EVALUATION OF COMBINING ABILITY OF STERILE AND FERTILE LINES OF DETERMINATE TOMATO WITH RESISTANCE GENES (I_2, V_E, *M,)* ON EARLY AND TOTAL PRODUCTIVITY

G.F. Monakhos, X.T. Dinh

(RSAU-MTAA)

Abstract: The results of the evaluation of general (GCA) and specific (SCA) combining ability of functional male sterile (ps-2) of determinate tomato with resistance to Fusarium wilt, Verticillium wilt, Meloidogvne incognita and fertile lines are provided. The evaluation was made in the system of crossing between two different groups of genotypes. 80 F_1 hybrids (2010), 170 F_1 hybrids (2011) and six standard forms are studied. High heterotic effect on early and total productivity compared with the parental forms and the best standards are shown. Hybridization of sterile and fertile lines of determinate tomato makes F_1 hybrids, the total productivity of which considerably exceeds the best standard F_1 Semko 18, F_1 Katya. For example, hybrid combination (Si 1-31 **x** *Bifkr), (Si 1-36* **x** **x** *Prima 1-4), (Si 1-36* **x** *Sunrise 1-32), (Si 1-31* **x** *Sa 1-3643 rin), (Si 1-31* **x** *Prima 1-4), (Sf04(19)* **x** **x** *Bifkr), (Si 1-33* **x** *Gector 1-6), (Sf04(20)* **x** *01-15) and (Si 1-36* **x** *Olga 1-1). When breeding for early productivity, sterile (Si 1-33, Si 1-36, Sf04(19), Sf04(20)) and fertile (01-15, RSKT 1-381) lines are proposed to be used, due to their high GCA effects. High correlation between the early productivity of fertile lines and their GCA effects was ascertained (0,92 ± 0,14 in 2010; 0,88 ± 0,12 in 2011). Both years, an average positive correlation between early and the total productivity was obsen'ed (0,64 ± 0,09 in 2010; 0,65 ± 0,06 in 2011). In the breeding high-yielding F_1 hybrids sterile (Si 1-31, Si 1-33, Si 1-36, Sf04(19), Sf04(20)) and fertile (Prima 1-4, Bifkr) lines having high GCA on the total productivity are separated and recommended for use. High heterotic effect in early productivity can be determined on high GCS of parental lines, and high effect of heterosis in the total productivity - high GCA parental lines or high GCA one of the parents with high SCA.*

Keywords: lines, hybrid, GCA, SCA, tomato, productivity.

Increasing adaptive potential of cultivated plants by the creation of new varieties, hybrids, which possess high productivity, resistance to pathogens and negative environmental factors is one of the most important trends in tomato breeding [4]. Efficiency of breeding in this direction depends primarily on the source material with economically valuable traits (earliness, resistance to diseases, pests, etc.). The value of lines and varieties is determined by their ability to have offspring with heterosis pronounced to a greater or lesser extent when crossing with other lines. Heterosis for the total and early yield in tomato exceeded that in local varieties by 20-50% or more [1, 3].

Evaluation of the combining ability of the parental forms allows the researcher to foresee the results of the future crossings and focus on promising material, while avoiding unnecessary costs and time spent on testing hybrids from parents of no practical value.

The purpose of the present work is to study and select the source material for the developing high-yielding F_1 tomato hybrids. To achieve this goal, the objectives included a study of F_1 hybrids and assessment of general (GCA) and specific (SCA) combining ability of the parental lines used in the breeding of F_1 tomato hybrids on economically valuable traits (early and total productivity).

