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EFFECTS OF SEED IRRADIATION WITH LASER ON THE YIELD AND CHEMICAL COMPOSITION OF SUGAR BEET ROOTS

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A b s t r a c t. Special attention was paid for pre-sowing seed preparing with the use of laser rays to increase sugar beet yield using economical and environment-safety methods. The field investigations aiming at determination of influence of laser exposure of seeds on biometric features, yielding and some of chemical constitution elements were carried out. The experiments were performed for two varieties (PN Mono 1, PN Mono 4) and for 0, 1, 2, 3, 4 times laser exposures of seeds with the use of helium-neon HNA-188 laser of power of 40 μW. The exposures were accomplished during free-fall of seeds through divergent laser beam. The investigation results show beneficial effect of laser exposure of seeds on sugar beet yielding. The leaves yield ranged from 35.6 t/ha (control combination-0) to 42.0 t/ha (4 times exposure). The leaves of plants exposed to laser rays were longer and thicker. The highest roots yield were obtained after one times seeds exposure (54.6 t/ha). The beet roots growing from the seeds exposed to laser rays were longer. Seed exposure resulted in dry matter increase by 0.1-0.3 %, sugar content by 0.1-0.2 %, ash by 0.026-0.080 % and decrease in α-amine nitrogen amount by 0.0028-0.0062 %.

K e y w o r d s: sugar beet roots, laser exposure, chemical composition

INTRODUCTION

Pre-sowing laser seed irradiation is one of methods used which has given hope for an increase in the crop yield of the sugar beet without causing detrimental damage to natural environment.

The experiments carried out on grains, vegetables and root plants showed that this type of operation stimulates plant growth and development [1,3-6]. The basis of the stimulation mechanism according to Biełozierskich and Zołotariewa [1] is the synergism between the polarized, monochromatic red laser beam and the phytochrome receptors of the sugar beet root as a result of seed irradiation photoactivation of the phytochromes came about which intensified the development of plant in later phases of growth.

The results of the study show that there exists the possibility of the awakening of the physiologic processes of plants with the utilization of light stimuli. The outcome of such treatment, among others, is an increase in the intensity of photosynthesis of plant pigments, amino acids, nucleic acids, proteins and consequently a rise in the crop yield.

Many experiments carried out by Injuszin [3-6] indirectly confirm the justiness of the hypothesis put forth by Biełozierskich and Zołotariewa [1].

Many authors confirm the rise in germination energy and an equalization of sprouts [2,7,11]. It had also been observed that the laser treatment of the sugar beet seeds influenced them in such a manner as to increase their resistance to disease. It must be underlined that the plants from the laser treated seeds had an average leaf surface 28 to 30 % grater than the control plants [3], the root yield grew 10-15 % [1,5,8,12] and

the sugar content increased by 0.3-1.4 % [4,8-10].

The goal of the study carried out in the years from 1990 tc 1992 was to define the influence of pre-sowing laser irradiation of sugar beet seeds on the biometric characteristics, yield and chemical composition of the sugar beet root.

MATERIALS AND METHODS

The field studies were initiated by the split-plot method in four repetitions which concerned two types of sugar beets (PN Mono 1 and PN Mono 4), a single, double, triple, quadruple seed laser treatment and also control combination (without treatment). The seeds had been treated with the utilization of a helium-neon HNA-188 laser with 140 μW power three days before sowing. The seeds had been treated in free falling time through a divergent beam of laser rays.

The field crop before the sugar beets was wheat. In autumn for the winter tillage 40 t/ha of FYM was used along with a potassium-phosphorous fertilizer (120 kg/ha P_2O_5 and 200 kg/ha K_2O). A nitrogen fertilizer was used in the spring in the amount of 160 kg/ha. Autumn and spring cultivations had been carried out according to the correct rules of agrotechnics.

The sowing of the sugar beet seeds took place on April 10-12, spaced in rows 45 cm apart. The distance between the plants in rows was 25 cm. During the plant vegetation period mechanical nursing operations had been carried out three times.

Before the harvest of 20 plants from each experimental plot biometric measurements had been performed. The leaf and root harvest had been carried out from October 10-20. After the harvest measurements of leaf and root yield along with the yield indices had been taken. During the harvest there had been taken root samples in order to determine the following contents: dry mass, sugar, soluble ash and - amine nitrogen. The content analysis was performed in the laboratories of the Lublin Sugar Factory. The results gained underwent statistical analysis, determining the significant differences utilizing the Tukey test.

