Results from studies conducted in Hungary and Bulgaria of the linear parameters of sunflower plants after pre-sowing electromagnetic treatment of the seeds

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Results from studies conducted in Hungary and Bulgaria of the linear parameters of sunflower plants after pre-sowing electromagnetic treatment of the seeds: *In spite of the aridness during the plants vegetation, it has been established that there is an effect from the pre-sowing electromagnetic treatment of seeds of Hungarian sunflower hybrids Nyh-1F1F and Nyh-1F1K and variety KV.*

The pre-sowing electromagnetic treatment of seeds of the Hungarian sunflower hybrids Nyh-1F1F and Nyh-1F1K and the variety KV has affected diversely the linear parameters of the plants that have grown in remote climatic areas.

It has been established that, under identical conditions of pre-sowing electromagnetic treatment applied, the uncontrollable impact factors affecting the development of the plants in different climatic regions have contributed to the resulting various effects of the electromagnetic treatment.

Keywords: *height of the plants, diameter of the stems, diameter of the flower heads.*

The studies in this research have been carried out together with representatives of the College of Nyíregyháza–Hungary under the agreement reached in the course of collaboration on the international project implemented within Framework Program 7: Bio Mob FP7 – REGIONS – 2009 -1 № 245449.

Introduction

After establishing the specific effects of the pre-sowing electromagnetic treatment on Hungarian sunflower seeds, in [1] and [2], the studies have continued with experiments in the field.

The aim of the studies is to determine the effects of the pre-sowing electromagnetic treatment of the seeds of Hungarian sunflower hybrids and variety on the linear parameters of the plants that have grown in remote climatic areas.

Material and method

For the purpose of this research, the experiments described in [1] and [2] continued with the used seeds of the Hungarian variety KV and the hybrids Nyh-1F1F and Nyh-1F1K.

The seeds were subjected to a three-step pre-sowing electromagnetic treatment on 23.03.2012, with the following controllable factors: voltage between the electrodes U, kV, and duration of treatment τ, s.

The values of the controllable factors are given in Table 1.

After having been subjected to pre-sowing treatment in 2012, part of the seeds treated by the options specified in Table 1 were sent to Hungary. For the field studies in Bulgaria the used seeds had been treated by treatment option No. 22 – for the hybrids Nyh-1F1F and Nyh-1F1K, and by treatment option No. 32 – for the variety KV. The studies included also a reference specimen - untreated seeds.

In Bulgaria, the seeds were sown in the field within the usual period of cultivation – on the 09.04.2012, following 17 days of rest. In Hungary, in view of the colder weather, the sowing was done on 23.04.2012, on the 31st day after the treatment.

During vegetation, measurements were made of the reached height of plants, the diameter of the stem at the middle, and the diameter of the resultant flower head.

Table 1..

Plan of the experiment in 2012 for pre-sowing electromagnetic treatment of Hungarian sunflower seeds of the hybrids Nyh-1F1F and Nyh-1F1K, and the variety KV

Treatment Option	Factor level		Processing Steps					
	x_1^o	x_2^o	I		II		III	
			U_1, kV	τ_1, s	U_2, kV	τ_2, s	U_3, kV	τ_3, s
For seeds of the hybrids Ny1F1F and Ny1FK								
21	+1	+1	8	10	6,5	20	5	50
22	-1	+1	4	10	2,5	20	2	50
23	+1	-1	8	5	6,5	15	5	25
24	-1	-1	4	5	2,5	15	2	25
25	Reference specimen (untreated seeds)							
Seeds of the variety KV								
31	+1	+1	8	5	6,5	15	5	25
32	-1	+1	5	5	4	15	1,5	25
33	+1	-1	8	4	6,5	4	5	35
34	-1	-1	5	4	4	4	1,5	35
35	Reference specimen (untreated seeds)							

Table 2 presents data about the average air temperatures and the rainfall over the experimental field of the Research Institute of Nyíregyháza, and the respective values in Rousse where the seeds were sown in the surroundings of the town.

Table 2.

