THE EFFICIENCY OF NATURAL BIOREGULATORS IN THE SELECTION OF VALUABLE TOMATO GENOTYPES

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Abstract. This work presents the data on five tomato genotypes and describes a procedure that includes presowing seed treatment, sowing and extraradicular treatment of seedling transplants with an aqueous solution of the steroid glycoside 3-O-{[β-D-glucopyranosil (1→4)]-[β-D-glucopyranosil (1→3)]-β-D-galactopyranoside}-(25R)-5α-furostan-3β,22α,26-triol-[26-O-β-D-glucopyranoside], isolated from *Hyosciamus niger* L., at concentrations of 0.001%, 0.005%, and 0.01% at the 3-4 leaf stage followed by treatment of inflorescences of the first, second, and third raceme with the same concentrations. The product of plant origin has demonstrated a stimulating action on seed germination rate and root length. The employment of the steroid glycoside under study has allowed an increase of the flower and fruit number on the first three clusters and, hence fruit productivity and quality. The concentration of 0.005% has proved to be the most efficient for all the samples studied. The experimental findings have confirmed that the steroid product of natural origin Hyosciamoside F has a positive effect on both reproductive processes and fruit productivity and quality resulting in acceleration of tomato growth and development and increase of total (up to 20.7%) and market (up to 35.7%) productivity.

Keywords: tomatoes, steroid glycosides, productivity, quality.

Rezumat. Eficienţa bioregulatorilor naturali în selecţia genotipurilor valoroase de tomate. În lucrare sunt prezentate date despre cinci genotipuri de tomate şi este descrisă tehnica care include tratamentul presemănare al seminţelor, semănatul şi tratamentul extraradicular al răsadului transplantat într-o soluţie apoasă de steroid glicosid 3-O-{[β-D-glucopyranosil (1→4)] - [β-D-glucopyranosil (1→3)] - β-D-galactopyranoside} - (25R) -5α-furostan-3β, 22α, 26-triol - [26-O-β-D-glucopyranoside], izolat din *Hyosciamus niger* L., la concentraţiile de 0,001%, 0,005% şi 0,01% în stadiul de 3-4 frunze, urmat de tratamentul inflorescenţelor din primele trei raceme cu soluţii la aceleaşi concentraţii. Analiza valorilor producţiei, faţă de Control, a demonstrat o acţiune stimulatoare asupra ratei germinaţiei seminţelor şi pentru lungimea rădăcinii. Utilizarea acestui steroid glicosid a permis o creştere a numărului de flori şi fructe pe primele trei inflorescenţe şi astfel şi productivitatea şi calitatea fructelor. Concentraţia de 0,005% a indus cele mai eficiente efecte la toate genotipurile studiate. Constatările experimentale au confirmat faptul că produsul de natură steroidă Hyosciamoside F manifestă un efect pozitiv atât asupra proceselor reproductive, cât şi asupra productivităţii şi calităţii, concretizate prin accelerarea creşterii şi dezvoltării tomatelor (o creştere de până la 20,7%), cât şi asupra productivităţii (până la 35,7%).

Cuvinte cheie: tomate, steroid glycoside, productivitate, calitate.

INTRODUCTION

The current important and basic problem of biology, modern agriculture and medicine consists in fundamental provision with increased and stable production of plant products in unstable, sometimes infavorable, environmental conditions. Steroid glycosides possess saponin properties, which make them extremely important for these areas of applied activity. Friendly steroid bioregulators are naturally-occuring compounds isolated from different crop plant organs (seeds, fruits, underground organs). Incontestable results have been currently obtained to show that steroid glycosides represent a new class of natural bioregulators with a diverse action range and high application prospects for agriculture. The majority of investigations have shown that steriod glycosides possess a high activity in various biological processes (seed germination, stimulation of plant growth and development, enhancement of plant resistance to ecologic stress factors, yield increase) etc. The presowing treatment of tomato seeds with a solution of succinic acid (prototype) (CHINTEA et al., 1987) is known to have a slight effect and has no influence on plant growth, fruit productivity and market quality. The presowing seed treatment with a solution of capsicoside 3-O-{[β-D-glucopyranosil (1→2)]-[β-D-glucopyranosil (1→3)]-β-D-glucopyranosil (1→4)-β-D-galactopyranosil (1→3)-β-D-glucopyranoside}-(25R)-5α-furostan, 2α,3β,22α,26-tetraol-26-O-β-D-glucopyranoside (Moldstim - a structural analog) contributes to increase of germination, seed germination rate, initial growth vigor and yields per ha [LUPAŞCU & KINTYA, 1997]. However, the stimulating action of the compound is slightly efficient. Noteworthy, there is information that shows a positive action of glycosides of plant origin on pollen fertility and viability in tomato F_1 hybrids. The action of Hyosciamoside F on tomato seed rate and germination has been studied for the first time.

