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Impact on nano-gro stimulator on the seeds germination and growth kinetics of seedlings of selected grass and legumes species

Wpływ stymulatora nano-gro na kiełkowalność nasion oraz kinetykę wzrostu siewek wybranych gatunków traw oraz roślin motylkowatych

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Słowa kluczowe: stymulator Nano-Gro, zaprawianie nasion, zdolność kiełkowania, energia kiełkowania, długość siewek

Abstract
The experiment was established in the laboratory of Grassland Department and Landscape Architecture Development at the University of Natural Sciences and Humanities in Siedlce in 2012. The study was carried out in Petri dishes in triplicate. In the study five species of grasses were used: *Festulolium brauni, Dactylis glomerata, Poa pratensis, Lolium perenne, Lolium multiflorum* and two legume species: *Trifolium pratense* and *Medicago sativa*. Nano-Gro stimulator was used as a study factor. The obtained results showed a significant effect of the used stimulator on the germination energy, and a varied effect of the growth of grasses.

Streszczenie
Doświadczenie założono w laboratorium Katedry Łąkarstwa i Kształtowania Terenów Zieleni na Uniwersytecie Przyrodniczo-Humanistycznym w Siedlcach w roku 2012. Badanie przeprowadzono na szalkach Petriego w trzech powtórzeniach. Do badań użyto pięciu gatunków traw: *Festulolium brauni*, *Dactylis glomerata, Poa pratensis, Lolium perenne, Lolium multiflorum* oraz dwóch gatunków roślin motylkowych: *Trifolium pratense*, i *Medicago sativa*. Jako czynnika użyto stymulatora Nano-Gro. Otrzymane wyniki badań wykazały istotne oddziaływanie zastosowanego stymulatora na energię i zdolność kiełkowania, a także zróżnicowany wpływ na wzrost traw.

1. INTRODUCTION

The aim of seeds processing is the increase of plant resistance to diseases and pests. The treatment includes the covering of the seeds with chemical or biological substances that protect the plants during germination and production of fine roots [Wachowiak and Kierzek 2009, Wenda-Piesik and Gałęzewski 2010]. With the increase in number of organic farms and for the care of the environment, the number of used chemicals is being replaced with biological agents. The composition of biological agents, often called biopreparations, is primarily based on organic compounds (e.g., Biosept 33SL) or on the basis of beneficial microorganisms (e.g. Polyversum) [Panasiewicz et al. 2008; Heel et al. 2004].
One of the organic preparations is the Nano-Gro stimulator. It is a mixture of sulfates of such elements as Fe, Co, Al, Mg, Mn, Ni and Ag, occurring at a concentration of 10^{-9} mol, available in the form of oligosaccharide pellets [Dyśko 2008]. The use of this stimulator is to excite the natural resistance in the plant to abiotic stress, which in turn results in a produce of growth hormones such as auxins, gibberellins and cytokinins. This makes use of nutrients and the water becomes more efficient, which results in a higher plant resistance, increasing its yield as well as quality [Agrarius].
Preparation of Nano-Gro has been applied in agriculture in the cultivation of cereals, oilseed rape, sugar beet, corn, vegetables and in greenhouses. However, in the literature, there is no information on the impact of this growth stimulator on the various grass and legume species. The aim of the study was to investigate the effect of Nano-Gro stimulator on energy and germination as well as the initial growth of selected grasses and legume species.

