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THE EFFECT OF VARYING SPEED RELEASE OF NUTRIENTS FROM FERTILIZERS ON GROWTH-PRODUCTION PROCESS OF TURF

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Abstract

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The aim of this experiment was to compare the influence of fertilizers with different speed of nutrients release on growth–production indicators of turf under non–irrigated conditions. The experiment was carried in warm and dry conditions in area Nitra (Slovak Republic). In the experiment were followed 5 treatments (1. without fertilization, 2. Nitre with dolomite, Superphosphate, Potassium salt, 3. Turf fertilizer Travcerit®, 4. Slow release fertilizer SRF NPK 14–5–14 (+ 4CaO + 4MgO + 7S), 5. Controlled release fertilizer Duslocote® NPK (S) 13–9–18 (+6S)). The highest gain of height reached variant fertilized by fertilizer SRF NPK 14–5–14 (+ 4CaO + 4MgO + 7S). Comparison of the individual treatments for the whole period showed significantly lower average daily gains of height on control treatment compared to fertilizing treatments Nitre with dolomite, Superphosphate, Potassium salt, SRF NPK 14–5–14 (+ 4CaO + 4MgO + 7S) and Duslocote® NPK (S) 13–9–18 (+6S). During the reported period the highest gain of weight reached treatment by application fertilizer Duslocote® NPK (S) 13–9–18 (+ 6S). Comparison of the individual treatments for the whole period, were found significantly lower average daily production of phytomass on control treatment in comparison with fertilization turfs by Travcerit® and Duslocote® NPK (S) 13–9–18 (+6S).

Keywords: turf, fertilizing, Slow release fertilizers, Controlled release fertilizers

INTRODUCTION

Nutrition and turfs fertilizing has important position in system of caespestechnical measures. Frequent mowing and removal of cut materials taken elements from soil serving to the construction of grass. To determine the healthy growth and gain flexible, deep green and resistant turf, we must depleted nutrients from soil to undo (Ondřej and Opatrná, 1997). Balanced and sufficient nutrition is a precondition for turf quality, their permanency and resistance to disease and influence of other stressors (Svobodová, 1998).

For fertilizing of turfs are used various forms and type of fertilizers (Gregorová, 2001). Nitrogenous fertilizers with nitrogen nitrate NO_3^- (eg. ammonium nitrate) although acting quickly, but in the soil are become unstable. Nitrogen was quickly flushes out into groundwater or a gas component of the compounds escapes into the atmosphere (Míka, 1991). Slow release fertilizers (SRF) are not coated fertilizers, with releases nutrients slowly and uncontrolled (Wu *et al*., 2008). The great advantage is that the required dose of fertilizer is applied to a reduced number of applications compared to other forms of fertilizer (Magni *et al*., 2008). The use of controlled release fertilizers nutrients – controlled release fertilizers (CRF) reduces the toxicity of the soil, reducing the risk of over-fertilization and reduces the frequency of application of fertilizers (Tomaszevska *et al*., 2002). These fertilizers released nutrients gradually throughout the growing season (Devasine *et al*., 2002). Fertilizer packaging is formed by sulphur, polymer or their combination (Tomaszevska *et al*., 2002).

The aim of the experiment was to compare the effect of varying speed release of nutrients from fertilizers on growth-production process of turf.

MATERIAL AND METHODS

In 2012–2014 was realized turf experiment in experimental station of the Department of Grassland Ecosystems and Forage Crops FAFR SUA in Nitra. Experiment was located in moderate climatic zone of warm and dry area. Average annual temperature is 9.7 °C and annual rainfall is 560 mm (Babošová and Noskovič, 2014). Average monthly temperatures (°C) and rainfalls (mm) on vegetation period are shown in Figs. 1–3.

The experiment was based on clay-loam fluvisol. In the autumn before the foundation of experiment, we collected soil samples 250 g from depth 0–200 mm. The samples were analysed or determinate of:

- N_t – Kjeldahl method,
- P – spectrophotometrically by phosphomolybdic method in the leachate by Mehlich III,
- K, Ca – flame-fotometrically in the leachate by Mehlich III,
- Mg – spectrophotometrically in the leachate by Mehlich III,
- oxidizable carbon (C_{ox}) – by Ťjurin method in modification by Nikitin,
- pH – exchangeable in KCl.

