applied: ammonium nitrate, a complex fertilizer with nitrogen and phosphorus and a commercial lawn fertilizer with macro and micronutrients. The experimental design was a split plot design with three replicates. Mixtures reacted positively to all three types of fertilizers. The highest nitrogen content was registered at the mixture M2 (2.33% nitrogen in DM). Considering the fertilizer used, the highest nitrogen content was determined at the fertilization with ammonium nitrate (2.32% nitrogen in DM) and the lowest concentration was registered at the control plot where fertilization was not applied (2.09% nitrogen in DM). Statistical interpretation of the data was done by analyzes of variance and limit differences.

Key words: nitrogen content in plant tissue; turfgrass quality; turfgrass mixtures

Using a single grass species for the establishment of a lawn will produce a very uniform and aesthetic green cover but the possibility of this lawn to persist under years of natural or artificial stress is limited. Each individual species has qualities but also limitations (Kellner, 1974). The latest changes in global climate have set a new perspective in terms of water conservation so that turf management must shift from an intensive management towards an extensive one (Morris, 2006; Waltz and Carrow, 2008; Githinji, 2009). The species selection for turf mixtures should consider drought resistant species that can produce a good quality lawn in conditions of limited irrigation (Aronson, 1987; DaCosta, 2006; Richardson et al., 2008). Testing the species performances under non irrigated conditions and especially testing new combinations of species for the creation of improved turf mixtures is very important. Macronutrients are represented by those elements consumed in large quantities by perennial grasses and are found in big concentrations in plant tissue. These macroelements are absorbed in plants through the root system: nitrogen, phosphorus, potassium, calcium, magnezium and sulfur or can be taken from the atmosphere: carbon, oxygen. Nitrogen is the element with the highest mobility in soils, it takes many forms both in the air and soil. It is directly involved in the synthesis of clorophyll, aminoacids, proteins, enzymes, vitamins and indirectly in the synthesis of other important compounds which are vital for the life of green plants. The excessive concentration of nitrogen in soils can prevent the growth of the root system (Christians N., 2004).

Nitrogen, along magnezium is also found in the central structure of clorophyll and in the structure of proteins that are spread in all green parts of grasses. This is why nitrogen plays a primary role in the growth of grasses, leaves growth, shoot growth, rhyzomes growth and also in the retaining of green color of turf (Dunn J. H., Diesburg K., 2004).

The aim of this study is to identify which is the best adapted turfgrass mixture in the pedoclimatic conditions of NE Romania under

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non irrigated management and to determine the influence of differentiated fertilization on turfgrass quality and nitrogen concentrations in plant tissue.

MATERIALS AND METHODS

The biological material consisted in three mixtures of cool season perennial grasses. The first mixture (M1) was composed by *Festuca arundinacea* 80% + *Lolium perenne* 10% + *Poa pratensis*10%. The second mixture (M2) consisted of three varieties of *Lolium perenne* mixed in equal proportions.

The third mixture (M3) was composed of *Festuca rubra* 60% + *Lolium perenne* 20% + *Festuca ovina duriusculla* 10% + *Poa pratensis* 10%.

Three types of fertilizers were applied: ammonium nitrate, a complex fertilizer with nitrogen and phosphorus and a commercial lawn fertilizer with macro and micronutrients. All three fertilizers were applied at a nitrogen rate of 75 kg ha^{-1}. The experimental design was a split plot design with three replicates. The surface of a plot was 8 square meters (2m x 4m), and the sub-plot surface was 2 square meters (1m x 2m). The evaluation of quality was done using a visual rating scale recommended by NTEP (National Turfgrass Evaluation Program, USA). Ratings are given on a scale of 1-9, where 9 represents the best quality and the perfectly green lawn, and 1 represents the worst quality. Field sampling of green tissue was done in the year 2011, samples were dried and grinded into powder and nitrogen content was determined using Kjeldahl method. The data were interpreted statistically by analysis of variance and limit differences.

RESULTS AND DISCUSSION

The mean annual temperature in the area is 9.6°C and the annual rainfall is 518 mm, with drought occuring in September.The mixture M2 recorded the best quality in June and July being noted with 7.6 and 7.2, but it recorded a drop in quality in August and September due to water stress. M1 mixture had a lower quality in the first two months but maintained a relatively constant overall quality throughout the season. M3 mixture had the poorest quality in all four months.

Table 1.

Turfgrass mixture overall quality (1-worst; 9-best) in 2011.

Turfgrass mixture	June	July	August	September
M1	6.8^{NS}	6.1^{NS}	5.9^{NS}	5.3*
M2	7.6*	7.2^{NS}	5.8^{NS}	5.1*
M3	5.3^{0}	5.8^{NS}	3.9^{0}	3.1^{0}
Control (field average)	6.6^{C}	6.4^{C}	5.2^{C}	4.5^{C}
LSD 0.05	0.8	1.0	0.8	0.2

* Positive significance; ^{0} Negative significance; ^{NS} Not significant; ^{C}Control.

