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Effect of Tytanit on selected morphological, physiological and chemical characteristics of *Lolium multiflorum* dry matter

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Abstract: The aim of the study was the determination the effect of foliar application of growth regulator containing Ti (Tytanit®), on *Lolium multiflorum* morphometry, photosynthetic activity, chlorophyll content and chemical composition of dry matter. A pot experiment was carried out in a plant breeding room of Siedlce University, Poland, in 2019. The experimental units were as follows: I) control – plants sprayed with distilled water; II) plants sprayed with 0.02% Tytanit concentration; III) plants sprayed with 0.04% Tytanit concentration; IV) plants sprayed with 0.06% Tytanit concentration. The following parameters were determined: the shoots number, the number and the length of leaf blades, the length of roots, the dry weight of roots, the dry weight of plants per pot and the content of chlorophyll a and b in leaf blades. In addition, maximum and actual efficiency of the leaf photosystem, *photochemical* and *non-photochemical quenching coefficients* and the content of total protein, crude fibre, monosaccharides, crude fat, crude ash, Ca, Mg, P, K and the ratio of K/(Ca + Mg), and Ca/P in the dry matter of plants were determined. Used in controlled conditions, the regulator contributed to the growth of most morphological characteristics, improved photosynthetic activity, increased the concentration of chlorophyll a and b, and the content of total protein, monosaccharides, calcium and magnesium, at the same time expanding ionic ratios.

Keywords: chlorophyll pigments, macronutrients, morphometry, organic compounds, photosynthetic activity, ryegrass, titanium

INTRODUCTION

The recent trend of increasing air temperature and changes in the amount and distribution of precipitation lead to a systematic deterioration of conditions for the growth and development of many crop species [Čimo *et al.* 2020, Kasperska-Wołowicz *et al.* 2021]. To overcome the impact of adverse environmental factors on plants physiological activity, some solutions improving the conditions for their growth and development are needed. One of such solutions, apart from application of mineral fertilizers and pesticides, might be the use of growth regulators [Auriga *et al.* 2020]. One of them is Tytanit®, a liquid mineral growth regulator, improving the condition of plants and stimulating their yield. It contains 8.5 g Ti per dm^3 as titanium ascorbate [Wadas, Kalinowski 2017a]. The effect of Ti on the increase in iron ion activity, the vigour of pollen, on plant health and the rate of nutrient uptake was confirmed [Borkowski *et al.* 2017; Michalski 2008]. The positive effect of this chemical element on the content of chlorophyll and carotenoids has been also reported [Hrubý *et al.* 2002; Samadi 2014; Samadi *et al.* 2015]. In addition, foliar use of Ti eliminates *Glycine max* L. growth inhibition caused by low phosphorus levels, while improving the root system architecture of the plant [Hussain *et al.* 2021]. However, Auriga *et al.* [2020] did not record any significant impact of Ti on water balance of *Fragaria vesca* L. growing in salt stress conditions, which may indicate that its action depends on the type of stress factor. Many authors [Du *et al.* 2010; Grajkowski, Ochmian 2007; Laskowska, Kocira 2003; Malinowska, Jankowski 2021; Radkowski, Radkowska 2010; Wadas, Kalinowski 2017a] report on the positive impact of Tytanit on the size and quality of the yield of agricultural crops, fruit and vegetables crops.

Photosynthesis is the basic physiological processes affected by many factors. Each decrease in the intensity of this process results in a decline in the quantity and quality of crops yields. The measurement of chlorophyll fluorescence can be regarded as a sensitive indicator used to predict the yield, and it largely replaces conventional measurements of photosynthetic activity [Michałek, Sawicka 2005]. Chlorophyll fluorescence measurements are used in ecophysiological studies to monitor crops and ecosystems at risk of phytotoxic agents and testing plant resistance to different stress factors [Kalaji, Łoboda 2010]. Maximum photochemical efficiency (F_v/F_m) is a useful indicator of the photochemical activity of the photosynthetic apparatus [Angelini *et al.* 2001]. The value of this parameter is up to 0.83 for most plants in full development and growing under optimal conditions. The research of Michałek and Sawicka [2005] with different potato varieties indicates that the F_v/F_m parameter value is dependent on the phenological stage of a plant, as well as on its variety. For most of the varieties a higher F_v/F_m value was obtained at the vegetative stage than at full flowering. The literature indicates the possibility of using the maximum photochemical efficiency of PSII to determine the impact of plant growth regulators on the physiological condition of crops [Auriga *et al.* 2020; Michalek *et al.* 2018; Romanowska-Duda *et al.* 2019; Sosnowski *et al.* 2020; Sosnowski, Truba 2021].