Average temperatures and rainfall in Nyíregyháza and in Rousse in 2012

Month	4	5	6	7	8	9
In Hungary						
Average temperature, °C	12	17	21	23	23	18,3
Average rainfall, mm	36,6	116,0	55,8	65,8	9,4	25,2
In Bulgaria						
Average temperature,°C	21,9	23,8	26,6	28,3	25,7	22,7
Average rainfall, mm	160,2	134,6	14,5	5,5	4,1	16,5

From Table 2 it can be concluded that in Hungary until July the rainfall (though insufficient) was more uniformly distributed during the different months. In Bulgaria, in June, July and August, it was quite symbolic. Moreover, the daily temperatures in July and August, through the majority of the days, reached 43^0C. The described conditions are an account of an abnormal ambient environment, in which the sunflower plants developed.

Results from the studies

The data from the studies of the linear parameters of sunflower plants of the hybrids Nyh-1F1F and Nyh-1F1K are given in Table 3.

Table 3.

Data from the studies conducted in Hungary and in Bulgaria, in 2012, of the linear parameters of sunflower plants of the hybrids Nyh-1F1F and Nyh-1F1K

	Sunflower hybrid Nyh-1F1F, grown in Hungary											
Treat-ment option	Height of plant, H_p				Diameter of the stem, d_{st}				Diameter of the flower head d_{flower}			
	cm	%/к	S^2	V, %	mm	%/к	S^2	V, %	cm	%/к	S^2	V, %
21	152,2	100,8	431	13,64	24,94	122,9	33,8	23,29	19,1	104,9	4,32	10,88
22	153,1	101,4	491	14,47	27,92	137,6	112,9	195,2	18,7	102,7	37,12	144,4
23	149,2	98,8	398	13,38	28,67	146,3	16,0	69,1	20,6	113,2	8,49	14,14
24	161,8	107,2	596	15,09	22,26	109,7	38,8	28,0	18,7	102,7	19,79	23,79
25 к	151,0	100,0	848	19,29	20,29	100,0	15,6	19,50	18,2	100,0	16,84	22,55
	Sunflower hybrid Nyh-1F1F, grown in Bulgaria											
22	164,3	106,0	137	60,51	15,0	108,7	5,0	14,9	12,1	109,7	520	18,9
к	155	100,0	322	11,58	13,8	100	6,7	18,8	11,0	100,0	250	14,4
	Sunflower hybrid Nyh-1F1K, grown in Hungary											
21	190,7	103,1	133	6,1	26,1	95,6	13,6	14,14	18,2	83,5	7,51	15,05
22	201,2	108,8	86	6,9	23,6	86,7	8,4	12,2	20,0	91,7	1,56	6,23
23	183,4	99,2	192	7,86	26,2	96,1	32,7	21,8	21,3	97,7	8,20	13,5
24	175,6	94,9	490	12,6	23,9	87,7	11,6	14,2	21,9	100,5	2,56	7,28
25	184,9	100,0	225	8,12	27,2	100,0	8,9	10,9	21,8	100,0	7,96	12,94
	Sunflower hybrid Nyh-1F1K, grown in Bulgaria											
22	162,2	94,11	509,0	13,9	15,6	114,1	1,8	8,6	101	111,2	117,5	10,7
к	172,4	100,0	495,0	12,9	13,7	100,0	20,2	32,9	90,8	100,0	1654	44,8

From Table 3 it can be concluded that the same type of treatment applied to the seeds of two related hybrids, Nyh-1F1F and Nyh-1F1K, whose plants are grown in Hungary, has had a different impact on the monitored parameters. For example, for the treatment options № 21 ... № 23 of the hybrid Nyh-1F1F seeds, it can be noted that the height of the plant is practically the same as that of the reference specimen. The conclusion can be made that, under all seed treatment options, the resulting stems have a larger diameter. This is a favourable observation, since the diameter of the flower heads of the said hybrid is larger and marks an increase of 13.2% in treatment option № 23.

After treatment of the seeds by option № 24, all monitored parameters of the plants have reached higher values as compared to the reference specimen – e.g. the height of the plant H_p is higher by 7.2%, the diameter of the stem d_{st} - by 9.7%, and the diameter of the flower head d_{fh} – by 2.7%.

For the hybrid Nyh-1F1F grown in Bulgaria, whose seeds are treated by option No. 22, an increase in the height of plants by 6.0% has been registered. The greater height of 164,3 cm, as compared to that measured in Hungary (153,1 cm for treatment option No. 22) can be attributed to the fact that in April and May of 2012 the rainfall in Bulgaria was significantly higher: (160.2 and 134,6) mm/m^2, while in Hungary these values were (36.6 and 116) mm/m^2, respectively. The above can be confirmed by the achieved height of plants of the reference specimen, which in Hungary is 151 cm, while in Bulgaria - 155 cm, i.e. a higher value.