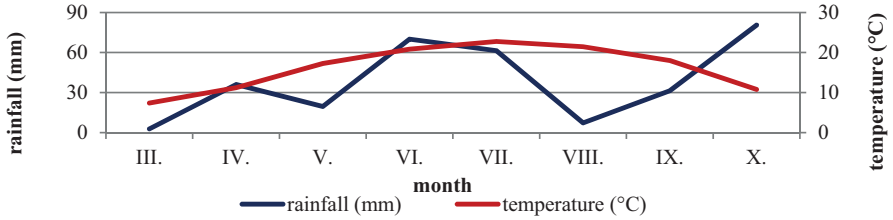
Soil type is fluvial soil. Agrochemical soil composition of the experimental site document the Tab. I.

The experiment was established in early October 2011. We used turf mixture designed for low slowly growing turfs that has the following composition: *Lolium perenne* L. (30%), *Festuca rubra* L. (50%) and *Festuca ovina* L. (20%).

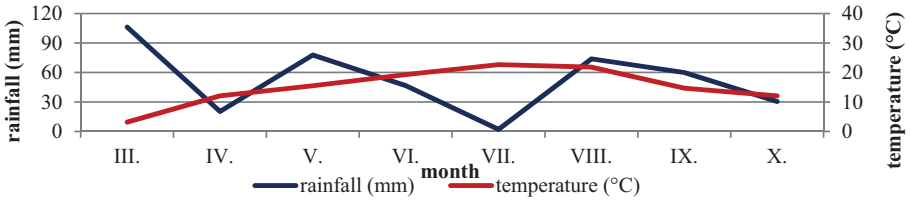
Experimental plots area was 2.4 m^2 and each treatment was in 3 random replications.

In the experiment were followed 5 treatments:

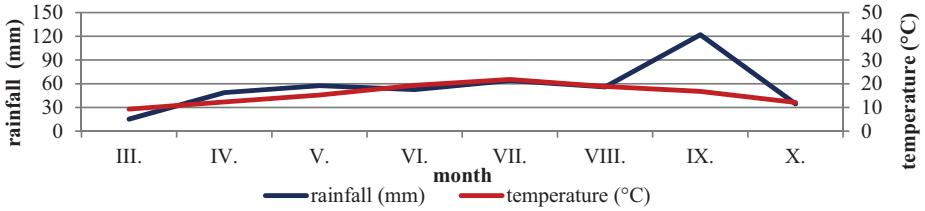
1. without fertilizing (in the text „control“),
2. classical NPK fertilizing (in the text „NPK“),
3. turf fertilizer Travcerit® (in the text „Travcerit“),
4. slow release fertilizer SRF NPK 14–5–14 (+4CaO + 4MgO +7S) (in the text „SRF“),
5. controlled release fertilizer Duslocote® NPK (S) 13–9–18 (+6S) (in the text „Duslocote“).



1: *Average monthly temperature and rainfall in vegetation period in 2012*
Source: Department of Biometeorology and Hydrology, HLEF SUA in Nitra



2: *Average monthly temperature and rainfall in vegetation period in 2013*
Source: Department of Biometeorology and Hydrology, HLEF SUA in Nitra



3: *Average monthly temperature and rainfall in vegetation period in 2014*
Source: Department of Biometeorology and Hydrology, HLEF SUA in Nitra

I: *Agrochemical properties of soil on the experimental site*

N_t	P	K	Mg	Ca	C_{ox}	pH/KCl
		mg.kg^{-1}			g.kg^{-1}	
1 823.2	58.3	336	541	6 067	7.7	6.78

In determining the dose of fertilizer was the basis for the recommended dose of 18 $g.m^{-2}$ N, which meets the requirements for used intensively turfs (Svobodová, 2004).

Characteristics of used fertilizers:

N – Nitrogen (27% N with dolomite), Nitrogen is in the ammonium and nitrate form,

P – Superphosphate (19% P_2O_5),

K – Potassium salt (60% K_2O).

Travcerit is the granular compound fertilizer intended for use by turfs throughout the year, in the form of starter fertilization at the beginning of vegetation, as well as multiple fertilization (3–5×) during the growing season divided doses. Besides great balance of the principal nutrients (15% N, 3% P_2O_5, 8% K_2O) also contains 3% MgO, 0.8% Fe and 18% S. Nitrogen is in the ammonium form.

SRF NPK 14–5–14 (+4CaO +4MgO +7S) it is a complex NPK fertilizer containing urea formaldehyde component as a source of nitrogen enriched with micronutrients. Part of major NPK nutrients found in fast-dissolving form.

