Results from the studies of the yield parameters of Hungarian sunflower after pre-sowing electromagnetic treatment of the seeds

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Results from the studies of the yield parameters of Hungarian sunflower after pre-sowing electromagnetic treatment of the seeds: *It has been established that the pre-sowing electromagnetic treatment effected with the selected values of the controllable factors stimulates an increase in the length of achene of the hybrid Nyh-1F1F. The resulting sunflower achene is of smaller thickness for both hybrids Nyh-1F1F and Nyh-1F1K; the linear dimensions of the achene (length, breadth and thickness) are suppressed for the variety KV; the growth of the kernel of the achene is stimulated within the range of (6,4…12,9)%, also for the variety KV.*

After the three-step pre-sowing electromagnetic treatment of the seeds of sunflower hybrids and varieties, the following effects have been established: an increase in the yield of the variety KV by nearly 42% as compared to the reference specimen, under treatment with initial values of the controllable factors: voltage U_1= 8κV and duration of treatment τ_1=4s; an increase in the yield of the hybrid Nyh-1F1K by 27% as compared to the reference specimen, under treatment with initial values of the controllable factors: voltage U_1= 8κV and duration of treatment τ_1=10s.

It has been established that the harvested crop in Hungary and in Bulgaria, after pre-sowing electromagnetic treatment of the seeds, has lower relative moisture content as compared to the reference specimen – for the variety KV, for example, it is 89,9%/R.

Key words: Hungarian sunflower hybrids and varieties, linear dimensions and relative moisture content of the achene

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

Increasing the yields of different cultivars is a concern for every society. Following a number of studies carried out in the laboratory and in open field conditions [1,2,3], the experiments have been continued with studies of the yield parameters of Hungarian sunflower plants whose seeds have been treated in an electromagnetic field before sowing.

The aim of these studies is to determine the yield obtained after electromagnetic treatment of the seeds and its interrelation with the linear parameters achieved under field conditions.

Material and method

For the purpose of this research, seeds of the Hungarian sunflower hybrids Nyh-1F1F and Nyh-1F1K, and of the variety KV have been used.

The seeds were subjected to a three-step pre-sowing electromagnetic treatment in the town of Rousse, Bulgaria, 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.

The seed treated as specified in Table 1. were sent to Hungary, and in Bulgaria experiments were carried out in the open field using: treatment option No. 22 – for the hybrids Nyh-1F1F and Nyh-1F1K, and 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 open 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.

After the crop was collected from the field, the sunflower achene parameters were examined (length L, breadth B, width D - expressed in mm, and kern of achene, expressed

in %), 1000-achene weight (g), yield (kg/ha) and relative moisture content of the achene W,%. Prior to performing the analysis, all results were expressed as a percentage of the reference specimen (%/R).

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)							
For 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)							

From the data given in [3] it can be concluded that both in Hungary and in Bulgaria the sunflower plants had developed in arid conditions.

Results from the studies

The data from the studies performed in Hungary of the linear parameters of achenes obtained from the hybrids Nyh-1F1F and Nyh-1F1K are given in Table 2.

Table 2.

Data from the studies of the linear parameters of achenes obtained from the Hungarian sunflower hybrids Nyh-1F1F and Nyh-1F1K after pre-sowing electromagnetic treatment of the seeds in 2012

