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RESEARCH ON THE INFLUENCE OF DIFFERENTIATED HYDRATION ON PHYSIOLOGICAL PROCESSES ON TWO LAWN MIXTURES

Laurențiu CAIMAC, Carmen BEINȘAN, Mihaela MOATĂR, Olimpia IORDĂNESCU, Tiberiu IANCU, Cosmin Alin POPESCU, Adina HORABLAGA, Dorin CAMEN

Banat's University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, 119 Calea Aradului, Timișoara, Romania

Corresponding author email: ahorablaga@yahoo.com

Abstract

Today, in most countries, which have reached a very high level of industrialization, technicalization and urbanization, the conservation and creation of green areas is an important means of protecting man and his living environment. Green spaces are good for human health, not only by creating a favorable microclimate and a calmer environment, with cleaner and better oxygenated air, but also by influencing the neuropsychic state. Lawn is an essential and irreplaceable element for leisure and sports and is more than just grass. It is an indispensable landscape element with multiple values, through its silky texture, attractive appearance, green color, color that represents nature and life, freshness, rebirth, hope and vigor. The aim of the research was to study the influence of differentiated hydration on physiological processes in two lawn mixtures. For this purpose we used two types of lawn, the first, Turfline, composed of a mixture of 3 types of lawn seeds (65% Festuca arundinacea Starlett; 15% Lolium perenne Double; 20% Poa pratensis Geisha) and the second RPR Regenerating, namely Lolium perenne with regeneration by stolons, both irrigated daily and every three days. For the study of differentiated hydration on the two lawn mixtures, we determined the content of chlorophyll pigments in the leaves (SPAD units) and the rate of photosynthesis (%). The results of the research show that irrigation did not significantly influence the chlorophyll content of the two types of lawn. Regarding the photosynthetic capacity of the turf mixtures under study, it is observed that this has higher values in the case of RPR Regenerating, irrigated every 3 days, which indicates that this type of lawn is more resistant to drought than Turfline.

Key words: *lawn, chlorophyll, photosynthesis, irrigation, Festuca arundinacea, Lolium perenne, Poa pratensis.*

INTRODUCTION

In the garden, the lawn is an element of great decorative value, which creates an atmosphere of calm and tranquility, the large expanses of lawn introducing a note of solemnity and romance into the landscape.

The lawn is also of sanitary importance, due to its ability to help refresh the air, change the temperature and humidity. During the summer, on days with high temperatures, the lawn heats up much less than sand, gravel, brick, concrete, etc. And that's why the layer of air that comes in contact with the lawn is colder. Also, the leaves of the plants that enter the composition of the lawn, having a sticky composition, retain a large part of the dust particles, thus participating in the purification of the air. In general, the term "lawn" defines an area covered with grass, especially gramineae, which is subject to care and intended to perform certain decorative, recreational or sanitary functions.

In order to obtain the lawn, we may use species from the genera: *Agrostis, Cynosurus, Deschampsia, Festuca, Lolium, Phleum, Poa*, of medium and small size and which are thickened by pruning. Most of the time the grass species used for lawn are not grown alone, but in a mixture of at least 3, the composition being chosen according to their temperament, nutritional requirements, soil moisture, resistance to low temperatures, pruning, rapid growth, etc. [16].

For a sustainable and pleasant lawn, we need to know the species, the pedoclimatic conditions, the competitiveness of the species, the morphological and biological peculiarities (www.greenfieldsport.ro/intretinere_gazon.html).

On meadows, in parks and gardens, depending on the mental state and the character of the observed scene, the human being is prone to calm, daydreaming, vivacity, toning, receptivity, good mood.

Recreation in nature is increasingly adopted, representing at the same time an escape from the ordinary and a way to directly benefit from the beneficial actions of natural factors [5].

We should not have too many species in a lawn mixture as this involves difficulties in installation as well as in the exteriorization of the characters. It is therefore estimated that a mixture should contain 2-5 species (or varieties) [13].

