Int. Agrophysics, 2000, 14, 89-92

EFFECT OF MAGNETIC FIELD ON YIELD AND CHEMICAL COMPOSITION OF SUGAR BEET ROOTS

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Accepted February 12, 1998

A b s t r a c t. The purpose of the research was to study the effect of alternating magnetic field on the yield and chemical composition of sugar beet roots. The investigations were undertaken on four varieties of sugar beet viz. Colibri, Evita, Kawetina and Maria and four magnetic exposure doses in the field. The results of the research showed that the effect of the pre-sowing magnetic biostimulation is positive. In all the combinations except Evita variety the yields of roots (5.0-9.4 t ha^{-1}) and leaves (5.0-9.4 t ha^{-1}) were higher than the yield of control. Also, the biological yield of sugar increased in all the combinations. The alcality coefficient was higher than 1.8, which from the technological point of view, is very advantageous.

K e y w o r d s: magnetic biostimulation, magnetic exposure dose, yield of sugar beet roots, yield of sugar beet leaves, bioyield of sugar

INTRODUCTION

Sugar beet (*Beta vulgaris sp.crassa provar crassa*) is a very valuable technical plant. It is the only raw material for sugar production in Polish climatic conditions. Both marc and leaves make valuable and cheap fodder. To obtain high sugar yield, high yield of roots with large sucrose content must be worked for in the first place. This calls for methods to increase plant yield in terms of sucrose.

Herzog and Zerjeski [2] were examining the influence of the electrostatic, alternating electric fields and crown discharge on the germination and growth of sugar beet seeds. The results achieved did not allow to state unmistakably if the method used influenced plant ability to germinate or its vegetation.

Kronsky and Ruml [3] used a set of physical factors to improve germination of sugar beet seeds. The factors used were: UV radiation, He-Ne laser rays, magnetic field (B = 0.02T), electrostatic field, glow discharge and low-temperature Na plasma. Several years of research did not bring univocal answer which method is the best. The results achieved have shown the existence of some positive influence, but also a negative influence has been observed. Additionally, the results were often not univocal for the method used.

Drobig [1] compared several research experiments with magnetic and electric field used in pre-sowing biostimulation of seeds. Basing both on the results observed and parameters of the physical fields, he stated that with a wide range of applied exposure doses, it is very difficult to make comparison and give univocally positive or negative answer concerning these method.

The research carried out in the University of Agriculture in Lublin, by means of alternating magnetic field to pre-sowing biostimulation of wheat seed gave a positive outcome. It was decided to use the same method for sugar beet seed biostimulation under the magnetic field described by Pietruszewski [4]. A certain effect of magnetic field on yield of roots, leaves, biological yield of sugar and other chemical composition was observed.

MATERIALS AND METHOD

The effect of magnetic field is proportional to energy density of the magnetic field and exposure time. A magnetic exposure dose D could be defined as:

$$D = \frac{10^7}{4\pi} B^2 t \ (\mathrm{J\ m^{-3} s})$$

where: B - value of magnetic induction measured with a gaussmeter, t - exposure time.

Sugar beet seeds were exposed to magnetic field with four exposure doses as stated below:
D_1=35.8 10^3 $\mathrm{Jm^{-3}s}$ (B=75 mT, t=8 s),
D_2=67.2 10^3 $\mathrm{Jm^{-3}s}$ (B=75 mT, t=15 s),
D_3=134.4 10^3 $\mathrm{Jm^{-3}s}$ (B=75 mT, t=30 s),
D_4=268.8 10^3 $\mathrm{Jm^{-3}s}$ (B=75 mT, t=60 s).

After seven days the seeds were sown into experimental plots. The field experiment was established on the brown soil formed of loess, of a good wheat complex. The experiment was carried out in 1994, 1995 and 1996, in the Experimental Farm in Felin near Lublin. The research was undertaken on four varieties of sugar beet viz., Colibri, Evita, Kawetina and Maria. The seeds of Maria variety were obtained from Sugar Beet Breeding in Kutno, the rest of the seeds from Sugar-Mills in Lublin and Krasnystaw.

The treated seeds were sown in the second decade of April using a hand drill into experimental plots with the area of 10 m^2 each, with the row spacing of 45 cm in three replications including control test, total number of plot was 60 each year. The sowing depth was approx. 3 cm. The plant-to-plant spacing was kept at 25 cm by uprooting extra plants after sprouting. All the agrotechnical treatments were performed according to the recommended practice of field -crop production. Observations on the plant growth and development were taken during vegetation period.

The crop was harvested in October. The yield of roots and leaves was expressed in t $\mathrm{ha^{-1}}$. Next, samples of roots and leaves were taken out of each plot to specify chemical contents. Analysis of such factors as: contents of dry mass, sugar, dissolvable ash, α-aminic nitrogen and alkality coefficients were carried out.

Biological yield of sugar was estimated based on root yield and polarisation, while the alkalinity coefficient was determined by the following formula:

$$\frac{\mathrm{K + Na}}{\mathrm{Na}_{\alpha}\ \text{- aminic}}$$

where K, Na, Naα-aminic were expressed in miliequivalents per 100 grams of cambium.

The results were described statistically to define the importance of differences with Tuckey's test.

RESULTS

The pre-sowing magnetic biostimulation had a great influence on the yields of roots and leaves depending on the variety and magnetic exposure dose. The results obtained are shown in Table 1.

The yields of roots increase significantly ($\alpha = 0.05$) for D_1 dose for all the cultivars except Evita which showed a non-significant effect in the case of all the doses. The root yield obtained were about 5.0-9.5 t $\mathrm{ha^{-1}}$ higher for Colibri variety and 5.0-9.4 t $\mathrm{ha^{-1}}$ for Maria variety than control. The yields of leaves increased significantly ($\alpha = 0.05$) D_3, D_4 exposure doses about 5.0-5.1 t $\mathrm{ha^{-1}}$ for Colibri variety and about 5.0-9.4 t $\mathrm{ha^{-1}}$ for Maria variety for all the doses.