The aim of this work is to study the influence of steroid glycosides of plant origin on germination and germination rate of tomato seeds, seedling growth and development, as well as to extend means assortment that improves tomato productivity and fruit quality [POPA et al., 1981; CHINTEA, 1997].

MATERIAL AND METHODS

Three tomato lines - 43PiNt; 44PiFc, and 46VcLpr, developed from crossing of the species *Lycopersicon esculentum* MILL. x *Lycopersicon peruvianum* L., *L. esculentum* MILL. *x L. esculentum* MILL. and two crop varieties Timpuriu-83 and Fachel served as experiment objects. A hundred of seeds of each genotype used in three replicates were soaked for 24 hours in an aqueous solution of the steroid glycoside 3-O-{[β-D-glucopyranosil (1→4)]-[β-D-glucopyranosil (1→3)]-β-D-galacto-pyranoside}-(25R)-5α-furostan-3β,22α,26-triol-[26-O-β-D-lucopyranoside], tentatively named Hyosciamoside F*,* isolated from *Hyosciamus niger L.* seeds, at concentrations of 0.001%, 0.005, and 0.01% and afterwards sown in a greenhouse. The seedling transplants were treated with a solution of the same glycoside at the 3-4 leaf stage, afterwards the flowers of the first, second, and third inflorescence of plants were sprayed with a Hyosciamoside F solution at a concentration of 0.005% (the first three inflorescences).

Likewise, the seeds of the tomato lines of the *Lycopersicon esculentum* MILL. genotypes were soaked in distilled water (witness), in a solution of succinic acid at 0.005% (prototype) and in a solution of Moldstim at 0.08% (structural analog). After soaking, the seeds were removed from the solutions, dried and sown in a greenhouse to grow seedling transplants. The surface of each parcel was 1 m^2 and the experiments were replicated three times for each treatment. The seedling transplants were sprayed at the 3-4 leaf stage with a solution of Hyosciamoside F at each concentration until the leaves were wet (0.5 L/m^2). To obtain the comparative data, the seedling transplants were treated with distilled water (witness), succinic acid solution (0.005%) (prototype) and Moldstim solution (0.08%) (a structural analog). The phenological investigation was carried out starting with seed germination, record of germination rate, growth and development of plants at early vegetative stages.

RESULTS AND DISCUSSIONS

The results of the investigation carried out have demonstrated that the presowing seed treatment with Hyosciamoside F increases seed germination rate by 2.0%-5.8% in comparison with the witness, germination by 3.4%-4.7%, root length by 7.5%-51.1%, while the treatment of seedling transplants accelerates the appearance of phenological developmental stages of seedling transplants. In the case of Hyosciamoside F*,* the seedling transplants were ready for planting by 5-8 days earlier than in the witness and by 3 days earlier than in the treatments with succinic acid and Moldstim. The number of standard seedlings ready for planting was by 17.9%-21.5% higher than in the witness, by 11.5%-20.0% than in the prototype and by 5.0%-16.0% than in the structural analog. The results of the investigation performed have demonstrated that presowing seed treatment with Hyosciamoside F increases seed germination rate in the variety Timpuriu-83 by 5.2% in comparison with the witness, germination by 3.8%, root length by 22.2%. The frequency of standard seedling transplants increased by 14.0% in comparison with the witness, by 12.6% in comparison with the prototype and by 9.0% against the structural analog.

In the variety Fachel, the seed germination rate increased by 4.6% in comparison with the control treatment, germination by 3.5%, while root length by 15.1%. The number of the standard seedling transplants ready for planting was by 13.3% higher than in the witness, by 12% than in the prototype and by 9% than in the structural analog (Table 1). The content of the steroid component changes singificantly at the ontogenetic stage depending on the conditions of germination rate, still, being specific for each genotype separately. After the seedlings were planted in the field, biometric measures were carried out during plant growth and development. The surface of each field parcel was 5.5 m^2, the plantings were repeated four times. The raceme of the first, second, and third inflorescence was sprayed with a Hyosciamoside F solution at concentrations of 0.01%, 0.005%, and 0.001%. The treatment was carried out in a great majority of inflorescences at the stage of half-opened corollas.