When choosing the species or varieties that are part of a mixture, it must be done according to the desired objectives (aesthetic appearance, resistance to traffic, ease of maintenance).

The main species used for lawn are: perennial ryegrass (*Lolium perenne)*; red fescue *(Festuca rubra)*; tall fescue *(Festuca arundinacea)*; blue grass *(Poa pratensis)*; timothy grass *(Phleum pratense)*; common bent *(Agrostis capillaris)*; Bermuda grass *(Cynodon dactylon),* sheep fescue *(Festuca ovina).* These species are used for turf due to their adaptive capabilities.

Global climate change and increasingly extreme weather conditions show the need to look for ways to mitigate and reduce their negative effects on agriculture and to increase crop adaptability [9]. Lack of water and rising temperatures are becoming a growing environmental concern on grasslands, leading not only to reduced productivity but also to negative changes in ecosystem structure and carbon balance [7,14]. Growing perennials, such as grasses, increases soil carbon stocks due to their prolonged photosynthetic activity and higher root biomass [12].

Drought resistant plants are able to change their morphological characteristics and metabolic processes in order to survive periods of drought and to restore normal functioning after stress. A major effect of water deficiency is a reduction in the intensity of photosynthesis, which results from slower leaf development and premature senescence of leaves [15]. Drought stress limits the availability of CO_2, induces the loss of photosynthetic pigments, affects the activity of enzymes and also the activity of photosystem II [4]. In response to water deficiency, plants stimulate the production of reactive oxygen species (ROS) that cause membrane damage, protein degradation, enzyme inactivation and thus induce oxidative stress [18]. The stress caused by the water deficit affects the size of the tissues, the translocation of the assimilated and the portioning of the dry matter in the organs of the plants. However, the magnitude of the effects varies depending on the species, the stage of growth and also the duration and severity of the drought [2, 3].

Photosynthesis provides plants with energy and organic matter, with photosynthetic adaptation being a major component of water tolerance [18]. Photosynthetic light response curves that describe photosynthetic capacity, efficiency, and other parameters are commonly used to evaluate the performance of photosynthesis under environmental stress conditions [11]. Although closure of the stomata induced by high water potential is considered to be the main reason for the reduction of photosynthesis during short-term floods, the reduction of chlorophyll content may eventually lead to reduced photosynthetic capacity during long-term stress [6, 10].

MATERIALS AND METHODS

The biological material consisted of two types of lawn, the first, Turfline, composed of a mixture of 3 types of lawn seeds (65% *Festuca arundinacea* Starlett; 15% *Lolium perenne* Double; 20% *Poa pratensis* Geisha) and the second RPR Regenerating, namely *Lolium perenne* with regeneration by stolons.

The most important forage grasses, cultivated in the temperate zone are *Festuca arundinacea* and *Lolium perenne*. They are characterized by variable feed quality and productivity in optimal growing conditions, but also by different resistance to environmental stress, such as water scarcity. *Festuca arundinacea* has the ability to avoid water shortages with great potential for the development of a deep and extensive root system. This species is able to tolerate water deficiency, reprogramming its cellular metabolism in leaves and other organs. At the same time, the quality of fodder in *Festuca arundinacea* is not as good as in *Lolium perenne* even in optimal conditions of air temperature and soil moisture [8]. *Lolium perenne* is a species widely used not only as fodder but also as lawn grass in urban areas throughout Central and Western Europe [1, 3].

RPR Regenerating, namely *Lolium perenne* with regeneration by stolons, is a grass with a very high density that does not allow the appearance of weeds, the number one in tolerance of heavy traffic, strong and resistant, allowing several hours of play (https://www.barenbrug.biz/rpr).

The resulting stolons, sometimes called "runners", are buds that grow out of the axillary buds at the base of each plant. When an RPR plant finds an empty space in a damaged lawn, stolons will grow horizontally in that space and develop roots at the internodes. RPR develops a natural network of stolons, as a kind of net. This gives the RPR the highest tolerance to use. Instead of separate plants, as in traditional *Lolium perenne*, each RPR plant connects to other plants in the topsoil.

