VERSITA VOL. 24, NO 4(58): 29–32
DOI 10.2478/oszn-2013-0038

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Effect of different concentrations of the Flordimex inhibitor on the shoot growth of perennial ryegrass and cocksfoot

Wpływ zróżnicowanego stężenia inhibitora Flordimex na przyrost pędów życicy trwałej i kupkówki pospolitej

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Keywords: inhibitor, ethephon, growth, cocksfoot, perennial ryegrass
Słowa kluczowe: inhibitor, etefon, wzrost, kupkówka pospolita, życica trwała

Abstract
In the pot experiment, conducted in a phytotron at a constant temperature 22°C and artificial lighting, the effectiveness of growth regulator concentrations on the inhibition of shoot growth of perennial ryegrass (*Lolium perenne* L.) and cocksfoot (*Dactylis glomerata* L.) was evaluated. In the study, a single growth inhibitor, with the trade name Flordimex SL 420 (active substance: ethephon, 2-chloroethylphosphonic acid), was applied in varying concentrations of 10%, 20% and 30%. In the experimental series, every 3 days in the period from 7 May to 6 June 2008, 10 measurements were performed. Empirical data were statistically evaluated. In the experiment with perennial ryegrass and cocksfoot, it was found that 30% of inhibitor concentration used inhibited the growth of shoots in the grass species studied.

Streszczenie
W doświadczeniu wazonowym, prowadzonym w fitotronie o stałej temperaturze 22°C i sztucznym oświetleniu, oceniano skuteczność zastosowanych stężeń regulatora wzrostu na zahamowania wzrostu pędów życicy trwałej (*Lolium perenne* L.) i kupkówki pospolitej (*Dactylis glomerata* L.). W badaniu zastosowano jednorazowo inhibitor wzrostu o nazwie handlowej Flordimex 420 SL (substancja czynna: etefon - kwas 2-chloroetylofosfonowy) w zróżnicowanych stężeniach 10, 20, 30%. W cyklu doświadczalnym wykonano 10 pomiarów co 3 dni w terminie od 7 maja do 6 czerwca 2008 roku. Dane empiryczne poddano ocenie statystycznej. W przeprowadzonym doświadczeniu z udziałem życicy trwałej oraz kupkówki pospolitej stwierdzono, że zastosowane 30 procentowe stężenie inhibitora Flordimex najbardziej ograniczało wzrost pędów u badanych gatunków traw.

1. INTRODUCTION

Growth regulators are organic compounds which, in very small quantities stimulate, inhibit or otherwise modify the physiological processes [Jankiewicz 1997; Sowiński 1994; Pawlonka and Skrzyczyńska 2004; Van Andel and Verkert 1978]. In addition, they participate in stimulating the creation of generative organs, increased and prolonged movement of assimilates to the seeds, reducing of water intake, increase of resistance to stress weather and some fungal infections [Koziara et al. 1993; Foreman and Marschall 1990]. The main use of the growth regulators in Poland is for agricultural crops or fruit and vegetable production. In Polish literature, there are few articles on the use of growth regulators on turf lawn. However, in the U.S., due to the widespread use of a variety of plant protection products and the specific approach to the use of lawns, these studies are conducted more frequently [Robbins et al. 2001; Qian, Engelke 1999].

According to different authors [Goliński et al. 2008, Rolston et al. 1997], the current problem in the cultivation of grass optimally fertilised with nitrogen, in particular, to the seeds, are plants lodging [Box et al.1992]. the treatment counteracting this phenomenon is the use of growth regulators. The main problem is the choice of appropriate substances. Therefore, the analysis of the effectiveness of plant growth regulators by examining their effectiveness in the shoot growth of grasses becomes increasingly justified [Edelmann 2002]. Therefore, the aim of the study was to evaluate the effectiveness of different concentrations of Flordimex regulator on the growth of vegetative shoots of perennial ryegrass and cocksfoot.

2. MATERIALS AND METHODS

The study was conducted in 2008 in laboratory condition. From the permanent grassland, the soil samples with the species of perennial ryegrass and cocksfoot in development stage BBCH 32 in quantities of 24 pieces were collected. The soil had a low abundance of phosphorus (64 mg $P_2O_5 \cdot kg^{-1}$ soil) and potassium (88 mg $K_2O \cdot kg^{-1}$ soil) and the average of magnesium (41 mg $Mg \cdot kg^{-1}$ soil) with KCl pH – 5.44. The cut blocks were filled the plastic pots (about 2 kg soil $\cdot$ pot^{-1}). In the experiment, growth inhibitor Flordimex 420 SL contains the active substance ethephon (2-chloroethylophosfon acid). It was used at 420 g in 1 litre of water (prod. Chemie AG Bitterfeld-Wolfen) in the form of an aqueous solution in May 2008. Studies included the following experimental variants: the control sample – 0% of Flordimex; F-10% – Flordimex with the concentration of 10%; F-20% – Flordimex with the

concentration of 20%; and F-30% – Flordimex with the concentration of 30%. The experiment was established in triplicate. In an experimental series, every 3 days in the period from 7 May to 6 June 2008, 10 measurements were performed. The experiments were conducted under conditions of daily 12-hour artificial light (the average illuminance 4000 lux). On May 7, tested grasses to a height of 100 mm (perennial ryegrass) and 120 mm (orchard grass) were cut. Then a growth regulator was sprayed. Empirical data obtained in the experiment were evaluated statistically using analysis of variance for one variate experiment. The significance of results differences were verified using Tukey's test at the significance level $P \leq 0.05$ by Statistica program (StatSoft, Inc. 2011).