Duslocote NPK (S) 13–9–18 (+6S) is coated controlled release fertilizer nutrient (for 5–6 months).

System of fertilizing is presented in the Tab. II.

Experiment was realized under non–irrigated conditions. When height of turf was approximately 80–100 mm high, it was mowed to required height of 50 mm. Before each mowing the turf height (mm) was determined as an average of 10 measurements in plots. Production of above-ground phytomass ($g.m^{-2}$) was determined by sampling the above-ground phytomass by means of accumulation scissors from the surface of 0.1×1 m.

The average daily gain of weight ($g.m^{-2}.day^{-1}$) was calculated according to the formula:

$$\text{The average daily gain of weight} = \frac{\text{Ø production on mowing } (g.m^{-2})}{\text{number of days accretion}}.$$

The average daily gain of height ($mm.day^{-1}$) was calculated according to the formula:

$$\text{The average daily gain of height} = \frac{\text{Ø height of mowing (mm)} - 50\ \text{mm}}{\text{number of days accretion}}.$$

The results were evaluated by software STATISTICA 7.1 complete CZ analysis of variance (Fisher LSD test, $\alpha = 0.05$).

RESULTS AND DISCUSSION

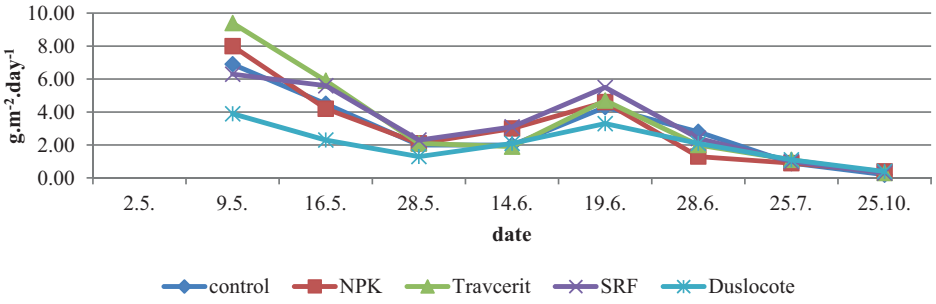
From the values of the average daily gain of weight in 2012 (Fig. 4) to see initially declining levels of intensity increments production of phytomass. At the beginning of the season recorded also Vozár *et al.* (2013) a similar trend of decreasing increments. From the end of May to the end of the second decade of June, the intensity of creation of phytomass for all treatments increased. The maximum value was recorded on variant fertilized by SRF (5.5 $g.m^{-2}.day^{-1}$). Subsequently the intensity of creation of vegetable matter gradually decreased and this trend was maintained until the end of the growing season. Almost throughout the season, the lowest average daily gain of weight, characterized by turf fertilizing fertilizer Duslocote. Similar results reached by some authors (Hanková and Slamka, 2012) who also found among fertilized treatments lowest mass aboveground phytomass, the effect of controlled release fertilizer Duslocote.

The second parameter was average daily gain of height in 2012 (Fig. 5). At the beginning of vegetation was the value of this characteristic from 5.81 $mm.day^{-1}$ (Duslocote) to 12.47 $mm.day^{-1}$ (SRF). Subsequently the growth rate declined until the end of the growing season with minimal differences between treatments. Transient increases in intensity of heights gain were recorded at the end of the second decade of June. During this period, control treatment differed with value 6.74 $mm.day^{-1}$ (9.0 Travcerit $mm.day^{-1}$, NPK 9.06 $mm.day^{-1}$ SRF 9.8 $mm.day^{-1}$, Duslocote 10.26 $mm.day^{-1}$). In compare the values of average daily gain of turfgrass height with the values of the Descriptor for *Poaceae* family (Ševčíková *et al.*, 2002), were found out that