The experiment had been initiated on loess soil. The thickness of the arable layer measured 50-60 cm. This type of soil is characterized by good physical properties. The soil has a neutral reaction, and P_2O_5, K_2O and MgO contents are as follows: 22.0, 26.7, and 6.4 per 100 g of soil. Total nitrogen makes up 0.120 % and the humus content was 2.61 %.

The atmospheric conditions during the experimental years were variable. The most favourable weather characterized the vegetation period in 1990; the average temperature of that vegetation period was 12.9 °C and the total rainfall 408.6 mm. In 1991 these values figured as follows: temperature 15.1 °C and total rainfall 332.7 mm. In 1992 the vegetation period temperature averaged 13.6 °C and total rainfall 411.4 mm. During 1992 there had been noted unfavourable atmospheric conditions, due to the fact that during the period of intensive root growth no rainfall was recorded.

RESULTS AND DISCUSSION

The results of the experiment point out that pre-sowing laser seed treatment favourably influenced some of the biometric characteristics of the sugar beet (Table 1). With the exception of the root circumference, whose largest measurement had been noted in the control combination, the remaining characteristics underwent a favourable modification, even after a single laser treatment. The plants with the longest leaves were gained in combination with a double laser treatment. The leaves achieved were longer by 4.5 cm over the sugar beet leaves from the control group. The tallest root grew from the seeds that had been treated 2-4 times, but the longest roots were achieved after 4 laser treatments.

The leaf yield in the combination with laser treated seeds were not less than 6.4 t/ha

Table 1. Some biometric features, yields and chemical composition of sugar beet roots

Specification	Combinations						Varieties		Years			$LSD_{0.05}$ between years
	0	1	2	3	4	5	PN - Mono 1	PN - Mono 4	1990	1991	1992	
Leaves length	58.2	60.1	62.7	66.6	60.7	60.2	61.9	59.3	67.0	63.4	51.3	7.5
Protrusion of root	3.6	3.9	3.4	2.9	3.9	3.2	3.5	3.5	5.2	2.7	2.6	1.0
Root length	21.1	23.0	21.9	22.0	23.4	22.4	22.2	22.4	23.3	18.9	24.6	2.2
Root circumference	29.9	29.3	29.6	29.4	29.8	27.9	29.4	29.3	33.2	28.7	26.1	2.2
Leaves yield	35.6	41.4	41.7	41.8	42.0	41.6	41.0	40.3	59.7	31.6	30.7	13.1
Root yield	50.5	54.6	53.6	54.3	52.6	53.6	53.0	53.4	66.7	47.3	45.5	6.3
Harvest index	0.59	0.57	0.57	0.57	0.57	0.58	0.57	0.58	0.53	0.60	0.59	-
Biological yield of sugar	8.79	9.79	9.52	9.34	9.29	9.32	9.29	9.40	12.49	8.06	7.47	2.0
Dry matter	22.5	22.8	22.6	21.8	22.3	22.6	22.5	22.3	23.8	21.9	21.5	-
Sugar	17.4	17.6	17.5	16.8	17.2	17.5	17.4	17.3	18.5	17.0	16.4	-
Ash	0.406	0.452	0.462	0.486	0.470	0.429	0.443	0.458	0.553	0.379	0.419	-
α-amine nitrogen	0.4028	0.0400	0.0446	0.0412	0.0406	0.0366	0.0402	0.0407	0.0463	0.0339	0.0427	-

higher than in the control group. The meteorologic conditions played an important role in the leaf yield during the vegetation period.

The root yield, similar to the leaf yield, was higher in the combinations in which had been sown the laser treated seeds. The highest root yield had been obtained after a single laser treatment of seeds. The biological sugar yield figured similarly.

Pre-sowing laser treatment of the sugar beet seed also had a favourable influence on the chemical composition of roots. Of the tested chemical root contents only the amount of the soluble ash was found to be decidedly higher (that being unwanted) in the combinations in which had been used laser treatment of the seeds. Triple and quadruple laser treatments unfavourably influenced the sugar content. In the remaining laser treatment, combinations the sugar amount in comparison with the control combination group was somewhat higher.

CONCLUSIONS

1. Pre-sowing laser treatment of sugar beet seeds caused an increase in the leaf length, root length along with an increase in exposure of the root above the soil.

2. In the combinations with the laser treated seeds the leaf yield was more than 6 t/ha greater than the control group.

3. The root and biological sugar yields were the highest after a single laser treatment.

4. Single, double and quadruple laser seed treatments best influence the sugar amount and dry mass.

5. The results achieved point toward the usefulness of pre-sowing laser treatment of the sugar beet seed.

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