We hypothesised that foliar application of the Tytanit growth regulator to *Lolium multiflorum* will improve the functioning of the photosynthetic apparatus and in the effect of this the chemical composition of dry matter.

The aim of our study was to determine the effect of foliar application of a growth regulator containing titanium (the trade name of Tytanit) on morphometry, photosynthetic activity, chlorophyll content and chemical composition of *Lolium multiflorum* dry matter.

METHODS

The experiment was carried out in a breeding room of the Institute of Agriculture and Horticulture, the University of Natural Sciences and Humanities in Siedlce, Poland, in 2019. The conditions of the experiment were as follows: air temperature in the light adapted state of 24 ±2°C and in the dark adapted state of 16 ±2°C. Soil moisture was 60% of field water capacity. Light intensity was 200 μmol·m^{-2}·s^{-1} (obtained using high-pressure sodium lamps) with photoperiod 16 h of light and 8 h of darkness. As a test plant, *Lolium multiflorum* (common name: annual Italian ryegrass) tatraploid var. Turtetra (Kroto) was used. It was grown in pots (a height of 300 mm and a base diameter of 200 mm) filled with 5 kg of medium loamy soil taken from the arable layer. Soil pH in KCl was 6.1, with $N\text{-}NO_3$ concentration of 1.6 mg·kg^{-1} DM, $NH_4\text{-}N$ of 60.7 mg·kg^{-1} DM and C_{org} concentration of 17.3 g·kg^{-1}. The soil contained high amounts of absorbable forms of P and Mg, with moderate content of absorbable K. Because of the abundance of soil nutrients, mineral fertilizers were not used.

In mid-March 2019, ten seeds of *Lolium multiflorum* were sown in each pot, at a depth of 1 cm. After germination, three plants with the highest number of leaves were selected, while others were removed. The experimental variants were as follows: I) control (plants sprayed with distilled water); II) plants sprayed with 0.02% Tytanit concentration in spray solution; III) plants sprayed with 0.04% Tytanit concentration; IV) plants sprayed with 0.06% Tytanit concentration.

Each experimental combination was carried out in three replications. The plants were sprayed twice during each growth cycle at the stage of 3 leaves and at the stage of 5 leaves, applying each time 25 ml of solution per pot.

The following characteristics were determined:

- morphometry: the shoots number per pot, the leaf blades number per pot, the length of plant shoots (cm), the length of plant leaf blades (cm), the length of plant roots (cm), the dry weight of plant roots per pot (g), the dry weight of plants per pot (g);
- chlorophyll pigments: content of chlorophyll a and b (mg·(100 g)$^{-1}$ of fresh weight) in leaf blades;
- photosynthetic activity: maximum photosystem efficiency (F_v/F_m), actual photosystem efficiency ($\Delta F/F_m$'), the non-photochemical quenching coefficient (q_N), the photochemical quenching coefficient (q_P);
- organic compounds: the content (g·kg^{-1} DM) of total protein, crude fibre, monosaccharides, crude fat and crude ash;
- macronutrients and their ratio: the content (g·kg^{-1} DM) of Ca, Mg, P, K and the ratio of K/(Ca + Mg) and Ca/P in dry matter.

CHLOROPHYLL CONTENT DETERMINATION

The content of chlorophyll a and b in leaf blades was determined according to the method elaborated by Arnon *et al.* [1956] and modified by Lichtenthaler and Wellburn [1983]. Leaf blades from the half height of the plant (3–4th node) were sampled for pigment content determination. The optical density of the supernatant was measured by the Marcel Mini spectrophotometer with wavelengths of 440, 465 and 663 nm. The content of chlorophyll a and b was calculated according to the formulas provided by Sosnowski and Truba [2021].

PHOTOSYNTHETIC ACTIVITY DETERMINATION

Photosynthetic activity was measured once before cutting the plants. Ten shoots were randomly selected at each site. The measurement was made on the lowest leaf on the shoot and on the third leaf from the bottom of the plant. Photosynthetic activity of plants was determined by measuring chlorophyll fluorescence induction using the PAM 2000 apparatus (Heinz Walz GmbH, Effeltrich, Germany). All measurements were performed during the growing season, on well-developed leaves of *Lolium multiflorum*, in 5 replications. For measurements, a 2030-B clip holder and a light emitting diode at 650 nm with the standard intensity (0.15 μmol·m^{-2}·s^{-1} PAR) were used. In the dark-adapted conditions, leaves were kept in the dark for 15 min.

