THE CHARACTERISTICS OF SOME TOMATO GENOTYPES WITH *U* GENE, ACCORDING TO THE ANALYSIS OF A COMPLEX OF AGRICULTURAL VALUABLE TRAITS

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Abstract. Development, implementation and promotion of new varieties corresponding to the consumers' ever growing requirements continue to be a paramount task of breeders. Combination of variety and hybrid resistance to environmental stress factors with a high level oh productivity and production quality is a priority direction in the strategy of plant breeding at the agriculture adaptive intensification stage. The quality of tomato fruits depends, at a great extent, on the presence or absence of the green spot at the fruit base. A fruit is more attractive if it is ripening simultaneously and uniformly on the whole surface. This character is controlled by the u mutant gene. A comparative assessment of some tomato genotypes, according to a complex of useful characters was carried out to demonstrate the variability of agronomic characters and to specify the value of the tomato samples, carriers of the **u** gene, for breeding. The sample assessment was carried out based on the most valuable biological parameters (total yields and market yields, mean fruit weight, share of market fruits, vegetation period, resistance to drought and cold). The genotypes that combine earliness with high productivity have been identified in the cultivated tomato collection. The analysis of the tomato genotypes resistance to drought and cold has allowed the discovery of the high-resistant genotypes, thus presenting an interest as initial material in breeding programs.

Keywords: tomato, breeding programs, resistance, cold, drought.

Rezumat. Caracteristicile unor genotipuri de tomate, purtătoare ale genei *u*, pe baza analizei unui complex de caractere agricole valoroase. Crearea, implementarea şi promovarea de noi genotipuri în corespondenţă cu cerinţele mereu crescânde ale consumatorilor, rămâne a fi şi în continuare o sarcină primordială a amelioratorilor. Direcţia prioritară în strategia ameliorării plantelor în etapa intensificării adaptive a agriculturii, este îmbinarea rezistenţei soiurilor şi hibrizilor la factorii de stres ai mediului, cu nivelul înalt al productivităţii şi calităţii producţiei. Calitatea fructelor de tomate depinde în mare măsură de prezenţa sau absenţa petei verzi la baza fructului. Suprafaţa fructelor este mai atractivă dacă coacerea are loc concomitent şi uniform pe toată suprafaţa lor. Acest caracter este controlat de gena mutantă ***u***. Pentru a demonstra variabilitatea caracterelor agronomice şi a preciza valoarea genotipurilor de tomate purtătoare a genei ***u*** pentru ameliorare, s-a efectuat evaluarea comparativă a genotipurilor de tomate, după un complex de caractere utile. Evaluarea genotipurilor s-a efectuat pe baza utilizării celor mai valoroşi parametri biologici (recolta generală şi recolta marfă, masa medie a fructului, cota fructelor marfă, perioada de vegetaţie, rezistenţa la arşiţă şi frig). În colecţia tomatelor de cultură au fost identificate genotipuri care îmbină însuşirea de precocitate cu productivitatea înaltă. Analiza genotipurilor de tomate după rezistenţa la arşiţă şi frig, a permis evidenţierea genotipurilor înalt rezistente, care prezintă interes ca material iniţial în ameliorare.

Cuvinte cheie: tomate, ameliorare, rezistenţă, frig, arşiţă.

INTRODUCTION

Development, implementation and promotion of new varieties corresponding to the consumers' ever growing requirements continue to be a paramount task of breeders. Combination of variety and hybrid resistance to environmental stress factors with a high level oh productivity and production quality is a priority direction in the strategy of plant breeding at the agriculture adaptive intensification stage.

The quality of tomato fruits depends, at a great extent, on the presence or absence of the green spot at the fruit base. A fruit is more attractive if it is ripening simultaneously and uniformly on the whole surface. This character is controlled by the u mutant gene. YEAGER (1937) used for the first time in breeding the mutant forms with fruit uniform ripening controlled by the u gene to exclude the green spot at the base of tomato fruits. KUZYOMENSKIY (2001) states that the fruits lacking the green spot are ripening simultaneously, while its presence delays ripening in this zone, which results in over ripening and softening of the fruit top. The phenomenon determines lowering of fruit quality. The sap content has been found to be higher in the varieties with the u gene (AVDEEV, 1992).

The aim of the investigation was to identify tomato genotypes that are u gene carriers and manifest valuable characters.

MATERIAL AND METHODS

A comparative assessment of tomato genotypes according to a complex of useful characters was carried out in 2007 to demonstrate the variability of agronomic characters and to specify the value of the tomato samples, carriers of the ***u*** gene, for breeding. Thirty samples from the tomato cultivars, carriers of the u gene (uniform ripening) belonging to the Center of Plant Genetic Resources of the Institute of Genetics and Plant Physiology, Moldovan Academy of Sciences, were used as biological material.