RPR brings strength and speed together in one species. This has the advantage that all the characteristics of a mixture are manifested in a single species. The seeds germinate quickly and can be used intensively after installing a dense lawn. Traditionally, strong species, such as Poa pratensis, germinate more slowly than Lolium perenne. In order to compensate for this in several lawn mixtures, slow-germinating species are combined with Lolium perenne. Despite the rapid germination and establishment of these mixtures, the tolerance to use is insufficient. RPR solves this problem by combining firmness and strength with speed of establishment and regeneration (https://www.barenbrug.com, https://dxgh891opzso3.cloudfront.net).

The aim of the research was to study the influence of differentiated hydration on two lawn mixtures (Turfline and RPR Regenerating).

For the study of differentiated hydration on the two lawn mixtures, we determined the content of chlorophyll pigments in the leaves (SPAD units) and the photosynthetic capacity of plants (%), in four phenophases, with the BBCH classification system to identify the stages of plant development. This classification system aims to find a common language for identifying the stage of the plant. The BBCH system was created by specialists from the world's leading pesticide producers: BASF (B), Bayer (B), Ciba-Geigy (C) and Hoechst-Shering (H). Identifying the main stages of development, the vegetative and generative phases, involve the use of this system. Each of these stages presents 5 stages of development encoded with numbers from 0 to 9, also each stage has 10 phenophases encoded with the same digits. The researches were determined in the development stages 22 (2 tillers visible), 29 (9 or more tillers visible), 33 (3 nodes detectable) and 45 (flag leaf sheath swollen (late-boot) (www.politicheagricole.it/flex/AppData/WebLive/Agrometeo/MIEPFY800/BBCHengl2001.pdf).

For experimentation we used two lawn mixtures: A_1 – Turfline and A_2 – RPR Regenerating, both irrigated daily (V_0) and at three days (V_1).

The total amount of chlorophyll (SPAD) in the leaves was determined using the portable chlorophyll meter SPAD-502 (Konica Minolta, Osaka, Japonia). This device determines the relative chlorophyll content by measuring the absorbance of a leaf in two wavelength ranges. The device measures the light absorbance of the leaf in the range of red light radiation close to IR. Using this principle, the chlorophyll meter calculates a numerical value, SPAD (single photon avalanche diode) which is directly proportional to the amount of chlorophyll in the leaf. With this device measurements were made at different stages of plant development, on healthy leaves.

The rate of photosynthesis was determined by the EARS Plant Photosynthesis Meter (PPM), which measures the use of photosynthetic light in plants. The measurement is based on chlorophyll fluorescence, a very weak optical signal emitted by the plant but which can be detected by the device. Due to its light weight, the instrument is very suitable for laboratory and field use. In addition, long measuring series can be performed automatically. For this reason, PPM has a wide range of applications in research, education and practice (www.groentennieuws.nl/article/88172/mini-fotosynthesemeter-voor-snelle-gewasanalyse/).

Already in the 1990's a number of interesting applications have been developed on the basis of measured photosynthesis yield. Provided these measurements are carried out at a fixed light level, they can predict the life of pot plants and cut flowers. They may also be used to judge the quality of green vegetables and fruit (https://silo.tips/download/the-photosynthesis-reaction).

Data represents mean and standard error. Statistical analysis of the data was performed using analysis of variance according to a three factor experiment (Lawn mix, watering, phenophase). Comparisons between averages were made using the multiple interval test. The meanings of the differences were represented on a letter basis, considering the values without common letters to be significantly different.

RESULTS AND DISCUSSIONS

Considering the analysis of the components of the variance in Table 1, we may observe that regarding the unilateral effects of the factors, only the mixture showed a real and strongly statistically influenced influence on the chlorophyll content of the plants. Also, the interaction between mixing and watering determined significant variations of this character, against the background of low and insignificant influences of the other sources of variation.