Table 1. The influence of steroid glycosides on germination, germination rate of tomato seeds and seedling development.
Tabel 1. Influenţa steroide glicoside asupra germinaţiei, ratei germinaţiei seminţelor de tomate şi a dezvoltării răsadului.

Genotype	Treatment	Germination %	Germination rate, %	Root length, cm	No of standard seedlings, unit/m^2	% of germination against the witness
Line 43PiNt	Witness	96.7	96.7	4.12	78	100.0
	Succinic acid 0.005%	98.7	98.7	4.26	83	106,4
	Moldstim 0.08%	98.9	97.9	4.23	88	112.8
	Hyosciamoside F 0.01%	92.7	98.7	4.44	87	111.5
	0.005%	100.0	99.7	4.79	92	117.9
	0.001%	95.7	95.4	4.13	90	115.3
Line 44PiFc	Witness	95.5	94.5	3.09	73	100.0
	Succinic acid 0 .005%	96.4	97.8	4.03	80	101.2
	Moldstim 0.08%	98.6	99.1	4.1	83	105.1
	Hyosciamoside F 0.01%	91.0	100.0	3.83	81	102.5
	0.005%	100.0	100.0	4.67	96	121.5
	0.001%	95.7	92.5	4.50	89	112.6
	Witness	95.6	94.6	4.65	81	100.0
	Succinic acid 0.005%	100.0	97.7	4.70	86	106.1

Line 46VcLpr	Moldstim 0.08%	97.8	98.3	4.72	91	112.3
	Hyosciamoside F 0.01%	93.3	89.9	4.88	91	112.3
	0.005%	100.0	100.0	5.00	96	118.5
	0.001%	96.7	90.4	4.80	94	116.0
Timpuriu-83	Witness	96.3	94.3	4.28	86	100.0
	Succinic acid 0.005%	96.4	96.6	4.67	87	101.2
	Moldstim 0.08%	97.6	96.8	4.81	90	104.7
	Hyosciamoside F 0.01%	97.7	96.9	5,07	93	108.1
	0.005%	100.0	99.2	5.23	98	114.0
	0.001%	96.8	96.1	4,84	94	109.3
Fachel	Witness	96.6	95.6	2,76	83	100.0
	Succinic acid 0.005%	97.6	96.6	3.51	84	101.2
	Moldstim 0.08%	98.3	97.9	3.92	86	103.6
	Hyosciamoside F 0.01%	95.7	96.8	3.29	89	107.2
	0.005%	100.0	100.0	4.18	94	113.3
	0.001%	96.8	95,3	3.52	90	108.4

Two additional treatments were also performed after the appearance of new inflorescences on the second and third raceme of the plants. The experiment was repeated three times for each treatment. The flowers of the first inflorescence on the second and third raceme treated with distilled water served as a witness. To obtain comparative data, tomato racemes were treated with a 0.005% succinic acid solution and 0.08% Moldstim solution during flowering.

The experiments have shown that tomato inflorescence treatment with Hyosciamoside F during flowering contributes to a better fruit setting by 8.0%-22.5% in comparison with the witness, 2.2%-6.3% in comparison with the structural analog, and by 3.9-15.0% in comparison with the prototype.

Table 2. The influence of steroid glycosides on tomato fruit setting.
Tabel 2. Influenţa steroid glicoside asupra coacerii fructelor de tomate.

Genotype	Treatment	The influence of steroid glycosides on the first three inflorescences		Fruit setting, %	% of the witness
		No of treated flowers, mean/ plant	No of set fruits, mean/ plant		
43PiNt	Witness	21.7	16.9	77.9	100
	Succinic acid 0.005%	21.0	17.6	83.8	107.5
	Moldstim 0.08%	18.2	16.5	90.7	116.3
	Hyosciamoside F 0.01%	18.0	16.9	93.8	120.5
	0.005%	20.6	19.6	95.2	122.5
	0.001%	18.7	17.6	94.1	120.8
44PiFc	Witness	17.2	15.2	88.4	100
	Succinic acid 0.005%	17.3	16.5	92.5	104.6
	Moldstim 0.08%	17.2	16.1	93.6	105.9
	Hyosciamoside F 0.01%	16.8	16.0	95.2	107.8
	0.005%	20.1	19.6	97.5	110.3
	0.001%	18.3	17.2	94.0	106.3
46VcLpr	Witness	13.7	12.6	91.9	100
	Succinic acid 0.005%	14.1	13.5	95.7	104.1
	Moldstim 0.08%	14.6	14.2	97.3	105.8
	Hyosciamoside F 0.01%	14.1	13.9	98.6	107.2
	0.005%	15.0	14.9	99.3	108.0
	0.001%	15.2	14.7	96.7	105.2
Timpuriu-83	Witness	20.3	16.1	79.3	100.0
	Succinic acid 0.005%	21.6	17.4	80.5	101.5
	Moldstim 0.08%	19.7	17.0	86.2	108.7