Materials and methods

Studies have been conducted in 2010-2011 at the Department of Breeding and Seed growing of horticultural crops of RSAU - MTAA named after K.A. Timiryazev and at the Breeding station named after N.N. Timofeev. For obtaining F_1 hybrids crossing between sterile *(ps-2)* maternal and fertile paternal lines of tomato was done in a greenhouse. Among the parental lines, Si 1-3, Si 1-31, Si 1-33, Si 1-36, Si 1-25, 01-15 were homozygotes in three resistance genes I_2, *Ve, Mi*; lines Sv 2-41, Sv 2-43, Sv 1-23, Sv 1-25, Olga 1-1, Sa 1-3643 *rin,* Khania 1-2, Bif kr, Sunrise 1-1, Sunrise 1-32, Renome 2-2, 1677-1, Joker 1-14, Joker 1-0 *rin,* Gector 1-6, Gector 1-9 *rin* - homozygotes in two resistance genes I_2, *Ve:* line Prima 1-4 - homozygote in two resistance genes *Ve, Mi.* The presence of resistance genes (A, *Ve, Mi)* and their homo- or heterozygotic state of the parental lines was identified at the Centre for Molecular Biotechnology of RSAU - MTAA named after K.A. Timiryazev on the basis of *SCAR* primers developed by G.I. Karlov and colleagues.

In 2010, testing of 80 F_1, hybrids was conducted, in 2011 - 170 F_1 hybrids and parental lines under field conditions without irrigation. A randomized complete block design with three replications was used. Thus, each block consisted of 5 plants. Local hybrids F_1 Katya, *I']* Server, F_1 Slot, F_1 Semko 18, F_1 Junior and variety Belyi naliv 241 were used as a standard for comparison.

In 2010, the seeds were sown on April 22nd, pricking-out seedlings - on May 4th, planting seedlings - on May 20th with scheme 70 x 35 cm.

In 2010, an unusually long period of abnormally hot and dry weather took place, the maximum air temperatures during the daytime reached 37 - 39°C, without rain. Tomato fruit harvesting was carried out by hand once a week in the period from July 26th to October 4th, before the first freezeng. In 2011, the seeds were sown on April 16th pricking-out seedlings - on May 7th, planting seedlings - on May 26th with scheme 70 x 20 cm. Tomato fruits were harvested once every 10 days during the period from August 1st to October 15th before the first freezing. The average air temperature in Moscow in July 2011 was 5-9 °C higher than normal. Almost for two weeks very hot weather was observed that summer, with a record temperature of 33 °C. At harvest, the fruit weight and the number of fruits per plant was counted, as well as the number of marketable fruits (fruit without blossom-end rot and without cracking).

Mathematical processing and analysis of combining ability of the parental lines was carried out according to V.K. Savchenko, the 1st model [5, 6]. The coefficient of correlation between various traits and effects of GCA was determined according to V.A. Dospekhov's technique [2].

Results

Combining ability of the parental lines on the marketable early productivity

In both years, all studied genotypes significantly differed in marketable early productivity (productivity of the first two harvestings, before August 1st). In 2010, in the fertile lines it varied from 0 to 338 g (Olga 1-2 and 01-15, respectively), and in hybrids - from 0 to 604 g (Sv 2-1 x Olga 1-2 and Sf04(20) x 01-15, respectively). Most hybrids overperformed parental lines on this trait. Marketable early productivity of hybrids Sf04(20) x x 01-15, Sf04(19) x 01-15, Si 1-2 x PCKT 1-381, Si 1-3 x Prima 1-4 was 79, 78, 55 and 48% (respectively) higher than that of the best parental lines, and 23, 22, 7 and 2% higher than that of the best standard hybrid F_1 Junior.

Dispersion analysis of combinational ability showed significant differences of lines on this factor. The largest effects of GCA were observed in sterile lines Si 1-3 (g_j = 82) and Sf04(20) *(*g_j = 41), low ones - in lines Sv 2-1 (g_j = -85), Si 1-1 (g_j = -27). Among fertile

lines, high GCAwas recorded in lines 01-15 (g, = 212) and RSKT 1-381 (g, = 102) whereas lines Olga 1-2 (g_i = -103), Khania 1-2 (g_i = -96) showed low GCA. The largest variance SCA was ascertained in a sterile line Si 1-3 (σ^2_{Sj} = 10528) and a fertile line 01-15 (σ^2_{Sj} = 9071) (Table 1).