№	L length		B breadth		D thickness		Kernel of the achene	
	mm	%/R	mm	%/R	mm	%/R	%	%/R
	Hybrid Nyh-1F1F							
21	17,04	110,6	7,63	108,2	4,27	93,8	60,75	102,0
22	15,97	103,6	6,80	96,5	4,17	91,6	51,35	86,2
23	15,96	103,6	6,87	97,4	4,17	91,6	42,24	79,9
24	16,33	105,9	6,64	94,2	3,8	83,5	54,7	90,8
25 Reference specimen	15,41	100,0	7,05	100,0	4,55	100,0	59,55	100,0
	Hybrid Nyh-1F1K							
21	17,88	100,7	6,57	95,2	3,94	95,7	65,74	87,2
22	17,54	98,8	6,42	93,0	3,07	90,0	67,96	104,4
23	17,97	101,2	6,9	100,0	4,3	98,0	52,86	81,2
24	17,85	100,5	7,13	103,3	4,39	106,8	59,63	91,6
25 Reference specimen	17,76	100,0	6,9	100,0	4,11	100,0	65,8	100,0
	Variety KV							
31	16,39	94,3	7,55	95,2	4,23	92,9	60,02	110,6
32	16,35	94,10	7,81	98,5	4,44	97,6	61,29	112,9

33	16,14	92,9	7,94	100,1	4,46	98,0	57,73	106,4
34	17,54	100,9	8,42	106,2	4,7	103,3	58,04	106,9
35 Reference specimen	17,38	100,0	7,93	100,0	4,55	100,0	54,25	100,0

A conclusion can be made from Table 2 that after every treatment option the resulting achene of hybrid Nyh-1F1F is elongated. Its length is (3,6…10,6)% greater than that of the reference specimen. The measured thickness of the individual achenes is, however, smaller than that of the reference specimen, and falls within the limits of (83,%...93,8)%/R. For treatment options № 22…№ 24 the kernel of the achene is also smaller than the reference and is in the range of (79,9…90,8)%. For treatment option № 21 (with high values of the initial voltage U_1= 8kV and of the duration of treatment τ_1=10s) the achene has by 8,2% greater breadth. The kernel is also larger but only by 2,0% as compared to the reference specimen.

With a few exceptions, the achene of the hybrid Nyh-1F1K obtained after pre-sowing treatment of the seeds has lower linear dimensions that those of the reference specimen. Except for option № 22, where the kernel is by 4,4% greater in size, for the other treatment options it is smaller and falls into the range of (81,2…91,6)%/R. In [3], a conclusion is also made that the selected values of the controllable factors – voltage and duration of treatment – suppress the linear parameters of the plant and the diameter of the flower head. Thus, for hybrid Nyh-1F1K they are smaller than those measured in the reference specimen, and are in the range of (83,5…97,7)%/R. Hence, it can be noted that there is a correlation between the effect of treatment during development and the fruitage of the sunflower plants.

For the variety KV, except for option № 34 (with low values of the initial voltage U_1=5kV and of the initial duration of treatment τ_1=4s), the resulting achenes are smaller in length, breadth and thickness as it can be seen in Fig.1, which shows the parameters in %/R.

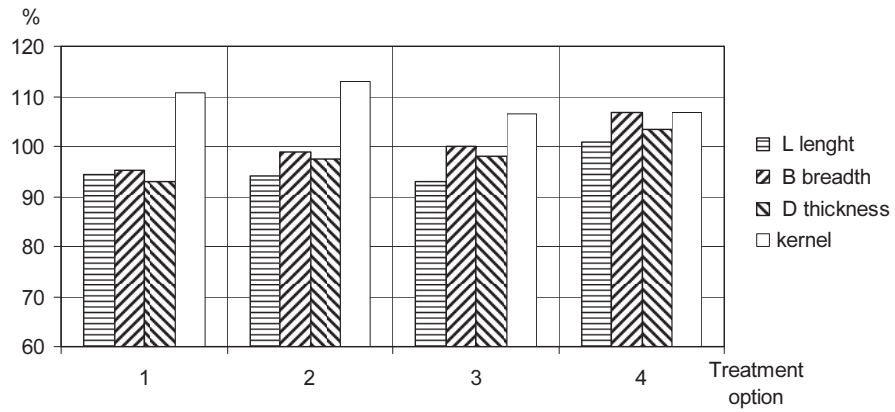

Fig.1. Linear parameters of the sunflower achenes obtained after pre-sowing electromagnetic treatment of the seeds of variety KV

From Fig.1 it can be concluded that, following the pre-sowing electromagnetic treatment of the variety KV by all treatment options, the achene has a kernel larger than that of the reference specimen, in the range of (6,4…12,9)%. This is one reason to assume that the obtained yield (kg/ha) may be expected to be higher.