Table 1 shows the origin of the tested material. The sample assessment was carried out based on the most valuable biological parameters (total yields and market yields, mean fruit weight, share of market fruits, vegetation period). The local cultivars, Iuliana and Nota were used as witness varieties. The growing technology was conventional

for tomato cultivation in Moldova. The cultivation was started through seedlings planted at a distance of 70cm between the rows and 30 cm between the plants in the row to allow the plants to realize their biological potential.

The plants were observed phenologically through the vegetation period. The tomato genotypes were assessed for resistance to cold ($+10^0$) in accordance with the methodical recommendations of the Institute of Phytotechnology of Russia (Methodical Instructions, 1990).

Tomato resistance to high temperatures was assessed in accordance with the methodical recommendations of the Institute of Phytotechnology of Russia (IVANKIV, 1979) based on the growing capacity of embryonic roots after their heating at the temperatures of $42\text{-}43^0$ for 6 hrs.

Table 1. Biological material origin.
Tabel 1. Originea materialului biologic.

NN	National registration number	Genotype name	Origin
1	MDI 00001	Starfire (u)	France
2	MDI 00002	Kecskemeti 1926 (u)	Hungary
3	MDI 00048	Xoyn N1 (u)	Japan
4	MDI 00005	Suvenir	Crimea
5	MDI 00009	Pobediteli 367 (u)	Volgograd Experimental Station
6	MDI 00011	Roter Gnom (u)	Hungary
7	MDI 00020	Mokka (u)	Hungary
8	MDI 00021	Sodruzhestvo	Volgograd Experimental Station
9	MDI 00027	Druuzhnyi	OSS Mayak Russia
10	MDI 00029	Columbian (u)	USA
11	MDI 00031	Heinz 1409 (u)	-
12	MDI 00033	Sanmark (u)	-
13	MDI 00037	Montabo (u)	France
14	MDI 00049	Zastava	Crimea
15	MDI 00064	106 /2 Paradisommag (u)	Hungary
16	MDI 00082	F 3002 VK (u)	Italy
17	MDI 00093	K 11-26 (u)	Hungary
18	MDI 00096	Volgoaktyubinskiy	Volgograd Experimental Station
19	MDI 00089	Isobilia (u)	Czechoslovakia
20	MDI 05664	Ont 7511 (u)	Canada
21	MDI 05666	Veemore (u)	Canada
22	MDI 05687	PV – 70 (u)	Netherlands
23	MDI 05689	N – 3 (u)	USA
24	MDI 05693	Bush Osena (u)	Denmark
25	MDI 06101	Myti	Kharkov
26	MDI 06102	Irishka	Kharkov
27	MDI 06104	Atlasnyi	Kharkov
28	MDI 06105	Funtik	Kharkov
29	MDI 06107	Seven	Kharkov
30	MDI 06111	Vicante	Kharkov
31	MDI 00045	Iuliana	Moldova
32	MDI 05741	Nota	Moldova

RESULTS AND DISCUSSIONS

Development of early-ripening genotypes with simultaneous ripening, resistant to biotic and abiotic factors is a difficult problem but quite relevant. The investigation conducted on tomato genotypes that belong to different ecological and geographical groups has revealed a considerable diversity in view of manifesting many valuable characters in conditions of the central zone of Moldova. Earliness constitutes a very important quality of tomato genotypes since it permits yielding work phasing during a longer period. According to some authors, quality correlates with both producing capacity and many other particular features of the plant, including cold resistance, chemical composition, production quality, resistance to the most dangerous pathogens and pests (GUSEVA, 1989). It has been found that earliness may be increased through crossing the varieties with different interphasic periods – short one from the appearance of full plantlets to flowering in one parent and from flowering to ripening in the other parent (MAMEDOV et al., 2002); the collection of the cultivated tomatoes studied presents a considerable variability of this character.

The phonological observation performed during the evaluation period has revealed great differences between development stages (Table 2), depending on the variety and climatic conditions. The research has demonstrated a large diversity of the varieties in regard of the interphasic period of plantlet appearance / flowering. A later flowering was observed in the genotypes Suvenir, Sunmark, Isobilia, N-3 (67 days). This character varied in the rangle of 59 and 60 days in the year of research. The analysis of the phenotypic variability of the interphasic period of flowering/ripening has shown essential differences in the varieties studied. A shorter period has been found in the genotypes Seven and Irishka (42 days), while a longer one in Sodruzhestvo and Ont 7511 (55 days).