2. MATERIALS AND METHODS

The experiment was established in the laboratory of Grassland Department and Landscape Architecture Development at the University of Natural Sciences and Humanities in Siedlce in 2012. The study was carried out in Petri dishes in triplicate. In the study five grass species were used: *Festulolium brauni* (Sulino variety), *Dactylis glomerata* (Born variety), *Poa pratensis* (Ani variety), *Lolium perenne* (cv. Info), *Lolium multiflorum* (cv. Gaza) and two legume species: *Trifolium pratense* (Prada variety) and *Medicago sativa* (legend variety). In each Petri dish were placed 50 seeds treated with Nano-Gro stimulant. Unprocessed seeds as a control were also placed (50 seeds on the plate). Treatment consisted 10 minutes of seeds immersion in a solution of Nano-Gro. Kernels were placed at equal distances on previously sterilized blotting- papers. Laboratory temperature was maintained at a constant level (about 23°C) and constant humidity was maintained by wetting of blotted papers in distilled water.
Estimation of germination energy for legume was done after 4 days, for *Festulolium brauni*, *Lolium perenne* and *Lolium multiflorum* – after 5 days, for *Dactylis glomerata* – after 7 days and for *Poa pratensis* – after 10 days. Capacity germination for legumes was determined after 10 days and for *Festulolium brauni*, *Lolium perenne* and *Lolium multiflorum* – after 14 days, for *Dactylis glomerata* – after 21 days and for *Poa pratensis* – after 28 days.
In addition, the measurements of the length of the grass seedlings every 7 days over a period of eight weeks were conducted. The growth kinetics of individual species have been developed using polynomial regression analysis, yielding the second-degree

polynomials. Significance of polynomial coefficients was tested by Student's t-test, at the significance level ≥ 0.05. Nonlinear coefficient of determination R^2 was also calculated. Compatibility of the selected model was tested by Snedecor, Fisher's F-test at the significance level ≥ 0.05.

3. RESULTS

Germination energy and germination capacity is defined as the percentage of seedlings grown from the seeds.
Germination capacity is taken as a criterion for assessing the viability of seeds [Grzywacz and Orzeszko- Rivka 2007]. Based on the results of the study (Table 1) it was found that the stimulant has a significant effect on the seeds germination energy of *Festulolium brauni, Lolium perenne, Lolium multiflorum* and *Trifolium pratense*. Nano-Gro stimulator most significantly affected *Festulolium brauni* and *Lolium perenne* species, where germination energy increased almost doubled as compared to that of the control.
Application of Nano-Gro stimulator has increased the germination capacity compared to the control objects in all plant species used in this study (Table 2). The largest increase of this feature was observed in the germination of *Festulolium brauni* and *Dactylis glomerata*.
Statistical analysis of the seedlings length of the grasses demonstrated that the stimulator not significantly affected in their growth (Table 3). The decisive factor was a grass species where the greatest length of the seedlings had *Festulolium brauni* and *Lolium multiflorum*.
Analyzing the graphs of seedling growth kinetics of the studied grass species (Figs. 1–5), it should be noted that they have a similar character within a given species. This phenomenon takes a similar course for *Lolium perenne* and *Lolium multiflorum*, as is shown in Figures 1 and 2.
The applied factor significantly accelerated the germination and seedling length regrowth in the initial growth phase for all grass species. However, it reduced the growth of seedlings at a later time for grass species such as *Lolium perenne*, *Lolium multiflorum* and *Dactylis glomerata* (Figs. 1, 2 and 3).
Seed treatment with Nano-Gro gave a positive result for species *Festulolium brauni* and *Poa pratensis*, where the growth of seedlings after the applied factor remained at higher level for the whole study period (Figs. 4 and 5).

Table 1. The germination energy of the tested seeds of grasses and legumes species [%].

Species (A)	Stimulant (B)		
	Without Nano-Gro	Nano-Gro	Mean
Festulolium brauni	47,22	83,33	65,28
Dactylis glomerata	11,11	6,48	8,80
Poa pratensis	9,26	2,78	6,02
Lolium perenne	8,33	14,81	11,57
Lolium multiflorum	22,22	28,71	25,47
Trifolium pratense	72,22	78,70	75,46
Medicago	56,48	52,78	54,63
Mean	32,41	38,23	-
$LSD_{0,05}$ for A = n.i.; B = 5,64; A × B = 6,85			

Table 2. The germination capacity of the tested seeds of grasses and legumes species [%].

Species (A)	Stimulant (B)		
	Without Nano-Gro	Nano-Gro	Mean
Festulolium brauni	64,82	89,81	77,32
Dactylis glomerata	52,78	81,48	67,13
Poa pratensis	33,33	41,68	37,50
Lolium perenne	42,59	62,96	52,79
Lolium multiflorum	38,89	50,93	44,91
Trifolium pratense	75,00	81,48	78,24
Medicago	60,18	59,26	59,72
Mean	52,38	66,93	-
$LSD_{0,05}$ for A = 22,12; B = 14,45; A × B = 20,27			

Table 3. The average length of the examined seedlings of grass species [cm].