The studies of the yield in Hungary include: 1000-achene weight (g), the obtained yield expressed in kg/ha, and relative moisture content of the achene in %.

The data about the 1000-achene weight (in g and in %/R) of both hybrids: Nyh-1F1F and Nyh-1F1K, and of the variety KV, are shown in Table 3.

Table 3.

Data about the 1000-achene weight of the hybrids Nyh-1F1F and Nyh-1F1K, and of the variety KV

Treatment Option	Hybrids				Treatment Option	Variety	
	Nyh-1F1F		Nyh-1F1K			KV	
	g	%/R	g	%/R		g	%/R
21	149,0	105,0	136,0	90,2	31	177,0	96,2
22	130,0	92,2	153,0	100,0	32	164,0	89,1
23	146,0	103,5	153,0	100,0	32	171,0	92,9
24	126,0	89,4	167,0	109,2	34	191,0	103,8
25 (K)	141,0	100,0	153,0	100,0	35 (K)	184,0	100,0

The data in Table 3 show that, as a rule, the resultant achene from treatment option № 24 for hybrid Nyh-1F1K and from option № 34 for variety KV has a greater 1000-achene weight as compared to that of the reference specimen, by 9,2% and 3,8%, respectively. An increase in the 1000-achene weight is observed also with treatment options № 21 and № 23, applied to the seeds of the hybrid Nyh-1F1F – treatment under these options was done at higher values of the initial voltage U_1= 8kV. The observed increase in the 1000-achene weight is by 5,0% and 3,5%, respectively.

The foregoing is a description of a specific reaction of the seeds of each of the sunflower hybrids and variety to the treatment in an electromagnetic field.

In Bulgaria, examinations were made of the weight of the flower head without the achenes, and the weight of the achenes in one flower head. In Table 4, these data are given (in g and in %/R) for treatment option № 22 applied to hybrids Nyh-1F1F and Nyh-1F1K, and for treatment option № 32 applied to variety KV.

Table 4..

Results from the studies conducted in Bulgaria of: weight of the flower head with the achenes; weight of the flower head without the achenes; achene weight in one flower head

Treatment Option	Sunflower type	Weight of						Relative moisture content	
		Flower head with achenes		Flower head		Achenes			
		g	%/R	g	%/R	g	%/R	%	%/R
22	Nyh-1F1F	282,2	159,7	191,2	166,6	95,6	150,3	12,64	91,3
25 Reference specimen	Nyh-1F1F	176,7	100,0	114,8	100,0	63,6	100,0	13,8	100,0
22	Nyh-1F1K	132,2	127,5	70,4	184,9	65,6	93,9	7,94	146,8
25 Reference specimen	Nyh-1F1K	107,9	100,0	38,1	100,0	69,8	100,0	5,41	100,0
32	KV	214,5	89,6	106,9	73,3	106,9	115,0	12,74	85,37
35 Reference specimen	KV	239,5	100,0	145,8	100,0	92,9	100,0	14,93	100,0

For the hybrid Nyh-1F1F and the variety KV, the quantity of achenes obtained in Bulgaria is larger than the quantity of the reference specimen by 50,3%/R and 15%/R respectively. The studies [3] of the linear parameters of the plants of these hybrids and variety also show a larger diameter of the flower head and thicker stems of the plants, i.e. interrelation exists between the linear parameters of the plants and the achene yield.

Under the same treatment conditions, with option № 22, the obtained quantity of achene from hybrid Nyh-1F1K is only 93,9%/R. This correlates with the obtained results for a smaller diameter of the plant and of the flower head for this hybrid, as specified in [3].

