SENSIBILITY OF GENOTYPES OF WINTER RAPE SEEDLINGS TO HIGHER CONCENTRATION OF Al AND Mn IONS IN SOIL

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INTRODUCTION

Soils of most agricultural areas in Poland have the mechanical composition of loamy sands. These soils are characterized by low water capacity and high acidity. An appropriate accommodation of winter rape forms to soil conditions is of a great practical importance.

The respective literature proves that the adaptation of particular plant varieties to the given soil acidity level is determined genetically. It is stressed that the above view concerns all species (T. Barszczak, J. Bilski 1983; C.D. Foy 1976; E.L. Klimashevskyi 1974).

Preliminary experiments carried out by us earlier with winter rape prove that also in this species a distinct genotypic differentiation of features of soil with higher acidity can occur (Z. Barszczak 1987). This constituted a basic substantiation of taking up the present investigations.

The direct aim of these investigations was to estimate double-improved breeding materials of winter rape to features of soil with higher aluminium and manganese concentration.

MATERIAL AND METHODS

The experiment comprised 88 samples in 1989 and 52 samples in 1990 of double-improved ("00") winter rape.

The seeds for testing constituted materials of the breeding programme realized by Prof. J. Krzymanski from Poznan.

The experiments comprised the Jet Neuf "0" and Bolko "00" cultivars with higher resistance to the soil acidity (Z. Barszczak 1987).

These materials were investigated in the series of vegetative experiments with seedlings. The experiments were carried out on soil of type of light loamy sand sand with acidity changing in connection with earlier different mineral fertilization and liming.

Soils used in the subsequent experiments differed distinctly with the pH value and the exchangeable aluminium and manganese content, Al - after Sokolov, Mn - after Schacht-schabel. (Table 1).

The content in soil of available phosphorus, potassium and magnesium was at the medium level.

Breeding materials obtained in 1989 were investigated in the experiments on A_1-A_4 soils and in 1990 on A_5-A_8 soils (Table 1). In microcontainers of 100 mm in height and 60 mm in diameter 350 g of soil were placed. To soil samples prepared for investigations NH_4NO_3 was added in the amount corresponding with 40 ppm of N. By 8 seeds were sown and after sprouting by 5 seedlings in each microcontainer were left. Soil moisture was maintained at the level of 60% of the total capillary water capacity. In the phase of the first proper leaf 30 mg N in the form of the NH_4NO_3 solution were added. The experiments were

carried out in 4 replications in the growing house with the temperature varying from 14°C at night to 25°C during the day. The plants were harvested 24-28 days after establishing of the experiment. The harvest consisted in rinsing soil of roots in the water stream and subsequent drying of seedlings, separation of roots and weighing.

Table 1. Characteristics of soil samples

Soil Features	Years of Investigations: 1989					1990		
	Denotation of Soil in Subsequent Experiments							
	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8
pH_{KCL}	5.5	4.1	4.8	4.2	5.5	5.3	4.4	4.6
Hh me/100 g	1.2	3.0	2.0	2.8	1.2	1.8	2.7	2.4
Al ppm	0.0	90.0	28.8	106.2	21.0	32.0	138.0	64.0
Mn ppm	11.2	21.5	80.6	88.6	51.0	110.0	92.0	170.0

RESULTS

During growth observations on the appearance of seedlings were performed. On the A_1 and A_5 soils seedlings were of healthy appearance and developed appropriately. Similarly normal growth of seedlings was observed on the A_2 soil, although in some genotypes small necrotic changes on leaves intensifying with the growth occurred.

On the A_3 soil cotyledons of emerging plants showed distinct symptoms of chlorosis. These symptoms ceased gradually with the growth of seedlings. Small differences between particular genotypes were observed.

On the A_4 soil cotyledons of sprouted seedlings showed strong symptoms of chlorosis, which slowly ceased along with the growth of seedlings. In most genotypes investigated chlorosis maintained till the harvest. The differentiation was distinctly dependent on the genotypes investigated. Plants in treatments denoted with the Nos. 3865/88, 3916/88, 825/1/88 and the Jet Neuf and Bolko cultivars distinguished themselves with green colour of leaves.

On the A_6 soil cotyledons of the sprouting seedlings showed the symptoms of chlorosis which decreased along with the growth. Small differences in the reaction of genotypes were found.

On the A_7 soil close after sprouting a distinct chlorosis of cotyledons and then of seedling leaves maintaining till the harvest was observed. Distinct genotypic differences occurred. A distinctly better appearance (less intensive chlorosis and necrosis) was found in the genotypes denoted with the Nos. 25/88/89, 49/88/89, 306/88/89, 319/88/89, 10/89, 23/89, 44/89, 47/89 and 337/89.

