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Research Article

EFFECT OF DIFFERENT CONCENTRATIONS OF KELPAK BIOREGULATOR ON THE FORMATION OF ABOVE-GROUND BIOMASS COCKSFOOT

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ABSTRACT
Studies with growing cocksfoot (cv. Amila) were performed in polyurethane ring with a diameter of 36 cm and a height of 40 cm, which were dug to a depth of 30 cm and filled with soil material. As the experimental factor the trade name of bioregulator Kelpak SL was used, which includes natural plant hormones (auxin and cytokinin). The following aqueous solutions of growth regulator were used: 20, 40, and 60% and control (no preparation). Kelpak were applied to all three regrowth in the form of spray at a dose of $3cm^3$•$ring^{-1}$ in the shoots elongation phase of the grass. The full use of experimental objects was in 2011-2012. At that time, the detailed study include aboveground biomass yield (g DM•$ring^{-1}$), leaf length (cm), width of the base of the leaf blade (cm), leaf greenness index (SPAD). On the basis of morphological leaf characters the ratio of leaf blade shaping and the ratio of their surface were calculated. The study showed a significant influence of growth regulator on the development of aboveground biomass of cocksfoot. The greatest effect was obtained with the use of sprays of solutions with a concentration 40 and 60%.

Key words: orchard, Kelpak, biomass, SPAD index, leaf blade, yield.

INTRODUCTION

In the last few years in the scientific literature [11, 13, 14], it was pointed the possibility of the use of bioregulators based on the phytohormons in agricultural crops. One such type of this formulations is Kelpak which is acting efficiently in the plants cultivation from *Monocotyledones* class (eg cereals), but the species such as white mustard and peas are less susceptible to its effect [11]. The authors also notice that even various individuals respond very differently to applications of a hormonal regulator. The researches [9, 23] also show that the use of hormone facilitates plant adaptation to stressful conditions, and treat them with extract amounts of auxin and cytokinin enhances resistance to drought, lack of nutrients and soil salinity. However, the main benefit of phytohormone biostimulators that should be considered is the yield increase, which is confirmed by numerous scientific studies [9, 10, 12, 14, 15, 19, 21, 23]. This fact was the basis for research into the possibility of using hormonal regulators in plantings of valuable fodder grass, including cocksfoot.

The aim of this study was to determine the effect of Kelpak preparation on the formation of aboveground biomass and leaf greenness (SPAD) of cocksfoot (*Dactylis glomerata* L.).

MATERIALS AND METHODS

The studies with growing cocksfoot (Amila cv.) were carried out in the polyurethane rings in 4 replications at the experimental objects of Grassland Department and Landscape Architecture Development. the rings Rings with a diameter of 36 cm and a height of 40 cm, were buried to a depth of 30 cm and filled with soil material belonging to the order of culture soil, hortisol type, formed from poor clay sand.

Based on the analysis performed at the Regional Chemical Station in Wesoła it was found that the soil in the rings was characterized by a neutral reaction (pH in 1n KCl = 7.2), high humus content (3.78%), available phosphorus (P_20_5 - 900 $mg·kg^{-1}$), magnesium (Mg-84 $mg·kg^{-1}$),average abundance of total nitrogen (N - 1.8 $g·kg^{-1}$) and absorbed potassium (K_20 - 190 $mg·kg^{-1}$). For each ring (in 3 April 2011) 6 seeds of tested grass species were sown. After seeds germination when the seedlings reached the 2-3-leaf stage, negative selection was done. The weakest plants were removedand then the experimental factor was introduced as a water solution at different concentrations of growth regulator: Kelpak SL - 20, 40, 60%, and without regulator (control). The preparation was applied to all regrowth in a form of spray at a dose of 3 $cm^3·ring^{-1}$ during the shooting of grass blade. Kelpak biostimulator is composed from natural plant hormones such as auxin (11 $mg·l^{-1}$) and cytokines (0.03 $mg·l^{-1}$). It is prepared as an extract from seaweed *Ecklonia maxima* [13].

Furthermore, mineral fertilizers were used in an annual dose: N 0.6 $g·ring^{-1}$, P_2O_5 0.25 $g·ring^{-1}$ and K_2O 0.9 $g·ring^{-1}$. The experimental objects were used in 2011 and 2012. In the period of a full, three- cut use of experimental objects, the detailed study included:

- aboveground biomass yield (g D.M.$·ring^{-1}$),
- leaf length (cm),
- width of the base of the leaf blade (cm)
- leaf greenness index (SPAD).

Measuring the length of the leaf blade and its width at the base were performed on 10 randomly selected leaves originating from each experimental objects in 10 day after spraying with bioregulator. At the same blades, using equipment SPAD-502 Spectrum Technologies, in 10 replications SPAD index was also measured. Also the ratio of leaf blade shape was calculated - as an unnumerical size [7] and leaf area index - expressed in cm^2 [8].