3. RESULTS

From the studies of observations on the use of the growth inhibitor (Table 1), in the case of perennial ryegrass the decrease of shoot growth resulted in great fluctuation from day to day.
Regarding the increments in ryegrass shoots it was observed that in the initial period of the experiment (the first three terms of measurements), reduction in the growth of shoots was visible only as compared with the control object. With respect to the variations between the inhibitor concentrations used, these differences were not observed (Fig. 1). In case of 10% inhibitor concentration of Flordimex with regard to the control object, the maximum reduction was observed in day 9 of the experiments (41 mm). In the next days in which the measurements were made, these trends were still positive, although there was a lower efficiency of the preparation (Fig. 1). In turn, the applied 20% inhibitor concentration limited the most the shoots increase from day 9 to 24 of the experiments, which oscillate between an average of 35 and 47 mm. There were slight variations in the growth inhibition at day 15 and 21. The analysis of further measurements showed that from day 18 to 27 for 20% concentration of Flordimex used, inhibition in the shoot growth occurred in perennial ryegrass. The biggest limitation of perennial ryegrass shoot growth compared with the control object was observed in case of 30% of the inhibitor concentration, which was in 24 day of conducted experiment, and amounted to an average 70 mm (Fig. 1), similar to the results obtained by Starczewski, Affek-Starczewska [2011] and Banaś et al. [2011] using Flordimex inhibitor.
The experiment involving cocksfoot species found that the differences in the reduction of shoot growth occurred in the various options of inhibitor concentrations used in the whole study period and were much more harmonious than in the experiment with perennial ryegrass (Table 1, Fig. 2). It was also found that, depending on the multiple dose of the inhibitor concentration shoot, regrowth was more limited. However, the greatest inhibition of shoot growth compared with the control variant in cocksfoot was

Table 1. Growth of shoots of perennial ryegrass and cocksfoot (mm/%) depending on the concentration of growth inhibitor in various periods of measurement

Lolium perenne Date of measurement – shoots increase [mm]												
Flordimex concentration	1	3	5	9	12	15	18	21	24	27	30	Mean*
0%	-	77	123	178	215	237	260	293	310	318	327	234 C
F-10%	-	58	103	137	192	218	257	290	300	310	323	219 BC
F-20%	-	57	100	133	168	197	215	258	265	280	300	197 BC
F-30%	-	50	98	127	147	167	200	233	235	257	267	178 B
Dactylis glomerata Date of measurement – shoots increase [mm]												
Flordimex concentration	1	3	5	9	12	15	18	21	24	27	30	Mean *
0%	-	113	187	260	288	295	317	333	335	337	340	281 D
F-10%	-	78	130	147	197	200	218	233	235	237	238	191 BC
F-20%	-	73	105	122	140	167	168	207	213	220	223	164 B
F-30%	-	53	70	73	75	77	79	80	83	103	111	80 A
Lolium perenne Date of measurement – shoots increase – variation from the control [%]												
Flordimex concentration	1	3	5	9	12	15	18	21	24	27	30	Mean
0%	-	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
F-10%	-	75.3	83.7	77.0	89.3	92.0	98.8	99.0	96.8	97.5	98.8	90.8
F-20%	-	74.0	81.3	74.7	78.1	83.1	82.7	88.1	85.5	88.1	91.7	82.7
F-30%	-	64.9	79.7	71.3	68.4	70.5	76.9	79.5	75.8	80.8	81.7	75.0
Dactylis glomerata Date of measurement – shoots increase – variation from the control [%]												
Flordimex concentration	1	3	5	9	12	15	18	21	24	27	30	Mean
0%	-	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
F-10%	-	69.0	69.5	56.5	68.4	67.8	68.8	70.0	70.1	70.3	70.0	68.0
F-20%	-	64.6	56.1	46.9	48.6	56.6	53.0	62.2	63.6	65.3	65.6	58.3
F-30%	-	46.9	37.4	28.1	26.0	26.1	24.9	24.0	24.8	30.6	32.6	30.1