The genotypes have been divided into four classes by the earliness degree: 1 – very early-ripening, the number of days from the mass appearance of plantlets to the beginning of ripening making <105 days; 2 – early ripening, 106…110 days; 3 – medium early-ripening, 111…115 days; 4 – tardy, <116 days. According to the data obtained, of

the total number of the samples assessed, only 10.2% were found very early-ripening, 38.5% - early ripening, 38.5% - medium early-ripening, 12.8% - tardy.

Table 2. Phenotypic variability of interphasic periods in tomato.
Tabel 2.Variabilitatea fenotipică a perioadelor interfazice la tomate.

NN	Genotype name	Appearance of plantlets/flowering, days	Flowering/ripening, days	Vegetation period, days
1	Starfire (u)	66	48	114
2	Kecskemeti 1926 (u)	65	45	110
3	Xoyn N1 (u)	59	52	111
4	Suvenir (u)	67	49	116
5	Pobediteli 367 (u)	67	48	115
6	Roter Gnom (u)	59	50	109
7	Mokka (u)	59	51	110
8	Sodruzhestvo	59	55	114
9	Druuzhnyi	63	51	114
10	Columbian (u)	66	44	110
11	Heinz 1409 (u)	66	48	114
12	Sanmark (u)	67	46	113
13	Montabo (u)	66	43	109
14	Zastava	64	45	109
15	106/2 Paradisommag (u)	66	43	109
16	F 3002 VK (u)	66	47	113
17	K 11-26 (u)	65	41	106
18	Volgoaktyubinskiy	63	46	109
19	Isobilia (u)	67	47	114
20	Ont 7511 (u)	63	55	118
21	Veemore (u)	63	43	106
22	PV – 70 (u)	63	46	109
23	N – 3 (u)	67	48	115
24	Bush Osena (u)	63	44	107
25	Myti	64	53	117
26	Irishka	62	42	104
27	Atlasnyi	64	49	113
28	Funtik	69	46	115
29	Seven	62	42	104
30	Vicante	65	53	118
31	Iuliana	64	40	104
32	Nota	65	42	107

One of the main directions in breeding is development of varieties with a high producing capacity. The biological producing potential of tomato is in a close correlation with the environment. The climatic conditions of the year were extremely unfavorable. Drought and high temperature of 35-45^{0}C (it exceeded 55^{0}C on the soil surface) that persisted during the whole vegetation period resulted in a considerable reduction of yields.

The assessment of the data referring to the yield structure (Table 3) demonstrated essential differences for both total yields and market yields.

Table 3. Results of cultivated tomato assessment by the complex of valuable characters.
Tabel 3. Rezultatele evaluării tomatelor de cultură după un complex de caractere valoroase.

NN	Varieties	Yields, M.T/ha		Share of market fruits, %	Fruit mean weight, g
		Total	Market		
1	Starfire (u)	23,1	22,2	96,3	105,5
2	Kecskemeti 1926 (u)	18,2	17,1	93,7	71,3
3	Xoyn N1 (u)	22,3	20,9	93,6	102,4
4	Suvenir (u)	19,4	16,3	83,8	95
5	Pobediteli 367 (u)	16,5	15,4	93,1	100,0
6	Roter Gnom (u)	18,4	12,7	68,9	41,4
7	Mokka (u)	26,5	23,9	91,3	58,5
8	Sodruzhestvo	22,7	19,5	86,1	111,0
9	Druuzhnyi	19,3	18,1	94,1	103,2
10	Columbian (u)	21,0	19,1	91,1	59,8
11	Heinz 1409 (u)	14,3	13,5	94,0	102,4
12	Sanmark (u)	21,7	20,5	94,7	54,7
13	Montabo (u)	18,3	16,9	92,0	65,3
14	Zastava	15,3	15,0	98,2	78,1
15	106/2 Paradisommag (u)	20,7	18,7	90,3	48,2
16	F 3002 VK (u)	14,7	11,6	78,7	58,0
17	K 11-26 (u)	21,7	20,5	94,7	48,3
18	Volgoaktyubinskiy	23,9	22,5	94,0	69,7