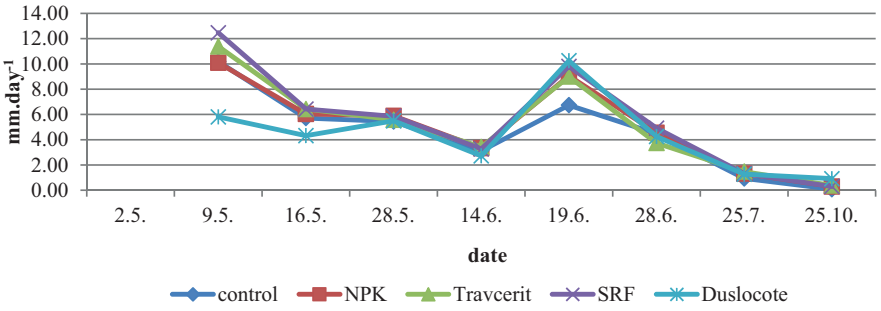
II: *System of fertilizing*

Type of fertilizer (number of applications per year)	Yearly dose (g)	Date of application					
		Beginning of vegetation	*app. 5.6.	app. 20.6.	Half of July	Half of August	Beginning of September
		Dose of fertilizer to variant (g)					
LAD (4×)	160	40	40		40		40
P_2O_5 (1×)	130.43	130.43					
K_2O (2×)	69.40	34.7			34.7		
Travcerit (3×)	288	96		96		96	
SRF (2×)	308.6	154.3			154.3		
Duslocote (2×)	332.32	166.16			166.16		

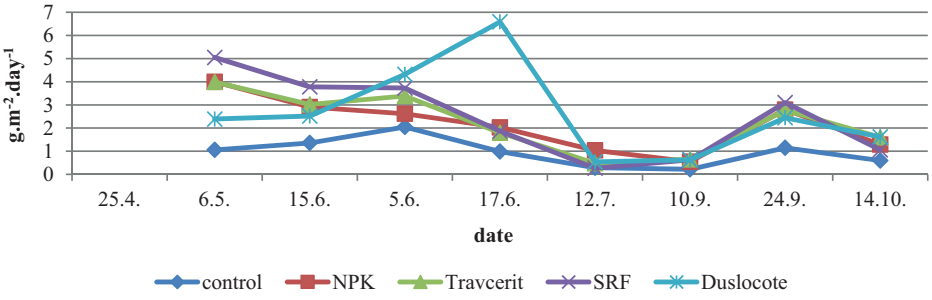
*app.- approximately



4: *The average daily gain of weight (g.m^{-2}.day^{-1}) in 2012*



5: *The average daily gain of height (mm.day^{-1}) in 2012*

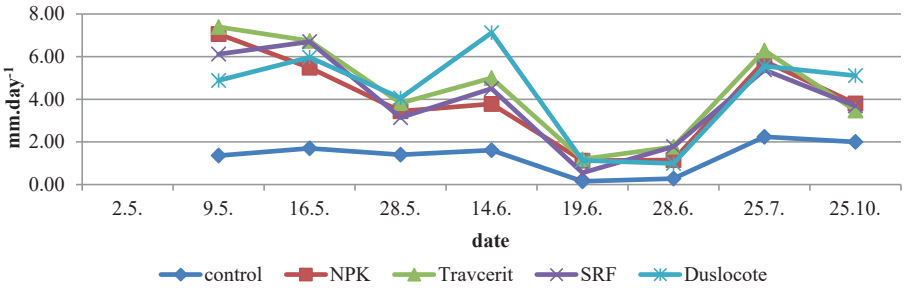


6: *The average daily gain of weight (g.m^{-2}.day^{-1}) in 2013*

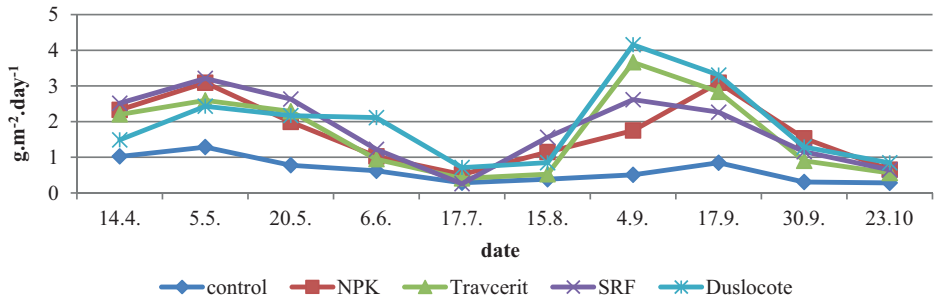
the turfs on treatments NPK, Travcerit and SRF had "*very fast*" growth, i. e. achieved 1 points on the scale where 1 is the worst and 9 is the best rating level. Control treatments and turf fertilized by Duslocote had "*moderate*" growth, i. e. achieved 3 points according to this scale.