The results were evaluated statistically using the analysis of variance. Medium differentiation was verified by Tukey's test at the significance level $p \leq 0.05$.

Meteorological data from the research years were obtained from the Hydrological and Meteorological Stations in Siedlce. However, in order to determine temporal and spatial variability of meteorological elements and their influence on plant growth, the hydrothermal rate of Sielianinov was calculated [2]. These values for each month and study year are shown in Table 1.

The data presented in Table 1 shows that in the experiment years only in the September 2012 there was a strong drought (K = 0.47). In the remaining months of the growing season there was no drought or poor drought. It is, therefore, clear that the course of meteorological conditions in the study years was favorable for the growth and development of plants.

RESULTS

From the cultivating point of view, size and fidelity of their yielding are important factors for crop nutrition . The analysis of the results showed that significantly highest yield characterized the crops grown in the rings, where the spray with 60% biopreparation solution was applied (Fig. 1). Average yield value for these objects was 72.4 g D.M. per ring and it was over 23% higher than average yields collected on the control objects. The use of 40%, concentration resulted in more than 12% increase in the harvested biomass relative to control objects. Spraying the plants with 20% solution of growth regulator did not contribute to significant yield increase.

As the data in Table 2 indicates, regardless of the cuts and the study year the longest leaf blades were formed by the plants sprayed with 40 and 60% solutions of growth regulator. Average length of leaf blade of cocksfoot on these objects amounted to 38.4 cm, and it was more than 12 cm longer than the length of blades of grasses from control rings.

Table 1. Value of hydrothermal index of Sielianinov (K) in individual months of vegetation

Year	Month						
	IV	V	VI	VII	VIII	IX	X
2011	1.10	0.89	0.72	2.19	0.84	0.78	0.94
2012	1.12	1.01	1.56	0.69	0.94	0.47	1.32

K < 0.5 – serve drought, 0.51 – 0.69 – drought, 0.70 – 0.99 – poor drought, K > 1 – no drought.

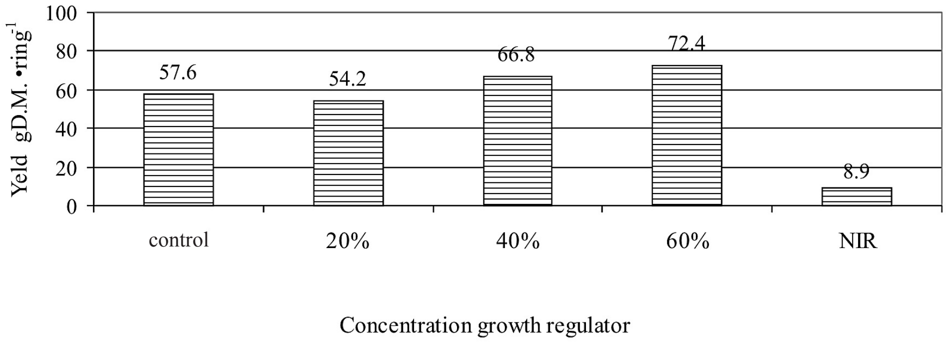

Fig. 1. Dry matter yield of cocksfoot depending on the concentration of growth regulator (sum of the three cuts, mean for years)

These values were transformed into to the ratio of a length to the width of the blade (blade shape index), which for plants from these objects amounted 72.0 and 67.7 respectively. No significant differences of leaves width under the influence of experimental factor caused the similar trend in the values of the space index.

The analysis of the relationship between morphological features of cocksfoot leaf and the parameters determining this quality (Table 3), showed a significant positive correlation between the length and width of the blade and between the shape index and the surface ratio. However, it should be noted, that the highest value of correlation coefficient ($r = 0.663$) was occurred only between the surface index and the length of leaf blade. In addition, only this relationship demonstrated the significances in the 99% confidence interval ($p = 0.01$). The lowest values of this coefficient were obtained by correlating the width of the leaf blade with the shape and surface characteristics.

During the whole study period, using biostimulator differentiated significantly the SPAD values of cocksfoot leaves (Fig. 2). Greenness measurements showed that a significantly higher value of SPAD characterized the plants grown in the rings, where the highest concentration of sp,0raying with growth regulator (60%) was used. The average value of the index for the plants from these objects, regardless of the cut and the study year amounted to 44.1 and it was about 10% higher than the average value of this characteristic for plants grown in the rings without spraying (control). The use of 20 and 40% concentration did not differentiate significantly the value of this parameter in compare to control objects.