Regarding the rate of photosynthesis, there are small and insignificant individual effects of the three factors, lower than the chlorophyll content. As in the case of chlorophyll content, it is found that the interaction between mixture and watering showed a considerable and statistically assured effect on the rate of photosynthesis, in conditions of insignificant effects of other interactions but higher than in the case of chlorophyll.

Table 1. Analysis of variance for the effect of mixture, watering and phenophase on chlorophyll content and photosynthesis rate of lawn

Source of variation		Chlorophyll content			Photosynthesis rate		
	DF	SS	MS	F	SS	MS	F
Total	319	17768.46			37381.3	283.10	
Lawn mix (LM)	1	1672.62	1672.62	31.72**	283.1	58.70	2.40
Watering (W)	1	0.31	0.31	0.01	58.7	46.13	0.50
Phenophase (P)	3	116.32	38.77	0.74	138.4	948.80	0.39
LM x W	1	245.05	95.05	4.69*	948.8	4.03	8.04**
LM x P	3	2.33	0.78	0.01	12.1	19.30	0.03
W x P	3	1.91	0.64	0.01	57.9	5.13	0.16
LM x W x P	3	0.95	0.32	0.01	15.4	117.98	0.04
Erorr	304	15878.97	52.73		35866.8	283.10	

Taking into account the unilateral effect of the mixture, it is observed that the chlorophyll content (Table 2) recorded an amplitude of 4.58 with values between 31.72 SPAD units for RPR Regenerating (A2) and 36.3 for Turfline (A1). As such, Turfline plants showed a significant increase in chlorophyll content of approximately 14.4%. According to the analysis of the variance, we may observe the existence of an insignificant variation of the chlorophyll content between the two watering variants.

Table 2. The effect of mixture and watering on chlorophyll content (CC) photosynthesis rate (PR) of lawn

Lawn mix	Watering		CC(SPAD)
	V0	V1	$\bar{x} \pm s_{\bar{x}}$
Turfline (A1)	x 36.87 a	x 35.72 a	36.30±0.66
RPR Regenerating(A2)	x 31.21 b	x 32.24 b	31.72±0.44
$\bar{x} \pm s_{\bar{x}}$	34.04±0.60	33.98±0.58	34.01±0.42
Lawn mix	Watering		PR (%)
	V0	V1	$\bar{x} \pm s_{\bar{x}}$
Turfline (A1)	x 56.90 a	x 54.31 b	55.61±0.69
RPR Regenerating(A2)	y 55.34 a	x 59.64 a	57.49±0.99
$\bar{x} \pm s_{\bar{x}}$	56.12±0.88	56.98±0.83	56.55±0.60

CC- $LSD_{5\%}$=2.26; PR-$LSD_{5\%}$=3.38; Different letters indicate signifficant at p<0.05 (a,b, for LM; x,y, for W)

Given the combined effect of the mixture and watering, it can be seen that regardless of the watering treatment, the plants of the Turfline mixture registered a significant increase in chlorophyll content with increases between 10.79% for the daily irrigated variant (V0) and 18.13% for watering at 3 days (V1). The chlorophyll content in the plants of the two mixtures was not influenced by the watering treatment.

Regarding the rate of photosynthesis, it is observed that in the case of the daily watered variant, the plants of the two mixtures showed close values of this character, on the background of a reduced variation of 1.56%. Under the effect of 3-day watering treatment, the plants of the RPR Regenerating (A2) mixture recorded a significantly higher rate of photosynthesis by 5.33%. The rate of photosynthesis in Turfline (A1) plants was not significantly influenced by watering treatment. In the case of plants of the RPR Regenerating mixture, the application of watering at 3 days (V1) resulted in a significant increase of approximately 4.3% in the rate of photosynthesis.

Regarding the effect of phenophase, the chlorophyll content registered a reduced amplitude (1.64), with the limits from 33.13 in phenophase 22 to 34.76 for phenophase 45 (Table 3). Thus, the whole experience confirms that the stage of development of the plants did not significantly influence the chlorophyll content.