The development of the average daily gain of weight in 2013 present Fig. 6. At the beginning of the season had treatment SRF relatively high level gain of weight (5.05 g.m^{-2}.day^{-1}). Conversely, on control treatment was daily gain of weight low (1.06 g.m^{-2}.day^{-1}). The same trend of accretion aboveground phytomass observed also Vozár *et al.* (2011). Were recorded on treatment fertilized by controlled release fertilizers Duslocote slow onset of action. Initially this treatment did not belong to the most productive, but in mid June significantly differs from others treatments (6.59 g.m^{-2}.day^{-1}). Many authors (Várady *et al.*, 2009; Hanková *et al.*, 2013; Vozár *et al.*, 2013) reached similar detections. Subsequently daily production rate of phytomass on all treatments decreased gradually with a transient increase in late September (24.9.)

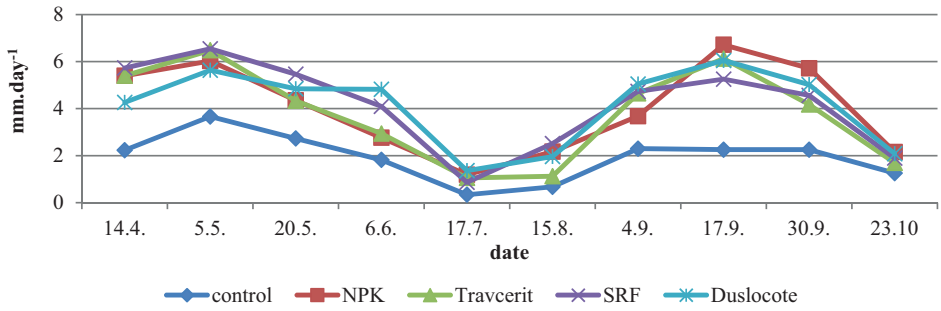
Dynamics of values of the average daily gain of height in 2013 (Fig. 7) had evaluated period similar course than in the previous year. After initial slight acceleration of growth (SRF, Duslocote) had average daily gain of height downward trend with transient increase in mid June. During this period turf fertilized by Duslocote (7.12 mm.day^{-1}) differed from other treatments. After the significant slowdown in the third decade of June, we again recorded an increase of values daily height intensity to the level of 6.29 mm.day^{-1} treatment Travcerit respectively 2.0 mm.day^{-1} (unfertilised treatment). At the end of the season turf growth slowed. In compare the values of average daily gain of turfgrass height with the values of the Descriptor for *Poaceae* family (Ševčíková *et al.*, 2002), were found out that the turfs on treatments Travcerit and Duslocote had "*moderate*" growth, i. e. achieved 3 points according this scale. Treatments NPK and SRF had "*moderate fast*" growth, i. e. achieved 5 points according to this



7: *The average daily gain of height (mm.day^{-1}) in 2013*



8: *The average daily gain of weight (g.m^{-2}.day^{-1}) in 2014*



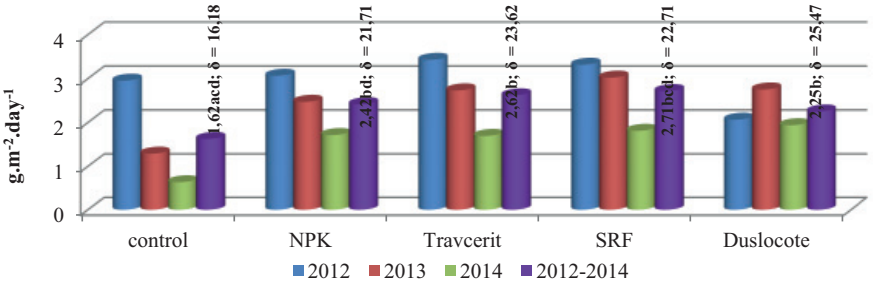
9: *The average daily gain of height (mm.day^{-1}) in 2014*

scale. On the control treatment was average daily gain of height low, which is positive from the point of view of turfgrass management (Turgeon, 2002; Cagaš and Macháč, 2005).