On the A_8 soil a very heavy chlorosis of cotyledons and then of plants, maintaining till the harvest, was observed. The chlorosis intensity depended on the genotypes investigated. Relatively lowest intensity of chlorosis was in the treatments denoted with the Nos. 25/88/89, 341/88/89, 10/89, 44/89, 50/89, 294/89 and 334/89.

In experiments on this soil as well as on the A_4 soil (1989) considerable differences between genotypes in the

chlorosis intensity as early as in the sprouting phase were observed. A part of the genotypes distinguished itself with intensively green colour of cotyledons, while other ones showed a heavy chlorosis. These differences maintained till the harvest of seedlings.

Genotypes distinguishing themselves with intensively green colour of cotyledons have been presented above and in description of the observations on the A_4 soil. The following genotypes were characterized by a very heavy chlorosis of seedling cotyledons: 3048/88, 3303/88, 3607/88, 3622/88, 664/1/88, 2/88/89, 34/88/89, 308/88/89, 338/88/89 and 603/89.

Soil conditions exerted a very strong effect on the mass of seedlings. It was the highest on the A_1 and A_5 soils being significantly lower on the remaining soils (Table 2).

Along with the Al and Mn concentration growth in soil the mean error of the arithmetic mean distinctly increased (Table 2). This proves that the differential of populations of the genotypes investigated increases under the effect of Al and Mn.

Table 2. Mean mass of seedlings in Mg per plant and mean deviation (expressed in % of mean) in subsequent experiments

Structure of the Mass of Seedlings	Years of Investigations: 1989 (88 Genotypes) Denotation of Soil in Subsequent Experiments				1990 (52 Genotypes)			
	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8
Mass Total	265	136	120	62	176	149	87	46
Green Parts of Plant	206	99	93	47	146	123	61	37
Roots	59	37	27	15	30	26	26	9
S^1 in % of Mean								
Mass Total	8.7	11.5	27.8	45.5	5.9	9.4	15.5	28.8
Green Parts of Plant	10.1	12.6	23.9	46.3	6.6	9.1	12.6	25.0
Roots	20.4	16.1	37.6	48.8	9.4	14.9	26.4	53.9

Changes in the mass of seedlings due to the higher Al and Mn concentration in soil constituted a basis of the classification of the material of rape. This classification was carried out while comparing the mass of seedlings in different soil treatments, separately for the experiment of 1989 an 1990.

The mass reduction of the aboveground parts and roots of plant in the treatment of A_2 soil as compared to that of A_1 soil bore evidence about sensibility of plants to higher concentration of Al ions; the A_3 soil as compared to A_1 - about the sensibility to higher Mn concentration and A_4 as compared to A_1 - about the sensibility to simultaneous increase of the aluminium and manganese concentration.

Similarly in the experiment of 1990, the reduction degree of the mass of seedlings in treatments of the A_7 soil as compared to A_5 bore evidence about sensibility of particular genotypes to Al, while the reduction of mass on A_6 and A_8 soils compared to A_5 - about sensibility to Mn.

To separate the collections of genotypes with the similar reaction to Al and Mn appropriate statistical calculations were

performed in accordance with the model:

$$Yij = m + ei \neq eij,$$

where

Yij - mass reduction degree (of roots or aboveground parts of seedlings) for the i-th genotype and the j-th replication,
m - general mean,
ei - effect of the i-th genotype,
eij - random error,

Verification of the zero hypothesis:

Ho : $m_1 = m_2 = \ldots\ldots\ldots m_{88}$ in 1989 and m52 in 1990.

Division of the genetic material investigated into uniform collections was performed using the Newman-Keuls' test.

CONCLUSIONS

On the basis of the reduction degree of the mass of winter rape seedlings on soil with different aluminium and manganese concentration and of observations of the chlorosis and necrosis intensity on the assimilation surface of leaves the following groups were distinguished:

- group of higher tolerance to increased Al and Mn concentration in soil: Jet Neuf, Bolko, 3865/88, 3916/88, 825/1/88, 10/88/89, 10/89, 25/88/89, 44/88/89 and 47/89,
- group of higher tolerance to increased Mn concentration: 58/88/89, 306/88/89, 307, /88/89, 314/88/89, 341/88/89, 582/88/89x and 50/89,
- group of higher tolerance to increased Al concentration: 7/88/89, 18/88/89, 333/88/89, 23/89, 286/88/89 and 337/88/89,
- group of relatively good tolerance to increased Al concentration and at the same time worse one to increased Mn concentration 3287/88, 3348/88 and 410/4/88.

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