Given the effect of phenophase on the chlorophyll content of the plants in the two mixtures, there are small and insignificant variations of this character during the study, between 1.55 for Turfline and 1.72 for RPR Regenerating. In each phenophase, the plants of the Turfline mixture recorded a significantly higher amount of chlorophyll associated with relative increases between 13.32% for development stage 45 and 15.26% for stage 29.

Regarding the rate of photosynthesis, there are small and insignificant variations from one phenophase to another, based on amplitudes of 1.37% for Turfline plants and 1.93% for RPR Regenerating plants. Also, in each phenophase the composition of the turf mixture did not significantly influence the chlorophyll content, in the conditions of small variations between 1.37% for phenophase 45 and 2.45 for phenophase 29.

Table 3.The effect of mixture and phenophase on chlorophyll content (CC) and photosynthesis rate (PR) of lawn

Lawn mix	Phenophase				CC (SPAD)
	22	29	33	45	$\bar{x} \pm s_{\bar{x}}$
Turfline (A1)	x 35.38 a	x 36.26 a	x 36.62 a	x 36.93 a	36.30±0.66
RPR Regenerating(A2)	x 30.87 b	x 31.46 b	x 31.97 b	x 32.59 b	31.72±0.44
$\bar{x} \pm s_{\bar{x}}$	33.13±0.85	33.86±0.84	34.30±0.82	34.76±0.80	34.01±0.42
Lawn mix	Phenophase				PR (%)
	22	29	33	45	$\bar{x} \pm s_{\bar{x}}$
Turfline (A1)	x 56.40 a	x 55.95 a	x 55.03 a	x 55.05 a	55.61±0.69
RPR Regenerating(A2)	x 58.07 a	x 58.35 a	x 57.10 a	x 56.42 a	57.49±0.99
$\bar{x} \pm s_{\bar{x}}$	57.24±1.26	57.15±1.24	56.07±1.18	55.74±1.15	56.55±0.60

CC- $LSD_{5\%}$=3.20; PR-$LSD_{5\%}$=4.78; Different letters indicate signifficant at $p<0.05$ (a,b, for LM; x, for P)

Taking into account the interaction between watering treatments and phenophases (Table 4) it results that the chlorophyll content showed small and insignificant variations during the four phenophases, associated with amplitudes of 1.44 for the daily irrigated variant (V0) and 1.83 for the variant irrigated at 3 days. Regardless of the plant development stage, the watering treatment showed an insignificant influence on the chlorophyll content, on the background of some variations between 0.04 in phenophase 33 and 0.29 in phenophase 22.

Table 4. The effect of effect of watering and phenophase on chlorophyll content (CC) and photosynthesis rate (PR) of lawn

Watering	Phenophase				CC (SPAD)
	22	29	33	45	$\bar{x} \pm s_{\bar{x}}$
Daily (V0)	x 33.27 a	x 33.91 a	x 34.27 a	x 34.71 a	34.04±0.60
Every three days(V1)	x 32.98 a	x 33.80 a	x 34.31 a	x 34.81 a	33.98±0.58
$\bar{x} \pm s_{\bar{x}}$	33.13±0.85	33.86±0.84	34.30±0.82	34.76±0.80	34.01±0.42
Watering	Phenophase				PR (%)
	22	29	33	45	$\bar{x} \pm s_{\bar{x}}$
Daily (V0)	x 56.17 a	x 56.62 a	x 56.15 a	x 55.52 a	56.12±0.88
Every three days(V1)	x 58.30 a	x 57.67 a	x 55.98 a	x 55.95 a	56.98±0.83
$\bar{x} \pm s_{\bar{x}}$	57.24±1.26	57.15±1.24	56.07±1.18	55.74±1.15	56.55±0.60

CC- $LSD_{5\%}$=3.20; PR-$LSD_{5\%}$=4.78; Different letters indicate signifficant at $p<0.05$ (a, for W; x, for P)

The effect of the plant development stage on the chlorophyll content was slightly lower in the case of the Turfline mixture, on the background of an average rate of 0.037 SPAD and a more accentuated variation between the first two phenophases (Figure 1). In the case of plants of the RPR Regenerating mixture, the impact of phenophase on this character recorded an average value of 0.041 SPAD, associated with a relatively constant variation between phenophases. The high accuracy of these estimates is highlighted by the values of the coefficients of determination (0.9608-0.9935).