Biological yield of sugar depends on root sugar content and root yield. Since sugar content in root for each variety and exposure doses were the same (Table 2), biological yield of sugar was directly proportional to root yield.

For each combination of variety and exposure dose, biological yield of sugar was higher than in control. The highest significant ($\alpha = 0.05$) increase was observed for the Maria variety and D_1 exposure time (2.03 t $\mathrm{ha^{-1}}$) and

D_4 exposure dose (1.41 t ha^{-1}). For the Colibri variety the increases was also high (1.58 t ha^{-1} for D_2 exposure dose ($\alpha = 0.05$) and 1.23 t ha^{-1} for D_4 magnetic dose but was not significant.

The results of biochemical analysis are presented in Table 3. The pre-sowing magnetic biostimulation did not have any effect on the contents of dry mass. Dissolvable soluble ash content depended on the exposure dose and plant variety. The results were very different, for example: for the Colibri variety and D_1 exposure dose higher content but for D_2, D_3, D_4 lower content for the Evita variety and D_2, D_4 higher content but for D_1, lower content for the Kawetina variety and D_4 exposure dose a higher content but for D_1, D_2, D_3 lower content

Table 1. Yield of sugar beet (means from 1994 to 1996)

Dose	Yield of roots (t ha^{-1})				Yield of leaves (t ha^{-1})			
	Colibri	Evita	Kawetina	Maria	Colibri	Evita	Kawetina	Maria
Control	61.8	61.9	62.0	56.2	36.8	44.4	45.6	40.2
D_1	66.8 *	61.7	67.0 *	67.1 *	40.9	43.7	46.4	46.0 *
D_2	71.3 *	61.4	64.5	61.9 *	40.6	42.1	47.1	49.6 *
D_3	65.1	61.5	63.8	59.1	41.9 *	43.3	49.2	45.2 *
D_4	69.7 *	61.8	66.0	62.1 *	41.8 *	43.8	46.2	47.2 *
Mean	66.9 *	61.7	64.7	61.3 *	40.7	43.5	46.9	45.6 *

Table 2. Yield of sugar (means from 1994 to 1996)

Dose	Sugar content (%)				Biological yield of sugar (t ha^{-1})			
	Colibri	Evita	Kawetina	Maria	Colibri	Evita	Kawetina	Maria
Control	16.9	16.3	17.0	17.2	10.40	10.04	10.55	9.50
D_1	17.2	17.5	17.2	17.3	11.45	10.62	11.44	11.53 *
D_2	17.2	16.9	17.5	17.1	11.98 *	10.38	11.19	10.52
D_3	17.0	16.9	17.5	17.3	11.04	10.31	11.09	10.06
D_4	16.7	17.6	17.4	17.7	11.63	10.72	11.44	10.91
Mean	17.0	17.0	17.3	17.3	11.30	10.41	11.14	10.50

Table 3. Chemical composition (means from 1994 to 1996)

Dose	Colibri	Evita	Kawetina	Maria	Colibri	Evita	Kawetina	Maria
	Dry mass (%)				Dissolvable soluble ash content (%)			
Control	19.9	20.1	20.0	20.1	0.515	0.478	0.528	0.532
D_1	19.9	20.0	20.1	20.8	0.520	0.445	0.514	0.438 *
D_2	20.7	19.9	20.8	19.7	0.479	0.500	0.471	0.498
D_3	19.7	20.4	20.8	20.7	0.457	0.478	0.513	0.519
D_4	20.0	19.2	19.9	20.5	0.505	0.488	0.559	0.505
Mean	20.0	19.9	20.3	20.4	0.495	0.478	0.517	0.497
	α-aminic nitrogen content (%)				Alkality coefficient			
Control	0.0450	0.0404	0.0430	0.0457	1.86	1.91	1.81	1.84
D_1	0.0367	0.0375	0.0396	0.0365	2.12	2.11	1.92	2.52
D_2	0.0442	0.0376	0.0388	0.0382	1.83	2.31	2.00	2.56
D_3	0.0303	0.0441	0.0392	0.0390	3.13	1.95	2.01	2.18
D_4	0.0439	0.0388	0.0438	0.0382	1.69	1.95	1.61	2.26
Mean	0.0400	0.0397	0.0409	0.0395	2.13	2.05	1.87	2.27

*significant at 0.05.

than in control. Only for the Maria variety the ash content was smaller than in control in each case.

The α-amonic nitrogen content in the fresh mass of roots was generally lower than in control. The value of alkality coefficient should be 1.8 or greater. In all the studied cases except one, these coefficients were greater than 1.8. It is very profitable in sugar production.

CONCLUSIONS

Considering the above results it can be concluded that the influence of pre-sowing magnetic biostimulation depends on beet seed variety and exposure dose used. All the examined features, both of yield and some chemical elements in root (biological yield of sugar, ash and α-aminic nitrogen content etc.) basically depend on the pre-sowing magnetic biostimulation, in a positive way. This can be seen in the case of leaf and root yields and biological yield of sugar. Reduction of dissolvable ash content is, from technological point of view, very desirable.

Maria variety was most sensitive to the pre-sowing magnetic biostimulation among all the four cultivars under study. The significant positive influence on some features have been observed

Finally, the best exposure dose for the magnetic biostimulation for sugar beet seeds was found to be $D_1 = 35800\ \mathrm{J\,m^{-3}s}$ ($B = 75$ mT, $t = 8$ s).

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