CHEMICAL COMPOSITION OF DRY MATTER

The content of organic compounds (total protein, crude fibre, crude ash, monosaccharides, and crude fat) in the dry matter of plants was determined by the NIRS method using NIRFlex N-500 (Büchi Labortechnik AG, Flawil, Switzerland). For determination of macronutrients concentration (Ca, Mg, P, K) the ICP-AES method was used.

STATISTICAL ANALYSIS

The obtained data were statistically processed using variance analysis. The differences between means were verified by Tukey's test at $p < 0.05$. The means presented in tables marked with the different letters are significantly different. The standard deviation (*SD*) was also determined. All calculations were carried out with Statistica 13 – 2017.3 software package.

RESULTS AND DISCUSSION

Tytanit significantly affected the number of *Lolium multiflorum* shoots (Tab. 1). The largest number, 39% higher than in control pots, was recorded for plants sprayed with the greatest concentration of 0.06%. The application of Tytanit at 0.02 and 0.04% concentrations increased the number of shoots in both cases to a similar level, but the differences were not significant. The growth regulator also influenced the number of leaf blades produced by *Lolium multiflorum* plants. The largest number of (383 leaves per pot), 22.8% more than in control, were noted for plants sprayed with concentrations of 0.04 and 0.06%. A similar reaction, with the highest values recorded in the units treated with higher concentrations of 0.04 and 0.06%, was observed in the case of the length of roots and leaf blades and dry weight of plants. Contrary to that, the largest dry weight of roots was in plants sprayed with the lowest concentration, i.e. 0.02%. The weight was on average 27% higher than that recorded as a response to higher concentrations of the regulator and 42% higher than in control units. For the rooted plants *Phaseolus vulgaris*, *Triticum aestivum*, *Rumex crispus* and *Elodea canadensis*, exposure to TiO_2 nanoparticles did not affect biomass production, but significantly increased root Ti sorption and uptake [Jacob *et al.* 2013]. Additionally, *R. crispus* showed translocation of Ti into the shoots. On the other hand, Monder [2019] found that titanite concentrations of 0.04 and 0.02% resulted in positive rooting effects of selected rose cultivars. As is evident from the chlorophyll fluorescence induction values and chlorophyll content, Tytanit affected the photosynthetic activity of *Lolium multiflorum* leaves (Tab. 2 and 3) in many ways. In relation to control, the treatment in significant way increased chlorophyll a and b content in the plant leaves (Tab. 2). The highest dose of Tytanit increased the content of chlorophyll a by 33.7% and chlorophyll b by 28.6%. According to some authors [Yokoya *et al.* 2007; Zhao *et al.* 2016] chlorophyll a and b is responsible for absorbing light energy, which is then transferred to photosynthetic reaction centres. The concentration of chlorophyll a and b is related to the effectiveness of photosynthesis. An increase in the content of photosynthetic pigments is the main factors enhancing photosynthetic activity of plants. So, Tytanit increased the concentration of chlorophyll pigments, which in turn increased *Lolium multiflorum* plants photosynthetic activity (Tab. 3). Similar results were obtained in experiment concerning the effects of Tytanit on chlorophyll content in potato [Wadas, Kalinowski 2017a]. It turned out that titanium ions supplied to leaves in the form of Tytanit stimulated an increase in plant chlorophyll content. In turn, it was found that triple application of titanium ions in form of foliar fertilizer caused that, leaves were dark green, more shiny and dense [Tan, Wang 2011], which was also confirmed in the present experiment with *Lolium multiflorum*. According to other authors, Tytanit increased the concentration of chlorophyll in the leaves of winter rape and winter wheat, and in *Phleum pratense* L. [Kováčik *et al.* 2014; Radkowski 2013].