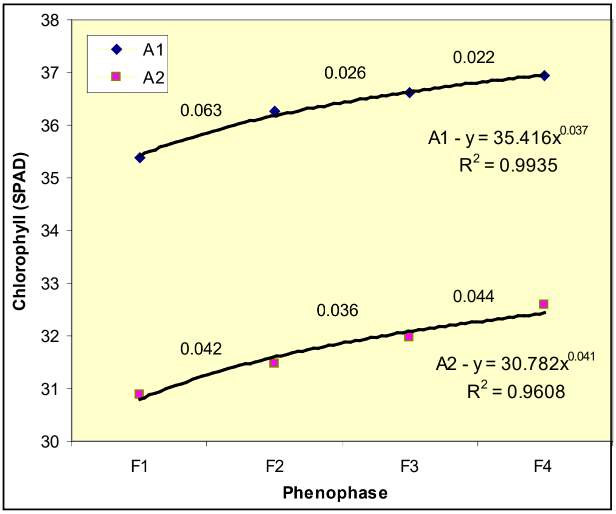

Figure 1. The variation of chlorophyll content during phenophases for different lawn mixture

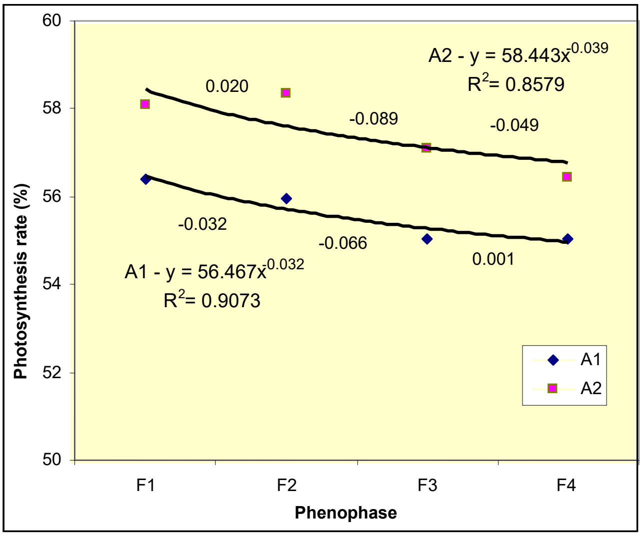

Figure 2. The variation of on photosynthesis rate during phenophases for different lawn mixture

On the background of a high accuracy (85.79-90.73%) it is estimated that the rate of photosynthesis has progressively decreased with the development of plants in the two mixtures. The respective variation was associated with average rates between -0.032% for the plants of the Turfline mixture and respectively -0.039% for the plants of the RPR Regenerating mixture (Figure 2). In both mixtures, the highest variation in photosynthesis rate is found between phenophases 29 and 33.

CONCLUSIONS

The results of the research show that irrigation did not significantly influence the chlorophyll content of the two types of lawn. Regardless of the plant stage of development, the watering treatment showed an insignificant influence on the chlorophyll content.

Turfline turf, irrigated daily, had a higher amount of chlorophyll compared to the 3-day irrigated version at all stages of development. In contrast, the RPR Regenerating lawn mixture had a higher chlorophyll content when watered at 3 days, compared to the daily irrigated variant, which indicates that RPR Regenerating is more drought resistant than Turfline.

Comparing the two lawn mixtures, the three-day irrigated RPR Regenerating recorded higher values in terms of photosynthetic capacity. In both mixtures, the highest variation in photosynthesis rate was found between phenophases 29 and 33.

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