Table 5 presents data about the obtained achene yield and the moisture content of the achenes produced in Hungary from hybrids Nyh-1F1F and Nyh-1F1K, and the moisture content of the achenes produced in Bulgaria. All data are given in %/R.

Table 5.

Data about the obtained achene yield and the moisture content of the achenes produced in Hungary, and the moisture content of the achenes in Bulgaria

Treatment Option	Yield in Hungary		Achene moisture content in Hungary		Achene moisture content in Bulgaria	
	Kg/ha	%/R	%	%/R	%	%/R
Nyh-1F1F						
21	2257	98,2	12,5	100,8		
22	1315	57,2	11,6	93,5	12,6	91,3
23	1749	76,1	12,3	99,2		
24	2226	96,9	12,4	100,0		
25 Reference specimen	2298	100,0	12,4	100,0	13,8	100,0
Nyh-1F1K						
21	4927	127,3	11,2	96,6		
22	4337	112,0	11,4	98,3	7,4	146,8
23	4451	114,9	11,4	98,3		
24	4078	105,4	11,2	96,6		
25 Reference specimen	3871	100,0	11,6	100,0	5,4	100,0

The yield received from the reference specimen of hybrid Nyh-1F1F (2298kg/ha) is assumed to be 100%, whereupon a conclusion can be made from Table 5 that this factor is suppressed by the pre-sowing electromagnetic treatment of the seeds. The resulting yield is in the range of (57.2 ... 98.2)%/R. The relative moisture content of the achene is up to 12.5%. For treatment option № 22, the achenes produced in Bulgaria have relative moisture content W = 11,6%, which is 93.5%/R, i.e. the achene has completed its ripening cycle earlier than the reference specimen.

Under the same treatment parameters applied to the seeds of hybrid Nyh-1F1K, the achene yield is significantly higher compared to the yield of 3871,6 kg/ha of the reference specimen. The highest yield of 127.3%/R has been obtained with treatment option № 21, i.e. at the maximum initial values of controllable factors (U1 = 8kV and и τ_1 = 10s). With the lowest values of the controllable factors, U1 = 4kV and τ_1 = 5s, (option № 24), respectively with the least quantity of energy imparted to the seeds, the effected stimulation is of the weakest extent and the resulting yield is only 5.4% higher than that of the reference specimen.

From the information given above and in [3], the conclusion can be made that there is no interrelation (correlation) between the resulting linear parameters of the studied hybrids and the yield obtained from them. For example, for all treatment options applied to the hybrid Nyh-1F1F, the linear parameters of the plants are greater as compared to those of the reference specimen, while the yield is lower. On the contrary, for the hybrid Nyh-1F1K, where significantly lower linear parameters of the plants have been achieved, the obtained achene yield is 200kg/ha (5.4%/R) more for treatment option № 24, and 1055,9 kg/ha more for treatment option No. 21, in other words the resulting yield per hectare was 27.3% higher.

Figure 2 shows the results of a study of the yield (%/R) of sunflower variety KV and the achieved relative moisture content of the achene W%/R