In Hungary, the diameter of the stem for the resulting plant of hybrid Nyh-1F1F after treatment by option № 22 is 37.6% larger than that of the reference specimen, while in Bulgaria this difference is only 8.7%. The diameter of the flower head is larger than that of the reference specimen by 2.7% in Hungary and by 9.7 % in Bulgaria. These differences can be explained by the different composition of the soil and the different intensities of the electric and magnetic components of the Earth's electromagnetic field on the territory of Nyíregyháza and Rousse.

The data for hybrid Nyh-1F1K show that the pre-sowing treatment has had a suppressing effect on the diameters of the stem and the flower head. In Hungary, under all

treatment options, the diameters are smaller compared to the reference specimen – e.g. for option № 22 they are, respectively, 86.7% and 91.7% of the reference specimen. In Bulgaria, the diameters of the stem and of the flower head are larger than the reference specimen by 14.1% and 11.2%, respectively. Under identical conditions of the pre-sowing electromagnetic treatment that can be explained by the above-mentioned uncontrollable factors - soil and Earth's electromagnetic field.

Contrary to the findings for the hybrid Nyh-1F1F, the average heights of the reference plants of hybrid Nyh-1F1K in Hungary are higher (184,9 cm) than those obtained in Bulgaria (172,4 cm). This can be attributed to the specific generic qualities of both hybrids, and their adaptability to different soils and climatic factors.

The results from studies of the linear parameters of sunflower pants of the variety KV are shown graphically in Figure 1.

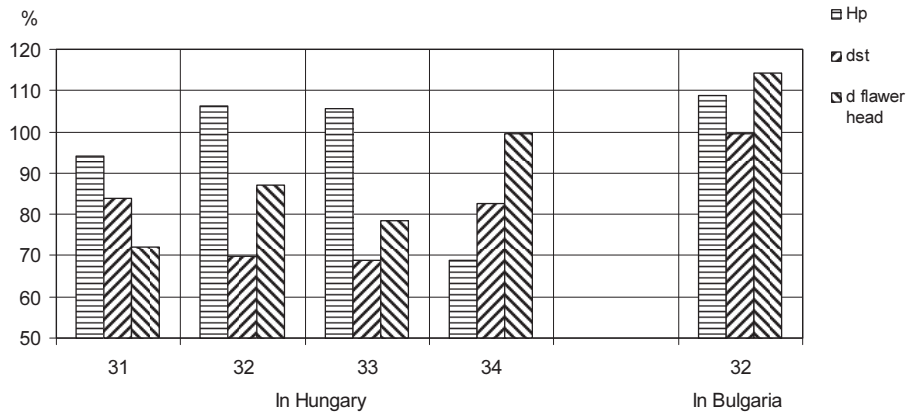

Fig.1. Results from studies of the linear parameters of sunflower plants of the variety KV

From Fig. 1 it can be concluded, that the pre-sowing electromagnetic treatment at higher value of the voltage in the first step, U_1=8kV, and duration of impact τ_1=5s (option № 31 – i.e, higher quantity of added initial energy), and option № 34 with a lower initial value of voltage (U1=5kV and τ_1=4s – i.e. less added initial energy) have resulted in lower values of the monitored linear parameters of the plants. For treatment option № 31, the height of the plants is 94% from the height of the reference specimen, the stem diameter - 83,9%, and the diameter of the flower head – 72,6%. For treatment option № 34 the values are, respectively, 68,7%, 82,6% and 99,4%.

For the option № 32, the average diameter of the stems in Hungary is 106.1% compared to the reference specimen. It is worth noting that in Bulgaria, the stems of the plants of variety KV are 108.2% compared to the reference specimen – i.e. it can be assumed that they are equal. The flower head that has formed in Bulgaria has a larger diameter - 114.3% of the reference specimen, while in Hungary it is only 87.1% of the reference specimen (option № 32). The diameters of the stems for option № 32 in Hungary and in Bulgaria are also different - 69.8% and 99.4% of the reference specimen respectively.