Table 1

Early productivity of F_1 hybrids (g), effects of general combining ability and variance of specific combining ability in a line during 2010

Line		♀										
♂		Si 1-1	Si 1-2	Si 1-3	Sv 1	Sv 2-1	Sv 2-4	Sf04(19)	Sf04(20)	g_i	σ^2_{Si}	$\bar{F}_1 - P_1$
Bif kr	93	163	288	152	256	97	208	416	210	-4	8193	61
RSKT 1-381	161	262	523	432	319	228	281	382	212	102	8663	68
Mongal 1-11 *rin*	50	190	141	464	181	55	196	68	153	-47	8914	-9
Joker 1-0 *rin*	30	126	73	349	204	178	214	237	314	-16	3481	86
Olga 1-2	0	144	101	181	75	0	26	185	288	-103	3096	-19
01-15	338	333	404	395	341	441	403	600	604	212	9071	107
Sunrise 1-5	26	221	79	213	168	142	178	63	212	-68	4084	-62
Khania 1-2	37	147	122	243	155	10	165	43	170	-96	1970	-15
Gector 1-1	133	165	112	169	114	147	184	233	217	-60	1467	3
Prima 1-4	196	261	409	499	269	131	279	302	313	80	3855	47
g_j		-27	-3	82	-20	-85	-14	25	41	u = 228		
σ^2_{Sj}		1901	8284	10528	568	2694	565	9783	6505			

Note: LSD_{05} x = 59, LSD_{05} g_i = 37, LSD_{05} g_j = 33. Standard: F_1 Semko 18 = 356 g/plant, F_1 Server = = 100 g/plant, F_1 Slot = 184 g/plant, F_1 Junior = 490 g/plant, F_1 Katya = 402 g/plant, Belyi naliv 241 = 271 g/plant.

The effect of heterosis on marketable early productivity of the best *I'* hybrids was mainly high GCA of the parent in combination with the high effect of SCA of parental lines. E.g., Sf04(20) x 01-15 (x_{ij} = 604, g, = 212, g. = 41, s_{ij} = 122), Sf04(19) x 01-15 ($x_{,y}$ = 600, g_i = 212, g_j = 25, s_{ij} = 135), Si 1-2 x RSKT 1-381 (x_{ij} = 523, g_j = 102, g_j = -3, s_{ij} = 196).

A very high correlation of the early productivity of paternal lines and their GCA effects r = 0,92 ± 0,14 was noticed. It allows to predict early yield of F_1 hybrids according to the parental factors and witnesses in favour of the dominance of the early yields.

In 2011, the marketable early productivity declined in most studied genotypes. In the fertile lines it varied from 0 (Prima 1-4, Bif kr, Sunrise 1-32, 1677-1, Joker 1-0 *rin*, Gector 1-6, Joker 1-17, Mongal 1-11 *rin)* to 156 g (01-15), and in the hybrid combinations - from 0 (Sv 1-23 x Sunrise 1-32, Sv2-41 x Sunrise 1-32, Sv 1-23 x Joker 1-17, Sv2-43 x Khania 1-2) to 604 g (Sf04(20) x 01-15). A number of hybrids overperformed the parental lines on marketable early productivity. The marketable early productivity in hybrids Sf04(20) x x 01-15, Sf04(19) x Bif kr, Si 1-33 x Joker 1-17, Sf04(19) x 01-15 was 287, 148, 143 and 135% (respectively) higher than in the best parental lines, and 178, 78, 75 and 69% higher than in the best standard hybrid F_1 Junior (Table 2).

Table 2

Early productivity of F_1 hybrids (g), effects of general combining ability and variance of specific combining ability in a line during 2011

