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ASSESSMENT OF OAT VARIETIES SENSITIVITY TO THE IMPACT OF ALUMINIUM

OCENA WRAŻLIWOŚCI ODMIAN OWSA (*Avena sativa* L.) NA DZIAŁANIE GLINU

Abstract: In this work, the influence of aluminium on the germination and growth of 9 oat varieties was researched The experiment was carried out in hydroponic cultures and four concentrations of aluminium were applied. The selected varieties of oat reacted to aluminium in various ways. Aluminium at concentrations of 100 and 200 μM reduced the growth of roots to the highest degree, however, its influence on the growth of shoots was negligible. A 75 μM concentration of aluminium had no effect on the growth of seedlings of chosen oat varieties in comparison with control. Amongst the assessed varieties of oat the following varieties were most tolerant to the toxic influence of aluminium: Flemingsprofi and Bohun at the lowest concentration (75 μM) as well as Borowiak and Akt at higher concentrations (100 and 200 μM). The obtained results will be used for cultivation selection in given areas.

Keywords: aluminium, oat, varieties, tolerant

In soil solutions aluminium ions may appear in various forms which depend on the pH balance and content of the soil. The most toxic element for plants is mobile aluminium Al^{3+}, whose harmful pH increases proportionally to the acidity of soil. 52 % of acidic soil in Poland is below pH = 5.5 [1, 2]. According to Furukawa et al [3] 30–40 % of the world's arable soil is acidic. On this soil a reduction of crop production has been observed.

The roots of plants are at highest risk of exposure to aluminium toxic stress. This harmful element interferes with the growth of roots which is caused by the reduced number of cell division in root meristems. If aluminium stress is maintained over a longer period of time, this may lead to a complete stunt of root growth, and next to the death of the plants.

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Aluminium also interferes with the mineral distribution in plants which is characterized by magnesium, potassium and phosphor deficiency [4]. Moreover, the toxic concentration of aluminium influences the process of respiration, DNA synthesis and proteolithic enzyme activity of cell membranes [5].

The aim of this work was to assess the influence of aluminium on the germination and growth of seedlings of oat varieties as well as the selection of tolerant varieties to the negative activity of this element.

Materials and methods

9 varieties of oat (7 Polish – Akt, Polar, Kasztan, Borowiak, Bohun, Deresz, Jawor and 2 German – Flaemingstern, Flemingsprofi) were used. At the first stage of the experiment, germination energy of the oat varieties was defined. 100 seeds of each variety were placed on Petri dishes (two repetitions) and left for 72 h in 4 aluminium combinations: control (0), 75, 100 and 200 μM. In the second part Aniola's [6] hydroponic nutrition growth test modified by Gallego i Benito [7] was applied. The germinated young seedlings (20 for each variety in three repetitions) were placed on the medium using the same concentrations for aluminium.

Germination energy of oat varieties after aluminium treatment was defined. The degree of the growth stunt for roots and shoots as well their number after 14 days of observation was also defined. Standard deviations were taken into account.

Results and discussion

In this paper, it was shown that aluminium lessens germination of seeds proportionally to its concentration levels. The highest germination energy was observed in Polish varieties Borowiak and Akt, ranging from 100 to 93 % (from the lowest to the highest aluminium concentration, accordingly) in comparison with control. However, the German Flaemingstern variety was most sensitive to the activity of aluminium at the germination phase in which its germination energy ranged from 88 % to 36 % in relation with control (Fig. 1).

A different response of the chosen oat varieties to the activity of aluminium was observed at the seedling development stage which was characterized by a differentiated growth of roots and shoots. The toxic influence of aluminium was first observed in the growth stunt of roots and for this reason it was basic criterion for tolerance assessment. Aluminium caused the shortening, browning and brittleness of roots. The greatest growth of root length in control was observed in Kasztan, Bohun and Flemingsprofi varieties. In the case of the last variety aluminium stimulated the growth of roots at concentration of 75 μM. Morever, the Jawor variety had a lower growth of roots in all combinations (Fig. 2).

The roots were directly exposed to the harmful influence of aluminium and for this reason their growth was significantly reduced in comparison with the growth of shoots. Aluminium concentration of 200 μM in the experiment lasting 14 days proved to be the threshold at which the first symptoms of plant death was already observed.

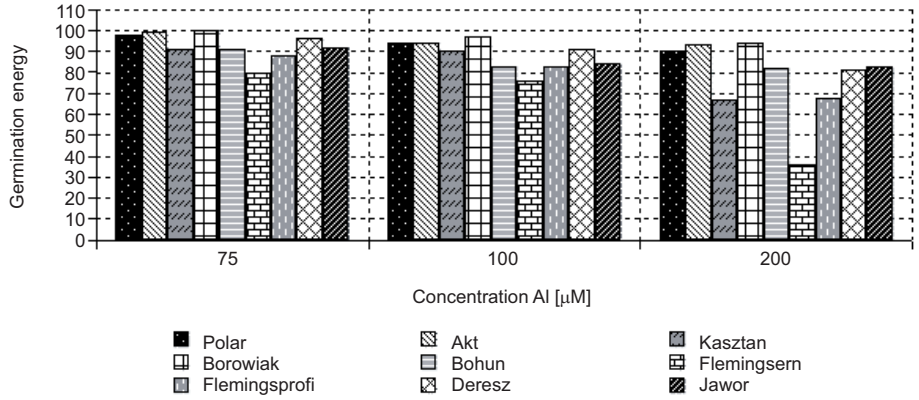

Fig. 1. Germination energy of seeds in oat varieties [in relation to control – %]