In effect of Tytanit application, the maximum efficiency of photosystem II in dark-adapted leaves significantly increased (Tab. 3). It should therefore be noted that this increase indicates

Table 1. The effect of Tytanit on *Lolium multiflorum* morphological characteristics

Characteristic	Control[1)]	Value at Tytanit concentration[1)]		
		0.02%	0.04%	0.06%
Number of shoots per pot	64 ±10.1 c	76 ±9.94 b	78 ±12.0 b	89 ±11.1 a
Number of leaf blades per pot	312 ±26.0 c	334 ±19.2 b	388 ±21.2 a	379 ±22.2 a
Length of shoots (cm)	42.4 ±4.02 b	56.7 ±5.21 a	53.4 ±6.22 a	51.9 ±4.32 a
Length of leaf blades (cm)	40.5 ±3.92 b	44.1 ±6.22 ab	59.4 ±8.72 a	50.8 ±7.42 a
Length of roots (cm)	10.8 ±2.82 b	11.4 ±1.10 b	12.9 ±1.73 a	13.6 ±1.78 a
Dry weight of roots per pot (g)	3.48 ±0.61 c	4.97 ±0.42 a	3.82 ±0.69 b	3.99 ±0.79 b
Dry weight of plants per pot (g)	30.1 ±4.02 c	40.1 ±3.11 ab	48.9 ±6.98 a	46.1 ±5.98 a

[1)] Average values ± standard deviation.
Explanation: the values with different superscript letters in a row are significantly different ($p < 0.05$).
Source: own study.

Table 2. The effect of Tytanit on chlorophyll pigment content *Lolium multiflorum* leaves (mg·(100 g)$^{-1}$ of fresh weight)

Characteristic	Control[1)]	Value at Tytanit concentration[1)]		
		0.02%	0.04%	0.06%
Chlorophyll a	172 ±17.2 c	191 ±19.0 b	227 ±22.0 a	230 ±21.7 a
Chlorophyll b	91 ±9.98 b	112 ±13.3 a	113 ±10.7 a	117 ±11.6 a

[1)] Average values ± standard deviation.
Explanation: the values with different superscript letters in a row are significantly different ($p < 0.05$).
Source: own study.

Table 3. The effect of Tytanit on photosynthetic activity of *Lolium multiflorum* leaves

Character-istic	Control[1)]	Value at Tytanit concentration[1)]		
		0.02%	0.04%	0.06%
F_v/F_m	0.611 ±0.10 b	0.720 ±0.03 ab	0.778 ±0.04 a	0.776 ±0.13 a
DF/F_m'	0.487 ±0.09 b	0.603 ±0.15 a	0.599 ±0.09 a	0.589 ±0.08 a
q_P	0.606 ±0.11 a	0.597 ±0.14 a	0.587 ±0.12 a	0.598 ±0.07 a
q_N	0.120 ±0.03 c	0.130 ±0.03 b	0.149 ±0.04 a	0.147 ±0.04 a

[1)] Average values ± standard deviation.
Explanations: F_v/F_m = maximum photosystem efficiency, DF/F_m' = actual photosystem efficiency, q_P = the photochemical quenching coefficient, q_N = the non-photochemical quenching coefficient; the values with different superscript letters in a row are significantly different ($p < 0.05$).
Source: own study.

Table 4. The effect of Tytanit on total protein, crude fibre, monosaccharides, crude fat and crude ash content in *Lolium multiflorum* (g·kg^{-1} DM)

Character-istic	Control[1)]	Value at Tytanit concentration[1)]		
		0.02%	0.04%	0.06%
Total protein	128 ±11.3 c	147 ±16.3 b	162 ±12.4 a	160 ±17.3 a
Crude fibre	289 ±14.9 a	274 ±10.5 ab	263 ±17.9 bc	257 ±13.0 c
Monosac-charides	56.2 ±7.11 b	67.8 ±6.14 a	68.3 ±7.12 a	69.8 ±8.07 a
Crude fat	36.2 ±3.03 a	33.9 ±4.03 a	34.8 ±2.74 a	35.7 ±5.04 a
Crude ash	121 ±9.79 a	119 ±11.3 a	118 ±8.78 a	123 ±9.56 a

[1)] Average values ± standard deviation.
Explanation: the values with different superscript letters in a row are significantly different ($p < 0.05$).
Source: own study.