Species (A)	Stimulant (B)		
	Without Nano-Gro	Nano-Gro	Mean
Festulolium brauni	9,14	10,79	9,97
Dactylis glomerata	4,02	4,42	4,22
Poa pratensis	1,92	1,94	1,93
Lolium perenne	5,20	5,86	5,53
Lolium multiflorum	8,23	8,48	8,36
Mean	5,70	6,30	-
$LSD_{0,05}$ for A = 1,21; B = n.i; B × A = 1,74			

In figures 1–5 are shown the values of square fraction coefficients describing the change in length of grass seedlings. The value of F-test and the corresponding level of tested probability, as well as the values of non-linear coefficient of determination (close to unity) indicate the adequacy of the used model.

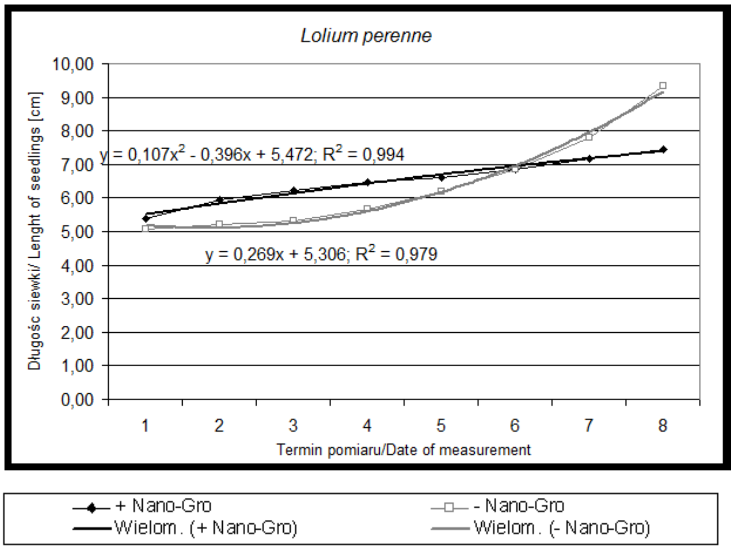

Fig.1. The growth kinetics of seedlings length of *Lolium perenne*.

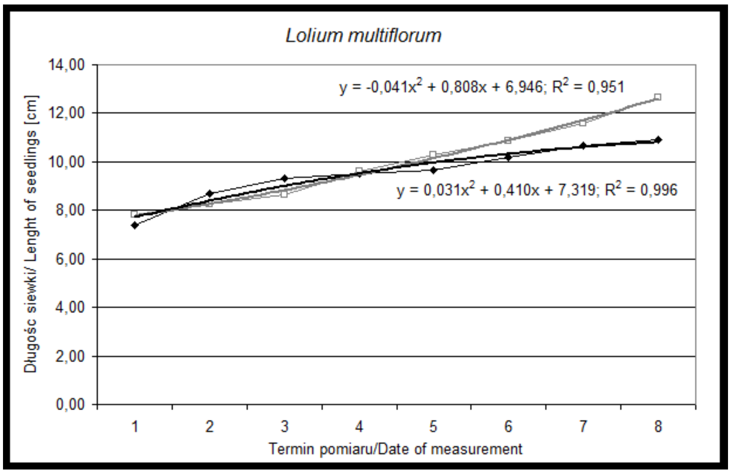

Fig.2. The growth kinetics of seedlings length of *Lolium multiflorum*. Explanations as in figure 1.

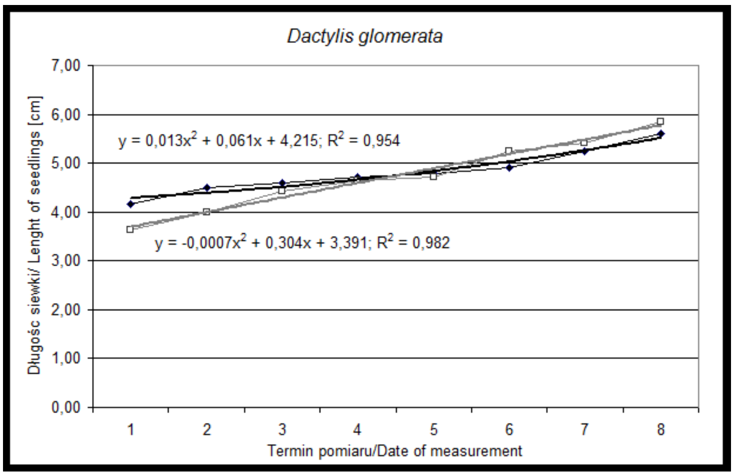

Fig.3. The growth kinetics of seedlings length of *Dactylis glomerata*. Explanations as in figure 1.