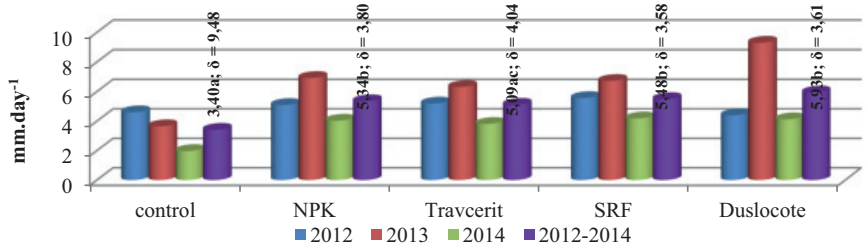
At the beginning of the vegetation season 2014 were recorded a slight increase in average daily gain of weight on treatments (Fig. 8). Kováčik (2014) supports our findings with arguing that in the spring period with advancing growth phase is intensifying the formation of phytomass. Subsequently the intensity of gains of aboveground phytomass decreased until mid August. In the following period, we observed a significant increase in the average value of daily weight gain on treatments. Probably this was due increased rainfall during the period (Fig. 3). In early September we observed the highest average daily gain of weight on treatments fertilized by Duslocote (4.15 g.m^{-2}.day^{-1}) and Travcerit (3.66 g.m^{-2}.day^{-1}). End of the season was characterized by a decrease of the formation of the aboveground phytomass on all treatments. An exception was NPK treatment (17. 9.)

The development of average daily gain of height in 2014 on monitored treatments had similar course of the dynamics of daily gain of weight in a given year (Fig. 9). At the beginning of the vegetation season were observed the increase in average daily gains of height with a maximum of 5. May turf fertilized by Duslocote. In the following period (5. 5.–17. 7.), were observed a slowdown turfs in height. In early June were recorded increases in average daily gain of height of the treatments fertilized by fertilizers SRF (4.10 mm.day^{-1}) and Duslocote (4.82 mm.day^{-1}). In the course of monitored period we observed an increase in average daily gain of height with a maximum of height (17. 9.) on treatment with application NPK (6.72 mm.day^{-1}). At the end of the growing season were observed a downward trend in average daily gain of height.

Values of the average daily gain of weight in monitored period showed interannual reduction of the formation intensity of turf phytomass and they are shown in Fig. 10. Only on the treatment Duslocote were recorded annual increases of



10: *The average daily gain of weight (g.m^{-2}.day^{-1}) in the monitored period*
* Different index (a, b, c, d) means statistically significant differences within column (Fisher LSD test, α = 0.05)
δ = standard deviation



11: *The average daily gain of height (mm.day^{-1}) in the monitored period*
* Different index (a, b, c) means statistically significant differences within column (Fisher LSD test, α = 0.05)
δ = standard deviation

phytomass production. In an experiment with grass mixtures Lošák and Ševčíková (2012) recorded using the slow-acting fertilizer, in comparison with other fertilizers, lowest production of aboveground phytomass. In our experiment this was not confirmed. Comparison of the individual treatments for the whole period, were found significantly lower average daily production of phytomass on control treatment in comparison with fertilization turfs by Travcerit and Duslocote. The differences between fertilized treatments were non-significant. Variability of aboveground phytomass gains, expressed by means of the standard deviation, was the lowest on variant Duslocote (δ = 2.25).

The average daily gain of height during the period documented in Fig. 11 also showed annual increase of intensity of growth of the turf to a height in 2013. Comparison of the individual treatments for the whole period showed significantly lower average daily gains of height on control treatment compared to fertilizing treatments NPK, SRF and Duslocote. Dynamics of average daily gains on treatment with the application of Travcerit was significantly lowest in comparison with other fertilized treatments. Variability of height gains, expressed by means of standard deviation, was the lowest on treatment fertilized by SRF (δ = 3.58).

CONCLUSION

Among the applied fertilizers – NPK, Travcerit, SRF NPK 14–5–14 (+ 4CaO + 4MgO + 7S) and Duslocote NPK (S) 13–9–18 (+ 6S) for three years we have not recorded in average daily gain of weight and height turf significant differences. It differs only turf fertilized with fertilizer Duslocote NPK (S) 13–9–18 (+ 6S) with low gain height and weight at the beginning of vegetation. Later during year, equalized other treatments, or in increments of weight and height surpassed. Changes in growth-production indicators might be caused by weather conditions

Based on the obtained results we can conclude that between the slow-acting fertilizer and coated fertilizer was inconclusive statistical influence. The turf fertilized with SRF NPK 14–5–14 (+ 4CaO + 4MgO + 7S) then achieved higher values of average daily gains of height and weight, making turfgrass management perspective is not very desirable, but the variability of increases was more balanced than fertilizing by fertilizer Duslocote NPK (S) 13–9–18 (+ 6S). These points to a more even release of nutrients from slow-acting fertilizer compared to coated fertilizer.

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