19	Isobilia (u)	19,3	18,1	94,1	85,4
20	Ont 7511 (u)	19,9	18,4	92,8	69,7
21	Veemore (u)	24,0	21,4	89,3	72,0
22	PV – 70 (u)	34,3	33,2	96,7	91,8
23	N – 3 (u)	14,0	128,6	91,8	54,9
24	Bush Osena (u)	12,8	11,1	86,6	48,1
25	Myti	27,7	25,7	92,8	48,9
26	Irishka	21,7	18,9	86,9	20,8
27	Atlasnyi	38,6	36,0	99,3	179,5
28	Funtik	9,1	8,3	90,6	35,7
29	Seven	29,6	27,3	92,2	79,5
30	Vicante	45,5	44,4	97,5	174,0
31	Iuliana	25,2	24,2	95,4	68,4
32	Nota	28,1	26,4	93,9	92,5

The obtained data show that the total yields varied between 9.1 M.T./ha (var. Funtik) and 45.5 M.T./ha (var. Vicante), while the market yields varied between 8.3 and 44.4 M.T./ha, respectively. The following may be mentioned among the varieties with a good productivity: Vicante, Atlasnyi, Seven, Myti, Marevo (Ukraine), PV-70 (Holland), S-120 (India), Mokka (Hungary), the productivity of which was 45.5 M.T./ha, 38.6M.T./ha, 29.6 M.T./ha, 27.7 M.T./ha, 27.1 M.T./ha, 34.3 M.T./ha, 29.0 M.T./ha, and 26.5 M.T./ha, respectively. A quite low productivity in comparison with the witness varieties Iuliana and Nota was observed in the varieties Funtik, Bush Osena, K 4444, Heinz 1409, Sunray, the yields of which made 9.1-14.5 M.T./ha; these varieties are characterized by quite low adaptation and, thus, present no interest for our conditions.

The climatic conditions had also an action on the fruit weight and accounted for its decrease. The variation amplitude of the fruit weight was between 20.8 g and 179.5 g in the studied forms (Table 3).

The varieties were exposed to temperature stress in laboratory conditions to reveal and employ genetic sources resistant to cold and drought.

The results of the genotype analysis based on the resistance to drought are summarized in Fig. 1. Their evaluation has discovered the presence of a considerable variability ranging between 38.7% (var. Mokka) and 99.0% (var. N-3). The varieties Myti, Vicante, Atlasnyi (Ukraine), Roter Gnom, 106/2 Paradisommag, K 11-26 (Hungary), Heinz 1409 (Italy), Volgoaktyubinskiy (Russia) demonstrated a high degree of resistance an present an interest for breeding.

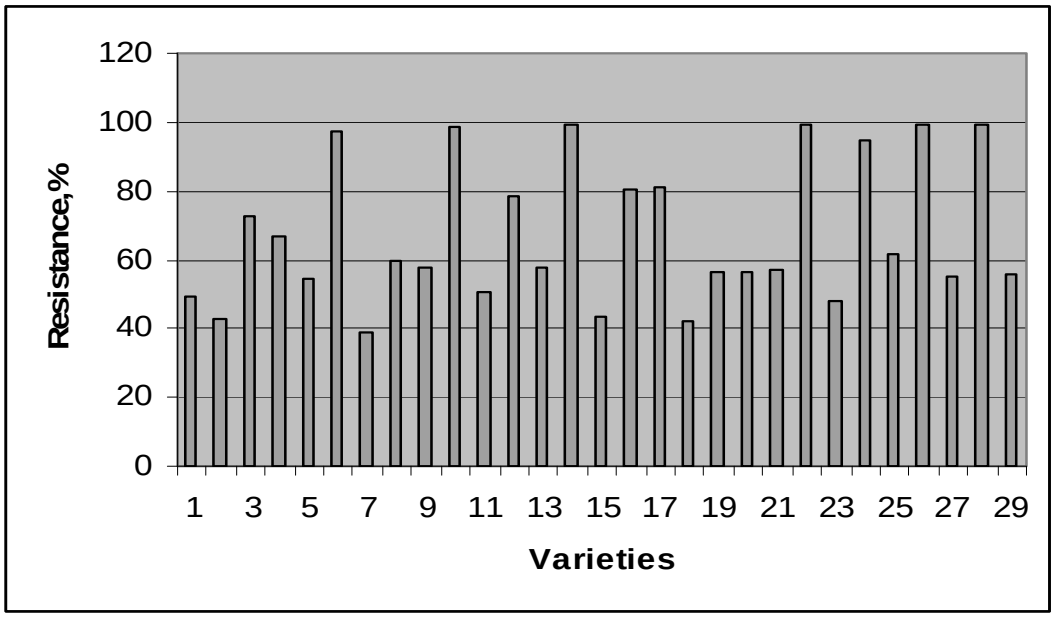

Figure 1. Evaluation of tomato genotypes for drought resistance.
Figura 1. Evaluarea genotipurilor de tomate după rezistența la arșiță.