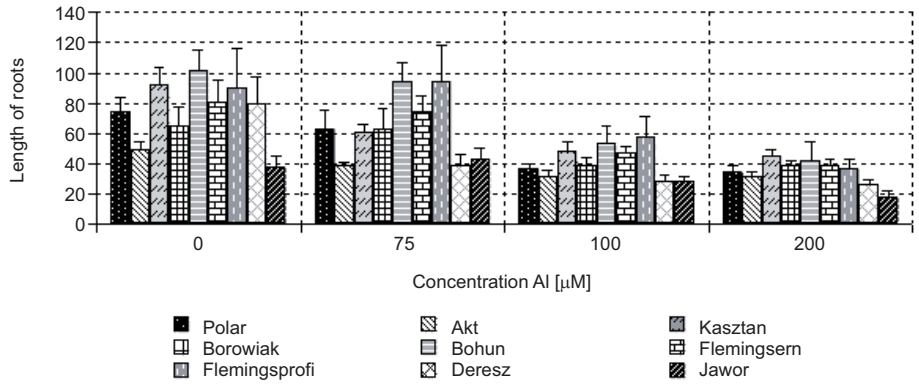

Fig. 2. The influence of aluminium on length [mm] of oat roots after 14 days

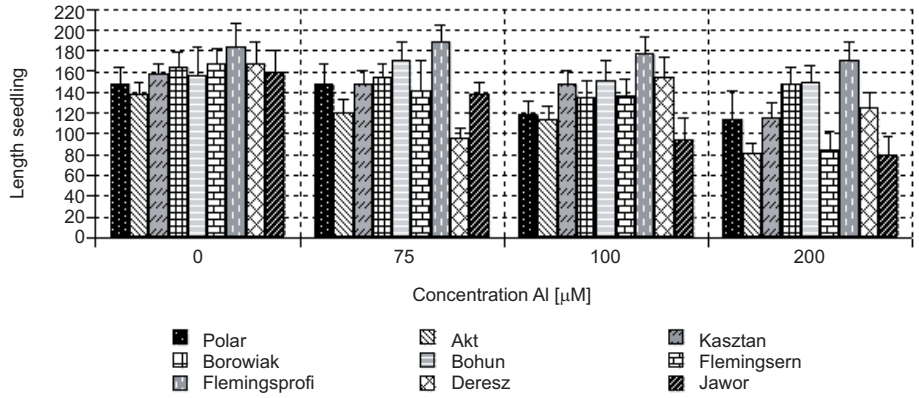

Fig. 3. The influence of aluminium on length [mm] of oat shoots after 14 days

Similarly as in the case roots, aluminium at concentration of 75 μm stimulated the growth of shoots in some varieties: Flemingsprofi, Bohun and Jawor. The greatest growth of shoots in all combinations was observed in the Flemingsprofi variety. This variety also created the highest number of roots – on average – 6, but in others around 4. The length of shoots in the remaining varieties lessened proportionally to the growth of aluminium concentration (Fig. 3).

On the basis of the obtained results, oat varieties tolerant to the activity of aluminium ions were identified: Flemingsprofi and Bohun – at lowest concentration (75 μM) as Borowiak and Akt – at higher concentrations (100 and 200 μM).

The researched oat varieties variously reacted to aluminum stress depending on the phase of plant development. The Flaemingstern and Flemingsprofi varieties proved the most sensitive to the toxic activity of aluminium ions at the germination stage, yet its harmfulness at the seedling phase of those varieties was significantly lower. The existence of similar differences among species and inbred lines of rye with regard to salinity stress sensitivity depending on the plant development stage has been reported by Noble [8] and Kubicka and Dec [9], eg the *Secale montanum* rye species was characterized by high sensitivity at the germination phase.

According to Aniol [10] and Zawada et al [11], some species and varieties of crops react differently to aluminium stress. It was demonstrated in the presented paper – seedlings of oat varieties differed in their root and shoot length after aluminium treatment.

A negative aluminium effect on the development phase was observed in the experiment, however it was less extensive for shoots.

The selected genotypes of oat tolerant to the harmful action of aluminium may be used in the breeding of varieties which are better adapted to acidic soils in Poland, However sensitive varieties can be used in genetic experiments to define the inheritance of this trait.

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OCENA WRAŻLIWOŚCI ODMIAN OWSA (*Avena sativa* L.) NA DZIAŁANIE GLINU

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Abstrakt: W pracy badano wpływ glinu na kiełkowanie i wzrost siewek 9 odmian owsa, w kulturach hydroponicznych, stosując cztery stężenia tego metalu. Wybrane odmiany owsa zróżnicowanie reagowały na jego działanie. W najwyższym stopniu glin wpływał na zahamowanie przyrostu długości korzeni w stężeniach 100 i 200 μM, zaś nieznacznie na wzrost części nadziemnych. Glin w stężeniu 75 μM prawie nie wpływał na wzrost siewek badanych odmian owsa, a nawet stymulował wzrost siewek u odmiany Flemingsprofi. Spośród ocenianych odmian owsa najbardziej tolerancyjne na toksyczne działanie glinu były odmiany: Flemingsprofi – w najniższym stężeniu (75 μM) oraz Borowiak i Bohun – w wyższych (100 i 200 μM). Uzyskane wyniki zostaną wykorzystane przy doborze odpowiednich odmian do uprawy na danym terenie.

Słowa kluczowe: glin, owies, odmiany, tolerancja