	Hyosciamoside F 0.01%	18.6	17.2	92.5	116.6
	0.005%	20.3	19.7	97.0	122.3
	0.001%	19.2	18.0	93.7	118.2
Fachel	Witness	18.3	15.1	82.5	100.0
	Succinic acid 0.005%	18.3	16.5	90.2	109.3
	Moldstim 0.08%	18.2	16.8	92.3	111.8
	Hyosciamoside F 0.01%	17.8	16.4	92.1	111.6
	0.005%	18.6	18.0	96.8	117.3
	0.001%	18.2	17.1	94.0	113.9

It has been found that tomato treatment with Hyosciamoside F during flowering contributes to a better fruit setting by 8.0%-22.5% in comparison with the witness, by 2.2-6.3% against the structural analog, and by 3.9%-15.0% in comparison with the prototype. The inflorescence treatment with Hyosciamoside F solutions contributes to a better fruit setting, acceleration of fruit ripening, increase of their quantity and quality, which eventually results in the increase of total and market productivity (Table 3).

Table 3. The influence of steroid glycosides on tomato genotype productivity and yield quality.
Tabel 3. Influenta steroid glicoside asupra productgivitatii si calitatii productiei genotipurilor de tomate.

Genotype	Treatment	Productivity			
		Total q/ha	% to the witness	Market, q/ha	% to the witness, %
43PiNt	Witness	464.9	100.0	363.6	100.0
	Succinic acid 0.005%	485.4	104.4	443.1	121.9
	Moldstim 0.08%	499.1	107.3	457.3	125.7
	Hyosciamoside F 0.01%	498.7	107.3	438.9	120.7
	0.005%	561.0	120.7	493.5	135.7
	0.001%	514.3	110.6	454.5	125.0
44PiFc	Witness	485.7	100.0	415.6	100.0
	Succinic acid 0.005%	496.1	102.1	440.1	105.9
	Moldstim 0.08%	503.2	103.6	446.0	107.3
	Hyosciamoside F 0.01%	507.3	104.4	462.3	111.2
	0.005%	555.8	114.4	490.9	118.1
	0.001%	522.8	107.6	477.9	115.0
46VcLpr	Witness	501.3	100.0	407.8	100.0
	Succinic acid 0.005%	507.3	101.2	470.9	115.4
	Moldstim 0.08%	519.2	103.6	483.1	118.5
	Hyosciamoside F 0.01%	535.1	106.7	477.9	117.2
	0.005%	572.5	114.2	543.2	133.2
	0.001%	509.1	101.5	493.5	121.0
Timpuriu-83	Witness	498.7	100.0	431.1	100.0
	Succinic acidc 0.005%	504.7	101.2	462.3	107.2
	Moldstim 0.08%	529.9	106.3	483.1	112.0
	Hyosciamoside F 0.01%	597.4	119.8	579.2	134.0
	0.005%	675.3	135.4	607.8	141.0
	0.001%	529.9	106.3	483.1	112.0
Fachel	Witness	515.4	100.0	463.5	100.0
	Succinic acid 0.005%	527.7	102.4	503.9	108.7
	Moldstim 0.08%	587.6	114.0	522.1	112.6
	Hyosciamoside F 0.01%	561.0	108.8	542.8	117.1
	0.005%	665.0	129.0	639.0	137.9
	0.001%	594.2	115.3	550.6	118.8

Thus, the treatment with Hyosciamoside F during flowering contributes to a better fruit setting by 8.0%-22.5% in comparison with the witness, 2.2%-6.3% against the structural analog and by 3.9%-15.0% in comparison with the prototype.

The treatment of the generative organs of tomato lines (seeds, seedlings and flowers) allows the growth of total fruit productivity by 70.1-96.1 q/ha (14.2%-20.7%) and market yields by 75.3-135.4 q/ha (18.1%-35.7%) in comparison with the witness and by 10.3%-12.4% (36.2-60.1 q/ha) in comparison with the closest solution, the increase of total and market productivity by 7.9%-12.4% (36.2-60.1 q/ha) and 12.2%-17.8% (50.4-72.3 q/ha), respectively.