Table 2. The quality of cocksfoot leaf depending on the concentration of growth regulator (average for cut and study years)

Concentration growth regulator [%]	Features			
	Length of blade [cm]	Blade width [cm]	Shape index	Area index [cm^2]
Control	26.3	0.51	51.7	13.4
20	28.6	0.53	54.0	15.2
40	38.9	0.54	72.0	21.0
60	37.9	0.56	67.7	21.2
$LSD_{0.05}$	7.7	r.n.	10.8	7.6

Table 3. Correlation (r) of morphological characteristics of cocksfoot leaf blade with its quality parameters

Leaf quality parameters	Features	
	x_1 Length of blade	x_2 Blade width
y. shape index	0.487*	0.473*
y. Area index	0.663**	0.462*

* Significant for $p = 0.05$.

** Significant for $p = 0.01$.

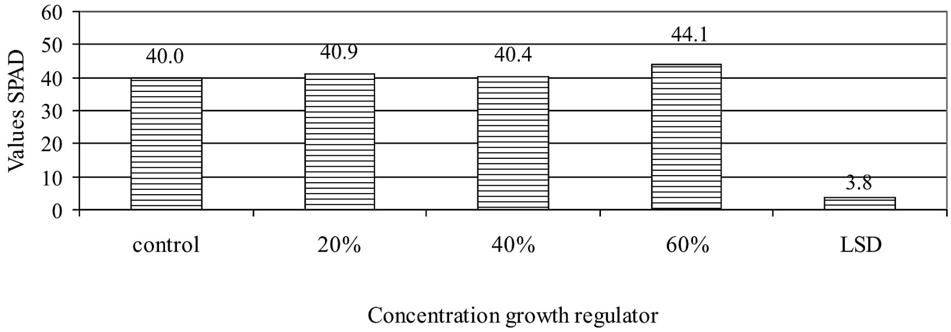

Fig. 2. SPAD value of cocksfoot leaves depending on the concentration of growth regulator (average for cuts and study year)

DISCUSSION

The preparations based on phytohormons is strongly dependent on the method of application, the species, a variety of crop, and concentration which is confirmed in our study [18]. The use of seaweed extract as an organic biostimulator, was quickly accepted in such a practice as in horticulture because of beneficial production effects [5, 21]. According to Sanderson and Jameson [16] and Stirk and Van Staden [17], the main ingredients of this extracts are cytokinins and auxin, which have been identified in the majority of seaweed concentrates. These hormones induced many processes connected with cytological and histological aspects of plants and influenced the content of some macroelements in plants [22]. According to the literature [19, 21] extracts can both stimulate and inhibit the growth of plants, which are mainly associated with the hormonal composition and the method of cultivation. Bioregulator Kelpak is seen as a preparation which did not destroy the crop, but stimulates the growth of somatic tissue [10, 12, 14, 15, 23].

De Villiers et al. [6], in their greenhouse experiments did not obtain a significant impact on the growth and development of study crops. However, the results of authors' own study, presented in the work, clearly show the beneficial effects of extracts from seaweed, particularly of higher concentrations, on the formation of aboveground biomass of cocksfoot. A similar trend has been described elsewhere [1, 10, 14, 24].

By Matysiak and Adamczewski [11], a plant that in the greatest extent responsive to the used hormonal growth regulator was corn. The study of these authors has shown that Kelpak increased its yield by over 21% compating to the control objects. In addition, it also contributed to the increase of the cereal yield, whereby the spring cereals have higher yielding tendency. In a study by Bai et al. [2] as a result of the foliar application of seaweed extracts, crops formed the shoots longer by 35% and the roots about 22% comparing to the control crops. Similar results were presented by Blunden et al. [3]. Moreover, research reports [10], confirming the beneficial effects of the Kelpak preparation on the crops, points to the greater importance the date of application, than the size of the dose.

Literature describing the research on hormonal bioregulators shows their varied impact on the value of leaf greenness index. The increase of SPAD value, after the application of extracts was received by Blunden et al. [4]. The Venkataraman-Kumar and Mohan [20] reported a negative impact of this factor on the discussed feature. In the cultivation of cocksfoot only sprayed with 60% solution of Kelpak significantly improved the value of this parameter, compating to the control object.

CONCLUSIONS

1. The use of Kelpak preparation contributed to a significant increase in dry matter yield of cocksfoot and a length of the leaf blade, out of which the strongest determined the value of indicators of the blades quality.
2. Measurements of leaf greenness showed that a significantly higher SPAD value characterized the crops grown on the objects with 60% spraying of Kelpak growth regulator.
3. The study showed a positive effect of growth regulator Kelpak on the formation of aboveground biomass of cocksfoot. However, the highest efficiency was recorded with the use of 40 and 60% solutions.

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