Turf quality has increased significantly with all three types of fertilizers. The best result was obtained at the fertilization complex with macro and micronutrients (*tab. 2*). The fertilizers used had a major influence in increasing the quality of turf mixtures especially in the first two months of summer when grasses are most active and the climatic conditions with favorable growing temperatures and sufficient rain create good conditions for nutrient absorption. As we can observe, the differences between fertilized plots and the control plot (without fertilization) are smaller at the end of the vegetation period of grasses which is the late September. The cooling weather and the drought stress during the summer have an influence over grasses by diminishing their capacity to sustain photosynthesis and the root activity is decreased.

Table 2.

The influence of fertilization on overall turfgrass quality in 2011.

Fertilization	June	July	August	September
Control ($N_0 P_0 K_0$)	5.3^{C}	5.6^{C}	5.0^{C}	4.0^{C}
N_{75}	6.7*	6.6*	5.1^{NS}	4.3^{NS}
$N_{75} P_{45}$	7.0*	6.5*	5.1^{NS}	4.7*
$N_{75} P_{45} K_{72} + Ca_{18} Mg_{15} S_{14}$ + ME (Fe, Zn, B, Mn, Mo)	7.2*	6.6*	5.5^{NS}	4.9*
LSD 0.05	0.5	0.4	0.6	0.5

* Positive significance; ^{0} Negative significance; ^{NS} Not significant; ^{C} Control; ME microelements.

The best density was observed in mixture M2 rated with 7.8 followed by mixture M3 rated with 6.7, but the differences were not significant (NS). The highest percent of ground cover was observed at the mixture M2 of 91% and the lowest at the mixture M3 being only 70% (*tab. 3*). Turf density increased in the first two months, in June and July and decreased in august and September due to warm weather and water stress. As the grasses reach the top temperature threshold for active growth the capacity to sustain photosynthesis and to create excess carbohydrates necessary for shoot development is highly reduce.

Table 3

Turfgrass mixture density (1-lowest; 9-highest) and ground cover (%) in the summer of 2011.

Turfgrass mixture	Density	Ground cover %
M1	6.5^{NS}	87^{NS}
M2	7.8^{NS}	91^{NS}
M3	6.7^{NS}	70^{0}
Control (field average)	7.0^{C}	83^{C}
LSD 0.05	0.8	10

* Positive significance; ^{0} Negative significance; ^{NS} Not significant; ^{C} Control

Turfgrass density increased significantly from 5.9 to 7.6 when we used a complex fertilizer with macro and micronutrients. The ground cover increased from 73% to 88% at the fertilization with $N_{75}P_{45}$ (*table 4, fig.1, fig. 2*).

Table 4.

The influence of fertilization on turfgrass density (1-lowest; 9-highest) and ground cover (%) in 2011.

Fertilization	Density	Ground cover %
Control ($N_0 P_0 K_0$)	5.9^{C}	73^{C}
N_{75}	7.1*	84*
$N_{75} P_{45}$	7.3*	88*
$N_{75} P_{45} K_{72} + Ca_{18} Mg_{15} S_{14}$ + ME (Fe, Zn, B, Mn, Mo)	7.6*	85*
LSD 0.05	0.6	4

* Positive significance; ^{0} Negative significance; ^{NS} Not significant; ^{C} Control.