an increase in the demand of plants for photosynthetic products and the absence of disturbances in the process of growth and development. In addition, an increase in the maximum photochemical efficiency of photosystem II means the activation of the photosystem in the dark-adapted state and a lack of photoinhibition occurring in plant cells with nitrogen deficit, thus, in effect, the energy required to transport electrons was not reduced [Khaleghi *et al.* 2012; Laisk *et al.* 2014]. At the same time, the increase in the activity of PSII reaction centres of in the dark-adapted state is a result of delivering adequate amounts of nitrogen to plant cells, which results in high activity of the photosynthetic apparatus, which increases the efficiency of light energy conversion [Nishiyama *et al.* 2006]. It is worth emphasizing, therefore, that according to the present experiment, spraying plants with Tytanit could cause better nutrition of plants with nitrogen. It was evidenced by an increase in photosynthetic parameters: maximum (F_v/F_m) and actual (F/F_m') photochemical efficiency of the *Lolium multiflorum* leaf photosystem. In addition, the use of the Tytanit regulator also contributed to a 22.5% increase, compared to control, in the value of the non-photochemical quenching coefficient (q_N), with its highest statistically significant value recorded for plants sprayed with the highest concentration of Tytanit. However, the treatment did not affect the photochemical quenching coefficient (q_P) of the grass leaves in a statistically significant way. According to Michałek and Sawicka [2002], fluorescence parameter depends on genetic conditions, which may explain the lack of differentiation in the value of the photochemical quenching coefficient (q_P) as an effect of Tytanit application. Similar findings were obtained by Sosnowski *et al.* [2020], who studied the effect of Stymjod on photochemical indicators of *Dactylis glomerata* leaves.

In the present experiment foliar use of different Tytanit concentrations significantly affected the content of organic components in the dry matter of *Lolium multiflorum* (Tab. 4). Higher doses of titanium resulted in a significant increase in the total protein content (on average by 25.8%) and monosaccharides (on average by 22.1%). However, the crude fibre content in plants treated with the highest concentration of Tytanit was 11.1% lower than in control. Contrary to that, the regulator did not affect crude fat and crude ash content. The above results have been confirmed by other authors. Studying the nutritive value of meadow plants, Radkowski and Radkowska [2013] in response to Tytanit doses recorded an increase in the amounts of protein and sugars and a decrease in the concentration of crude fibre.

According to Table 5, application of examined growth regulator in different doses resulted in statistically significant differences in Ca content in *Lolium multiflorum* plants. Its highest amounts, 12.9% higher than in control plants, was in variants sprayed with 0.04 and 0.06% doses. Lower Ca content was found in plants treated with the lowest dose of Tytanit, but it was still statistically significantly higher than in control. Similar findings were obtained by Radkowski and Radkowska [2010], in whose experiment varied doses of titanium applied in form of Tytanit caused increase of Ca content in meadow plants. Its highest contents were recorded in plants sprayed with a 0.04% concentration of titanium. In the 1st year of their study, the increase in Ca content was 79%, in the 2nd year – 133% and in the 3rd – 63%. Such a high increase was not observed in our studies. Some researchers [Skupień, Oszmiański 2007; Wojcik 2002] argue that the fact that titanium regulators increase mineral content in the aboveground parts of plants is due to a stronger roots development, particularly the elongation of the hair zone. As a consequence, the more intensive uptake of nutrients from the soil is observed. According to some other studies, Tytanit do not affect Ca concentration in plant dry matter and in very low concentrations might even decrease it.

Table 5. The effect of Tytanit on calcium, magnesium, phosphorus, and potassium content in *Lolium multiflorum* (g·kg^{-1} DM)

Element	Control[1)]	Value at Tytanit concentration[1)]		
		0.02%	0.04%	0.06%
Ca	17.4 ±1.13 c	18.9 ±1.34 b	19.2 ±1.84 a	20.1 ±2.03 a
Mg	2.51 ±0.89 b	2.49 ±0.75 b	3.18 ±0.87 a	3.20 ±1.01 a
P	3.32 ±0.91 a	3.48 ±0.84 a	3.53 ±0.98 a	3.41 ±0.97 a
K	18.2 ±1.03 ab	17.9 ±1.03 b	19.4 ±2.04 a	18.7 ±1.94 ab

[1)] Average values ± standard deviation.
Explanation: the values with different superscript letters in a row are significantly different ($p < 0.05$).
Source: own study.