From the foregoing the conclusion can be made that the same parameters of pre-sowing electromagnetic treatment have a role in obtaining diverse effects in areas of different climatic and soil conditions.

As the selected values of controllable impact factors meet the requirements for full factorial experiment (FFE1 for the hybrids Nyh-1F1F and Nyh-1F1K, and FFE2 for the

variety KV), below are given the estimated regression equations. Their initial data are the values correlated as a percentage of the reference specimen.

- for the hybrid Nyh-1F1F:

- for the heights of plants, H_p $$\hat{Y} = 102,1 - 9,0\overset{\circ}{x}_1 - 3,8\overset{\circ}{x}_2 + 7,8\overset{\circ}{x}_1\overset{\circ}{x}_2 \quad (1)$$

- for the diameter of the stem d_{st} $$\hat{Y} = 129,1 + 21,9\overset{\circ}{x}_1 + 4,5\overset{\circ}{x}_2 - 51,3\overset{\circ}{x}_1\overset{\circ}{x}_2 \quad (2)$$

- for the diameter of the flower head d_{flower} $$\hat{Y} = 105,9 + 12,7\overset{\circ}{x}_1 - 8,3\overset{\circ}{x}_2 - 8,3\overset{\circ}{x}_1\overset{\circ}{x}_2 \quad (3)$$

- for the hybrid Nyh-1F1K:

- for the heights of plants, H_p $$\hat{Y} = 101,5 - 1,4\overset{\circ}{x}_1 - 17,8\overset{\circ}{x}_2 - 9,3\overset{\circ}{x}_1\overset{\circ}{x}_2 \quad (4)$$

- for the diameter of the stem d_{st} $$\hat{Y} = 91,5 + 17,3\overset{\circ}{x}_1 - 1,5\overset{\circ}{x}_2 + 0,5\overset{\circ}{x}_1\overset{\circ}{x}_2 \quad (5)$$

- for the diameter of the flower head d_{flower} $$\hat{Y} = 93,4 - 10,6\overset{\circ}{x}_1 - 23,0\overset{\circ}{x}_2 - 5,4\overset{\circ}{x}_1\overset{\circ}{x}_2 \quad (6)$$

- for the variety KV:

- for the heights of plants, Hp $$\hat{Y} = 93,6 + 24,7\overset{\circ}{x}_1 + 25,9\overset{\circ}{x}_2 - 48,9\overset{\circ}{x}_1\overset{\circ}{x}_2 \quad (7)$$

- for the diameter of the stem d_{st} $$\hat{Y} = 76,32 + 0,4\overset{\circ}{x}_1 + 2,2\overset{\circ}{x}_2 + 27,8\overset{\circ}{x}_1\overset{\circ}{x}_2 \quad (8)$$

- for the diameter of the flower head d_{flower} $$\hat{Y} = 84,4 - 35,3\overset{\circ}{x}_1 - 18,3\overset{\circ}{x}_2 + 6,3\overset{\circ}{x}_1\overset{\circ}{x}_2 \quad (9)$$

The plus signs in front of the coded factors $\overset{\circ}{x}_1$ and $\overset{\circ}{x}_2$ in equations (1) ... (9) indicate that the increase of the value of the controlled factor will lead to an increase in the respective optimization parameter. The minus signs indicate that the increase in the value of this factor will lead to suppression of the optimization parameter. In some of the equations the factor value in front of the first-order interaction $\overset{\circ}{x}_1\overset{\circ}{x}_2$ is great and with a negative sign at that.

The above description of the derived equations should be taken into consideration for further optimizations of the process of pre-sowing electromagnetic treatment of sunflower seeds.

Conclusions:

1. In spite of the aridness during the plants vegetation, it has been established that there is an effect from the pre-sowing electromagnetic treatment of seeds of the Hungarian sunflower hybrids Nyh-1F1F and Nyh-1F1K and variety KV.
2. The pre-sowing electromagnetic treatment of seeds of the Hungarian sunflower hybrids Nyh-1F1F and Nyh-1F1K and the variety KV has affected diversely the linear parameters of the plants that have grown in remote climatic areas.
3. It has been established that, under identical conditions of pre-sowing electromagnetic treatment applied, the uncontrollable impact factors affecting the development of the plants in different climatic regions have contributed to the resulting various effects of the electromagnetic treatment.

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