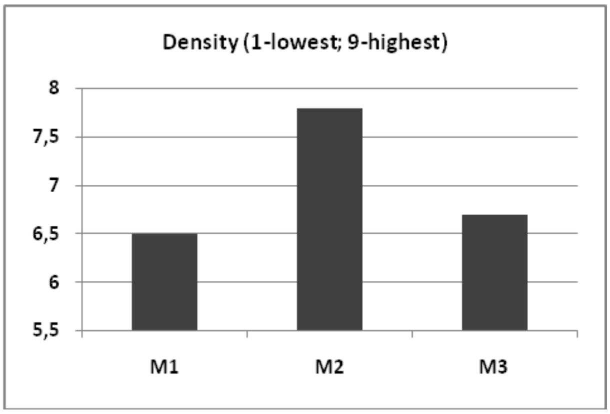

Fig. 1 **Turfgrass density**

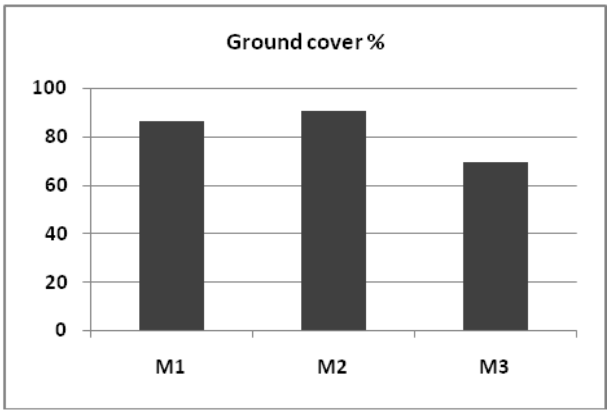

Fig. 2 **Trufgrass ground cover**

The highest average content in nitrogen was observed at the mixture M2 (2.34% nitrogen in DM) and the lowest content was registered at the mixture M1 (based on the species *Festuca arundinacea*) with an average concentration of 2.04% nitrogen in DM. Considering the influence of different fertilizers applied, we observed that the highest nitrogen content was reached using ammonium nitrate (2.32% nitrogen in DM) and the lowest concentration (2.09% nitrogen in DM) was determined at the control plot (without fertilization). In average the concentration of nitrogen (% in DM) ranged from 2.09% to 2.32% (*tab. 5, fig. 3*).

Table 5

The influence of fertilization and turfgrass mixture on nitrogen content (%) DM

Turfgrass mixture	Control (N_0 P_0 K_0)	N75	N75 P45	$N_{75} P_{45} K_{72} + Ca_{18} Mg_{15} S_{14}$ + ME (Fe, Zn, B, Mn, Mo)
M1	1.80	2.26	1.99	2.13
M2	2.23	2.48	2.28	2.34
M3	2.25	2.23	2.29	2.32
Average	2.09	2.32	2.18	2.26

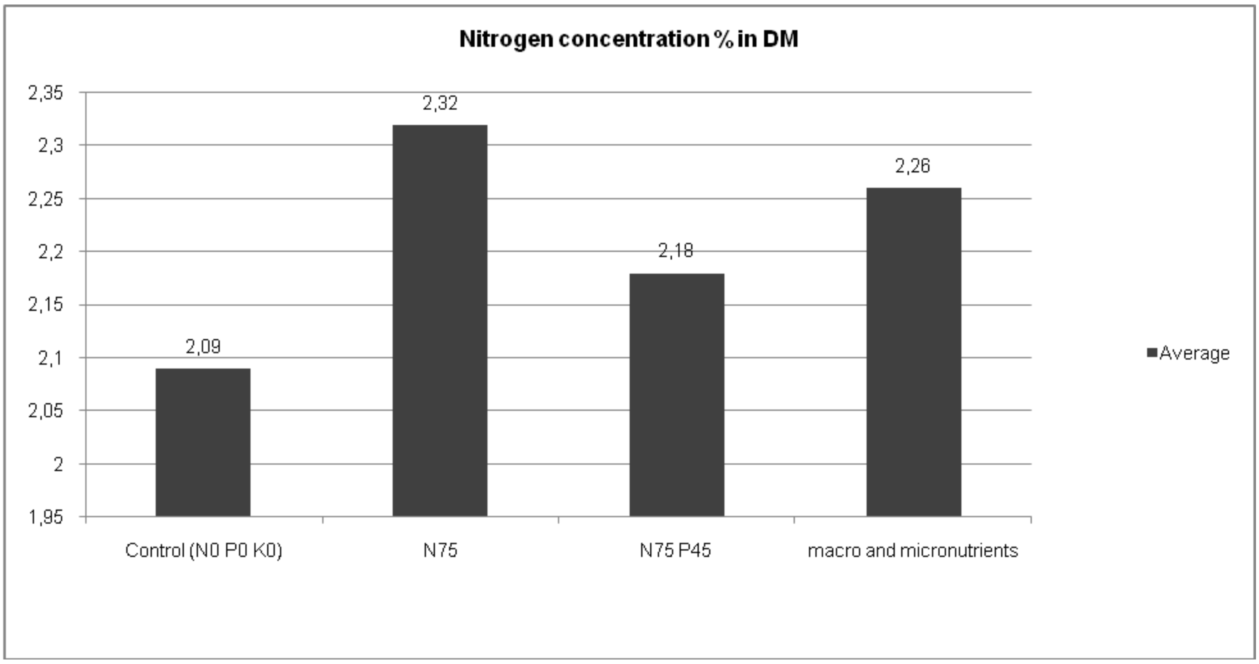

Fig. 3 **Nitrogen concentration in mixture M1**

CONCLUSIONS

The highest concentration of nitrogen in turfgrass plant tissue was achieved using ammonium nitrate as fertilizer.

The mixture based on the species *Lolium perenne* had the highest concetration of nitrogen in leaves compared with mixtures based on the species *Festuca rubra* and *Festuca arundinacea*.

The best quality was recorded at M2 mixture, consisting of three varieties of *Lolium perenne*, in terms of overall quality.

The second best turfgrass mixture was the M1 mixture that recorded significant differences in September.

The mixture with a high content of *Festuca rubra* had a poor quality and negative significant differences in June, August and September.

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