1. Starfire; 2. Kecskemeti 1926; 3. Xoyn N1; 4. Suvenir; 5. Pobediteli 367; 6. Roter Gnom; 7. Mokka; 8. Sodruzhestvo; 9. Columbian; 10. Heinz 1409; 11. Sanmark; 12. Montabo; 13. Zastava; 14. 106 /2 Paradisommag; 15. F 302 VK; 16.K 11-26; 17. Volgoaktyubinskiy ; 18. Isobilia; 19. Ont 7511; 20. Veemore; 21. PV – 70; 22. N – 3; 23. Bush Osena; 24. Myti; 25. Irishka; 26. Atlasnyi; 27. Seven; 28. Vicante; 29. Nota.

Identification of the forms resistant to lower temperatures presents a special interest in order to extend the range of genetic variability. The analysis of the genotype has revealed the presence of a considerable variability (5.4-100%) (Fig. 2).

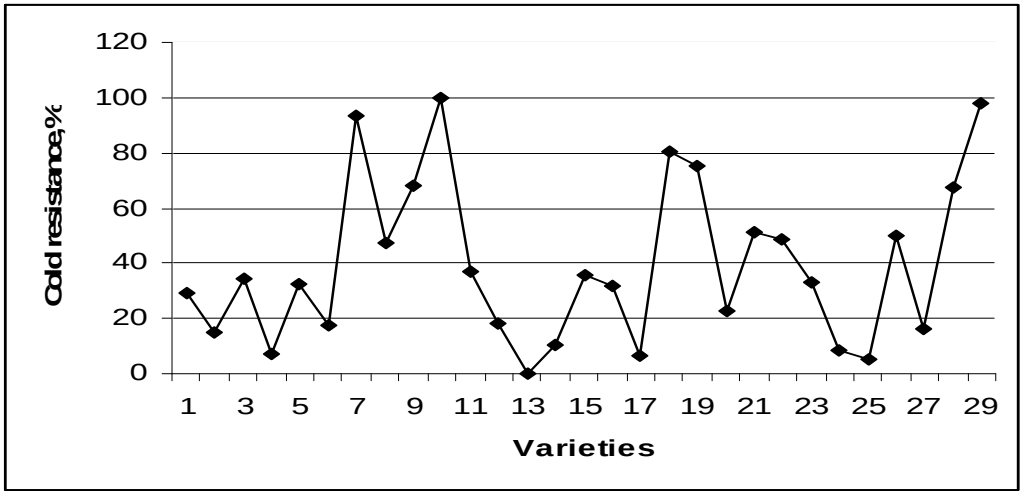

Figure 2. Evaluation of tomato genotypes by the resistance to cold.
Figura 2. Evaluarea genotipurilor de tomate după rezistența la frig.

1. Starfire; 2. Kecskemeti 1926; 3. Xoyn N1; 4. Suvenir; 5. Pobediteli 367; 6. Roter Gnom; 7. Mokka; 8. Sodruzhestvo; 9. Columbian; 10. Heinz 1409; 11. Sanmark; 12. Montabo; 13. Zastava; 14. 106 /2 Paradisommag; 15. F 302 VK; 16.K 11-26; 17. Volgoaktyubinskiy ; 18. Isobilia; 19. Ont 7511; 20. Veemore; 21. PV – 70; 22. N – 3; 23. Bush Osena; 24. Myti; 25. Irishka; 26. Atlasnyi; 27. Seven; 28. Vicante; 29. Nota.

The genotypes have been divided into five categories by the degree of the sporophyte resistance to lower temperatures:

1. High-resistant – 4 forms (seed germination: 81-100%)
2. Resistant – 4 forms (61-80%)
3. Mid-resistant – 4 forms (41-60%)
4. Weak-resistant – 8 forms (21-40%)
5. Non-resistant – 11 forms (less than 20%)

The varieties from categories 1 and 2 that demonstrated a high degree of resistance present an interest and may be involved in breeding programs.

CONCLUSIONS

1. The varieties PV-70 and Seven that combine earliness with high productivity have been identified in the cultivated tomato collection.

2. The analysis of the tomato samples by their resistance to drought has allowed the discovery of the high-resistant varieties Heinz 1409, 106/2 Paradisommag, K 11-26, N-3, Atlasnyi, Vicante. They may be recommended for employment in breeding programs as genetic sources of the resistance to this factor.

3. The varieties Mokka, Heinz 1409, Isobilia, Ont 7511, Vicante, Columbian possess a high resistance to cold, thus presenting an interest as initial material in breeding programs.

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