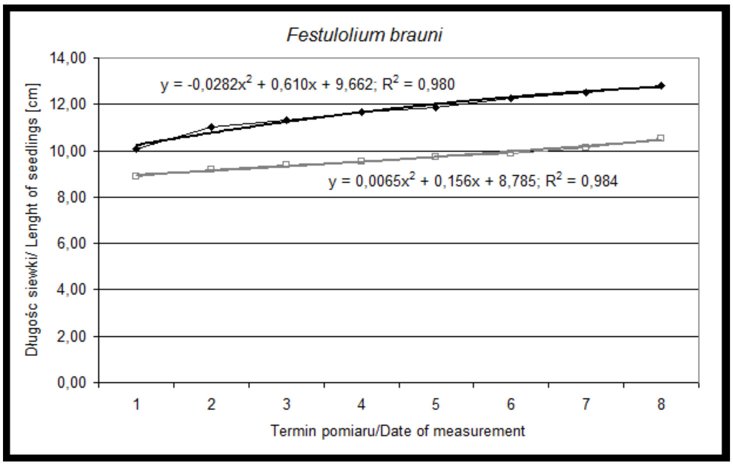

Fig.4. The growth kinetics of seedlings length of *Festulolium brauni*.
Explanations as in figure 1.

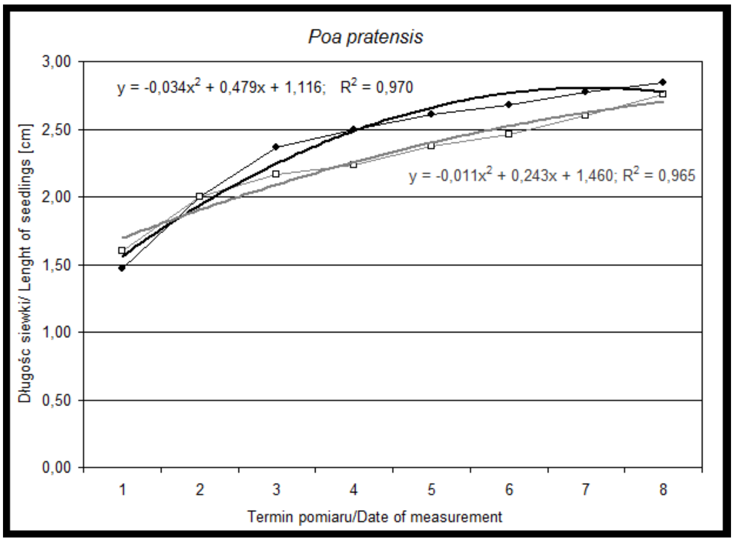

Fig.5. The growth kinetics of seedlings length of *Poa pratensis*.
Explanations as in figure 1.

4. CONCLUSIONS

1. The obtained results showed a significant effect of Nano-Gro stimulator on germination energy of *Festulolium brauni, Lolium perenne, Lolium multiflorum* and *Medicago sativa*.
2. Germination capacity of such grasses as *Festulolium brauni, Dactylis glomerata, Poa pratensis, Lolium perenne, Lolium multiflorum* and legumes *Trifolium pratense* and *Medicago sativa* was determined by using the Nano-Gro stimulator.
3. Nano-Gro significantly accelerated the germination and seedling length regrowth in the early stages of growth in all grass species. Throughout the study period, the most beneficial effect of used Nano-Gro stimulant was found in grass species such as *Festulolium brauni* and *Poa pratensis*.
4. The varied response of individual species of grasses and legumes for Nano-Gro stimulator indicates the need for wider research in this area including other species of grasses and legumes.

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