*Average estimated with the same letters did not differ significantly

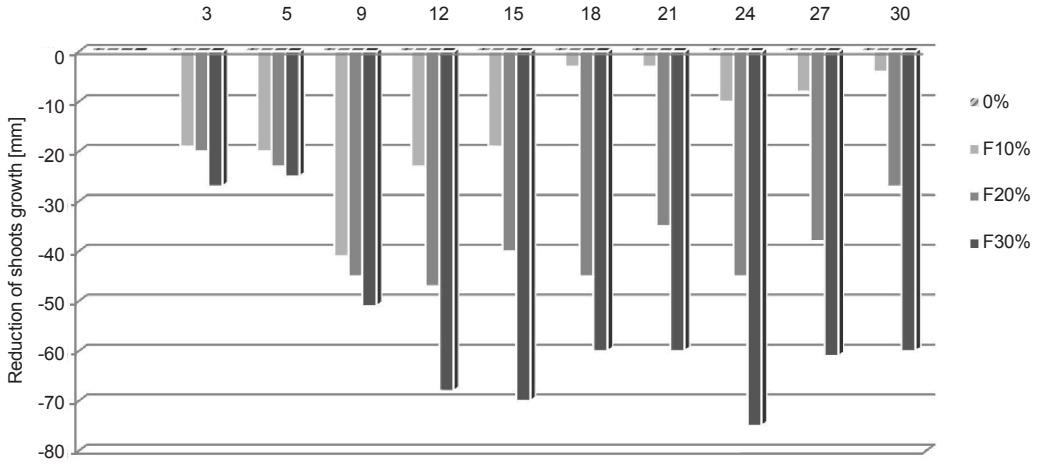

Fig. 1. Inhibition in the growth of perennial ryegrass shoots depending on the concentration inhibitor of the growth in relation to the control of the individual measurement dates

observed in days 21 and 24 of the experiments and it amounted to 250 mm in the case of the application of 30% of the inhibitor concentration. In 10% concentration of Flordimex, the increase was most limited only at the beginning of experiment in the 9th day of measurement. However, when 20% concentration of Flordimex was used, the biggest limitation of shoot regrowth increase compared with control variant was observed on days 12–18 of experiment (Fig. 2).

Statistical analysis on the comparison of average shoot regrowth throughout the experimental period for the inhibitor concentrations used showed that in comparison with the control object in both grasses 30% of inhibitor concentration (Table 1). However, in the experiment with cocksfoot, significant differences in the shoot regrowth in comparison with control variant occurred for all inhibitor concentrations in the whole experiment cycle. At the same time, there was no difference in the species between the shoot growth for Flordimex inhibitor used on the object with 10% and 20% (Table 1). This indicates that for this species a sufficient concentration which limited the shoot growth was Flordimex used at 10% of solution.

4. CONCLUSIONS

1. In the experiment with perennial ryegrass and cocksfoot, the greatest reduction in the shoot growth was obtained using a 30% concentration of inhibitor Flordimex which in relation to the control object was respectively 56 and 201 mm.
2. The most beneficial effect of limiting the shoot growth was achieved in cocksfoot that indicates a greater sensitivity of this species to the Flordimex inhibitor used, which indicates the possibility of Flordimex use in reducing the growth of this grass species especially grown for seed.
3. The limiting effect of the growth of perennial ryegrass as a result of Flordimex growth inhibitor application can be used in turf, which will help to reduce the frequency of mowing.
4. In the experiment with perennial ryegrass, significant differences were noted in the shoot regrowth only in the case of 30% concentration of inhibitor use in comparison with the control object. In contrast, for cocksfoot, significant differences in the shoot growth in comparison with control variant occurred for all concentrations of Flordimex inhibitor.

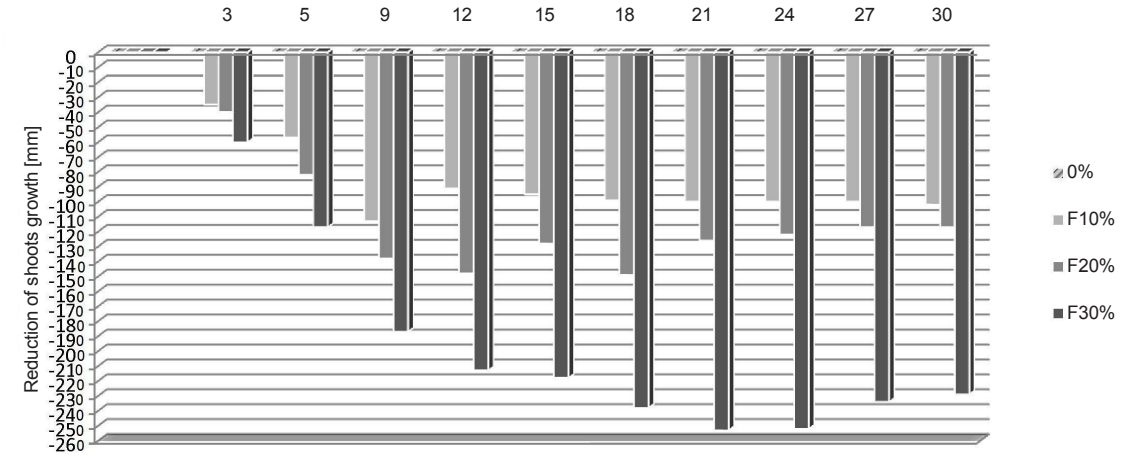

Fig. 2. Inhibition in the growth of shoots in cocksfoot depending on the concentration of the growth inhibitor in relation to the control of the individual measurement dates

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