Statistical analysis also showed a significant impact of the regulator on Mg concentration in *Lolium multiflorum* biomass. Its significantly higher (by 27.1%) content compared to control was in plants treated with Tytanit in two concentrations: 0.04 and 0.06%. The influence of titanium foliar application on higher Mg accumulation in meadow plants was also observed by RADKOWSKI and RADKOWSKA [2010]. In a similar way Tytanit affected the concentration of Mg in crops in the studies of KLEIBER and MARKIEWICZ [2013]. They found the highest Mg content in tomato leaves sprayed with a liquid containing titanium in dose of 960 g Ti·ha^{-1}, while a small dose of titanium (80 g Ti·ha^{-1}) lowered it compared to control. In contrast, KALEMBASA *et al.* [2014] found the highest Mg content in leaf blades and petioles of ribbed celery plants treated with 1.0, 1.2 and 2.4% concentration of Tytanit. A concentration of 3.6% or a low dose did not affect Mg content in relation to control.

In the present research P content did not change in response to doses of titanium. The content of this macronutrient in dry matter ranging from 3.32 to 3.53 g·kg^{-1} DM was typical of *Lolium multiflorum*. In turn, the K content was the lowest in *Lolium multiflorum* plants treated with a regulator dose of 0.02%. Some studies [KLEIBER, MARKIEWICZ 2013; WOJCIK, WOJCIK 2001] report an increase in P content in vegetable plants treated with titanium. In turn, KLEIBER and MARKIEWICZ [2013] observed no significant effect of titanium doses on P concentration in fruits of tomato. On the other hand, RADKOWSKI and RADKOWSKA [2010] found that Tytanit application of in a concentration of 0.04% caused the largest increase in the concentration of all macronutrients in the dry matter of meadow plants. Compared to control, this increase was 28% for P, 78% for K, 80% for Ca, 81% for Mg and 60% for Na. A higher concentration of the regulator (0.08%) reduced macronutrient content compared to a concentration of 0.04%, and in some cases compared to a concentration of 0.02%.

In the present research, the K/(Ca + Mg) ratio in the dry matter of *Lolium multiflorum* varied significantly and ranged from 0.80 to 0.91 (Tab. 6). This could be interpreted as the favourable macronutrient content as, according to GAWEŁ [2009], for roughage to be of good quality, the ratio should range from 0.66 to 0.98. Additionally, the author claims that the value of this parameter is influenced by the intensity of utilisation (frequency of mowing) and by the number of years since the grass was planted. The highest value of the Ca:P ratio was noted in *Lolium multiflorum* plants treated with a 0.06% concentration of Tytanit. This dose caused a significant increase in Ca content, which directly translated into a very high value of the ratio. Different outcomes were presented by WADAS and KALINOWSKI [2017b], who applied titanium in form of Tytanit to potato leaves and did not observe any change in Ca or P accumulation in the tubers or, consequently, any increase in the Ca/P ratio.

Table 6. The effect of Tytanit on K:(Ca + Mg) and Ca:P ratios in *Lolium multiflorum*

Character-istic	Control[1)]	Value at Tytanit concentration[1)]		
		0.02%	0.04%	0.06%
K:(Ca + Mg)	0.91 ±0.11 a	0.84 ±0.13 a	0.87 ±0.34 a	0.80 ±0.43 a
Ca:P	5.24 ±0.79 b	5.43 ±0.51 ab	5.44 ±0.97 ab	5.89 ±1.02 a

[1)] Average values ± standard deviation.
Explanation: the values with different superscript letters in a row are significantly different ($p < 0.05$).
Source: own study.

CONCLUSIONS

The use of Tytanit at 0.04 and 0.06% concentrations in solution significantly improved number of shoots, number of blades and the length of shoots, leaf blades and shoots of *Lolium multiflorum*. In result of this higher weights of roots and plants were observed. The same amounts of the Tytaniu caused the increase of the concentration of chlorophyll pigments in the leaf blades. It turned out that when used under controlled conditions, Tytanit improved the photosynthetic activity of plants, increasing maximum (F_v/F_m) and actual ($\Delta F/F_m$') efficiency of the photosystem. However, it had no effect on the values of the photochemical quenching coefficient (q_P). The regulator in a variety of ways affected the content of organic compounds and macroelements in the dry matter of *Lolium multiflorum* plants. Its higher concentrations in solution reduced the amounts of crude fibre in the dry matter, but increased the content of total protein, monosaccharides, calcium and magnesium, thus expanding ionic ratios. Tytanit did not affect the content of crude fat, crude ash and phosphorus in the plant material. The results obtained can be used to develop cost-effective strategies to overcome the effects of adverse environmental factors on plant physiological activity, which will be related to the improvement of plants condition and their yield.

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