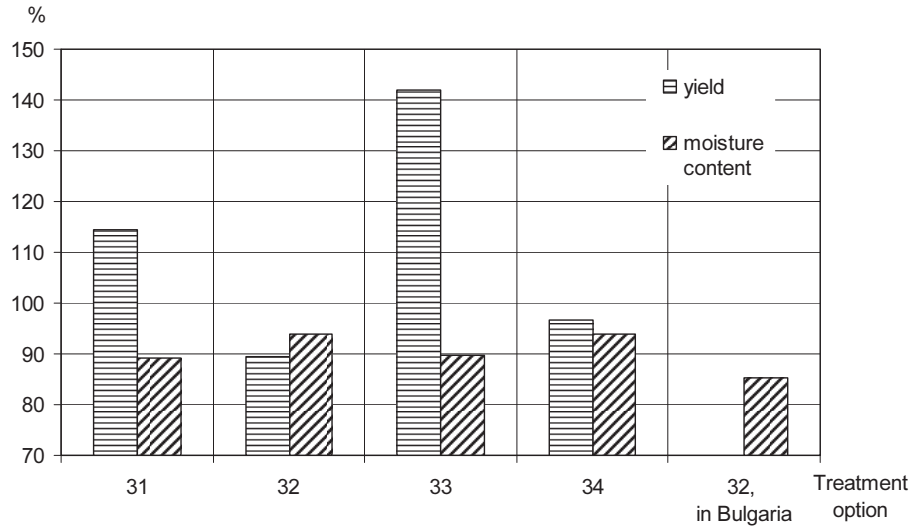

Fig.2. Results from the studies in Hungary of the yield (%/R) of sunflower variety KV and the achieved relative moisture content of the achene W%/R in Hungary and in Bulgaria

The achene yield of the reference specimen of the variety KV, established in Hungary, is 2939,9 kg/ha which is assumed to be 100%. The resulting yield from treatment option № 33 (at U1 = 8kV and τ_1= 4s) is 4171,8 kg/ha, i.e. 1231,9 kg/ha more, which stands for 41.9% increase. Similar is the situation with treatment option № 31 (at U1 = 8kV and τ_1= 5s). Its results show an increase in the yield of 14.4%/ R. In option № 32, at U_1= 5кV and τ_1=5s, and option № 34, at U_1= 5кV and τ_1=4s, a smaller quantity of energy is imparted to the seeds. For these options the achieved yield is lower as compared to the reference specimen, 89.4%/R and 96.8%/R, respectively.

In [3] it is established that for treatment option № 33 where the highest yield has been obtained, the values of the height and diameter of the plant and of the diameter of the flower head, expressed in %/R, are 105.5%/R, 68.9%/R and 78.9%/R respectively. It points to the fact that for this variety grown in Hungary there is no full correlation between the achieved linear parameters and the produced achene yield. This fact suggests that under the weather conditions in Nyíregyháza-Hungary, the energy added to the seed during the pre-sowing treatment is "used" by the plant during its fruitage.

Conclusions:

1. It has been established that the pre-sowing electromagnetic treatment with the selected values of the controllable factors:

а) stimulates the growth of the achene in length, for the hybrid Nyh-1F1F. The resulting sunflower achene has lower thickness, for both hybrids Nyh-1F1F and Nyh-1F1K

б) suppresses the achene linear dimensions (length, breadth, thickness), for the variety KV

в) stimulates the growth of the kernel of the achene by (6,4…12,9)%, for the variety KV

2. After the pre-sowing electromagnetic treatment of the seeds of the sunflower hybrids Nyh-1F1F and Nyh-1F1K, and the variety KV:

а) an interrelation is established between the monitored linear parameters and the quantity of achene yield from plants grown in Bulgaria

б) no interrelation has been established between the monitored linear parameters and the quantity of achene yield from plants grown in Hungary

3. It has been established that the three-step pre-sowing electromagnetic treatment of the seeds of the sunflower hybrids and variety results in:

а) increase in the yield of the variety KV by nearly 42% as compared to the reference specimen after treatment with the following initial values of controllable factors: voltage U_1= 8κV and duration of treatmentτ_1=4s;

б) increase in the yield of the hybrid Nyh-1F1K by 27% as compared to the reference specimen after treatment with the following initial values of controllable factors: voltage U_1=8κV and duration of treatmentτ_1=10s

4. For the studied hybrids Nyh-1F1F and Nyh-1F1K, and the variety KV, it has been established that, after pre-sowing electromagnetic treatment of the seeds, the harvested achene yields in Hungary and in Bulgaria have lower relative moisture content than that of the reference specimen – for example, for the variety KV it is 89,9%/R.

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Докладът е рецензиран.