Simultaneously, the treatment of generative organs of tomato plants, var. Timpuriu-83 (seeds, seedlings and inflorescences) in an optimal concentration of 0.005% according to the method proposed allowed an increase of total productivity of fruits by 35.4% (176.6 q/ha), the market productivity being 41%, which made 176.7 1/ha; the total productivity made 29% (149.6 q/ha), the market productivity was 37.9% (175.5 q/ha) in comparison with the witness for the Fachel variety. The total productivity of the Timpuriu-83 variety was 33.8% higher, the market productivity by 31.5% in comparison with the witness; the total productivity was 26.0%, while the market productivity by 26.8% in the Fachel variety. In comparison with the closest solution, the total productivity in the Timpuriu-83 variety was higher by 27.4% and market productivity by 25.8%, respectively; the total productivity was by13.7% higher and market productivity by 22.4% higher in the Fachel variety.

Finally, the acceleration of plant growth and development and increase of total productivity made up to 20.7% and market productivity up to 35.7%.

Figure 1. Genotype 44PiFc.
Figura 1. Genotipul 44PiFc. (original).

Figure 2. Genotype 46VcLpr.
Figura 2. Genotipul 46VcLpr (original).

CONCLUSIONS

1. In the case of treatment with Hyosciamoside F, the seedlings were ready to be transplanted 5-8 days earlier in comparison with the witness and 3 days earlier than in the accinic acid and Moldstim treatments. The number of seedlings ready to be transplanted was 17.9%-21.5% higher than in the witness, by 11.5%-20.0% than in the prototype and by 5.0%-16.0% than in the structural analog.

2. The investigation demonstrated that the presowing seed treatment with Hyosciamoside F increased the seed germination rate in the variety Timpuriu-83 by 5.2% in comparison with the witness, germination by 3.8%, root length by 22.2%. The frequency of standard seedling transplants was higher by 14.0% than in the control treatment, in comparison with the prototype by 12.6% and by 9.0% in comparison with the structural analog. For the Fachel variety, the germination rate increased by 4.6% in comparison with the control treatment, germination by 3.5%, while root length by 15.1%. The number of standard seedlings ready to be transplanted was by 13.3% higher than in the control, by 12.0% higher than in the prototype and by 9.0% higher than in the structural analog,.

3. It was found that the treatment with Hyosciamoside F during flowering contributed to increase of fruit setting by 8.0%-22.5% in comparison with the witness, 2.2%-6.3% against the structural analog and by 3.9%-15.0% in comparison with the prototype. At the same time, for the Timpuriu-83 and Fachel varieties, the treatment with Hyosciamoside F at the same concentration increased tomato fruit setting by 22.3% and 17.3%, respectively, in comparison with the control treatment by 20.5% and 7.3%, 12.5% and 4.9% in comparison with the prototype.

4. The treatment of generative organs of tomato plants allowed an increase of total and market productivity by 70.1-96.1 q/ha (14.2%-20.7%) and 75.3-135.4 q/ha (18.1%-35.7%), respectively, in comparison with the witness and 10.3%-12.4% (36.2-60.1 q/ha) in compaison with the structural analog, total and market productivity by 7.9%-12.4% (36.2-60.1 q/ha) and 12.2%-17.8% (50.4-72.3 q/ha), respectively.

5. It was demonstrated that the treatment of generative organs of tomato plants, var. Timpuriu-83 (seeds, seedlings and inflorescences) in an optimal concentration of 0.005% allowed an increase of total productivity of fruits by 35.4% (176.6 q/ha), the market productivity being 41%, which made 176.7 1/ha, for the Fachel variety, the total productivity made 29% (149.6 q/ha), the market productivity was 37.9% (175.5 q/ha) in comparison with the witness. The total productivity of the Timpuriu-83 variety was 33.8% higher, the market productivity by 31.5% higher in comparison with the witness. In the Fachel variety, the total productivity was 26.0%, while the market productivity by 26.8%. The total productivity of the Timpuriu-83 variety was by 27.4% and market productivity by 25.8%, respectively, higher in comparison with the structural analog Moldstim; the total productivity was by 13.7% and market productivity by 22.4% higher for the Fachel variety.

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Received: April 25, 2010
Accepted: June 30, 2010