Line		♀												
♂		Si 1-25	Si 1-31	Si 1-33	Si 1-36	Sv 1-23	Sv 1-25	Sv 2-41	Sv 2-43	Sf04(19)	Sf04(20)	g_i	σ^2_{Si}	$\overline{F_1} - P_1$
Olga 1-1	30	216	144	101	218	0	9	29	222	253	122	-13	3728	101
01-15	156	295	212	240	323	260	301	248	348	367	604	176	10581	164
Sa 1-3643 *rin*	15	105	258	48	193	36	59	14	29	175	191	-33	2922	96
Prima 1-4	0	142	126	82	118	25	69	29	52	219	213	-37	572	108
Bif kr	0	160	121	90	257	18	114	25	157	387	188	8	4768	152
Sunrise 1-32	0	110	109	58	263	0	40	0	15	138	131	-58	1218	86
Renome 2-2	45	151	206	205	253	75	136	104	41	219	146	10	257	109
1677-1	0	166	116	108	159	5	88	47	78	212	195	-27	-232	117
Sunrise 1-1	4	160	80	181	151	9	51	36	70	146	159	-40	-675	100
Joker 1-14	7	173	140	239	130	38	47	103	170	174	207	-2	915	135
Gector 1-9 *rin*	9	199	162	312	208	44	96	74	87	241	171	15	238	150
Joker 1-0 *rin*	0	152	69	291	127	42	89	36	50	146	106	-33	1791	111
Gector 1-6	0	151	262	280	248	22	76	50	78	158	127	1	1954	145
Joker 1-17	0	124	209	380	164	0	21	31	18	151	166	-18	4980	126
RSKT 1-381	140	272	270	332	282	179	231	179	133	217	220	88	1142	92
Khania 1-2	46	178	21	214	213	75	40	89	0	199	105	-31	2148	67
Mongal 1-11 *rin*	0	140	175	236	205	13	90	104	59	224	158	-4	-337	140
g_j		26	14	56	63	-95	-52	-74	-49	69	45	u = 144		
σ^2_{Sj}		-271	3176	8226	1103	-248	-64	-414	2147	1977	4106			

Note: LSD_{05} x = 58, LSD_{05} g_i = 32, LSD_{05} g_j = 25. Standards: F_1 Semko 18 = 159 g/plant, F_1 Server = 98 g/plant, F_1 Slot = 54 g/plant, F_1 Junior = 217 g/plant, F_1 Katya = 181 g/plant, Bélyi naliv 241 = 186 g/plant.

In 2011, high GCA effect was observed in sterile lines Sf04(19) (g. = 69), Si 1-36 (g_j = 63), Si 1-33 (g_j = 56), Sf04(20) (g_j = 45), and the low one - in lines Sv 1-23 (g_j = -95), Sv 2-41 (g_j = -74). Among fertile lines, very high GCA effect was shown by lines 01-15 (g_i = 176) and RSKT 1-381 (g_i = 88), and low effect - in lines Sunrise 1-32 (g, = -58) and Sunrise 1-1 (g, = -40). Maximum variance SCA was found in a sterile line Si 1-33 (σ^2_{Sj} = 8226) and a fertile line 01-15 (σ^2_{Si} =10581) (Table 2).

In the fertile lines pronounced correlation was also observed between the early productivity and GCA effect (r = 0,88 ± 0,12). It confirms the stability of the genetic determination of «early yield» trait in the parental lines. Thus, in both years the maximum early productivity was observed in fertile lines 01-15 and RSKT 1-381. These lines were outstanding by their maximum GCA on this trait, because most F_1 hybrids with the participation of these lines have shown marked earliness.

Combining ability of parental lines in relation to the marketable total productivity

In 2010, studied genotypes significantly differed in marketable total productivity. In the fertile lines it ranged from 350 (Sunrise 1-5) to 1102 g (Bif kr), and in hybrids - from 312 (Si 1-2 x Mongal 1-11 *rin)* to 1925 g (Si 1-3 x Prima 1-4). The line Bif kr was distinguished by very high marketable total productivity. Only 10 hybrid combinations considerably exceeded this line in terms of productivity, and among the standards, only F_1 Semko 18 and F_1 Katya have demonstrated higher figures. The marketable total productivity of the majority of hybrids was higher than that of the parent component. This regularity is visible in all paternal lines, except the line Bif kr. Marketable total productivity of the hybrids Si 1-3 x Prima 1-4, Si 1-2 x Prima 1-4, Sf04(20) x 01-15, Si 1-3 x Gector 1-1, Sf04(20) x x Joker 1-0 *rin,* Sf04(19) x Bif kr and Si 1-3 x Joker 1-0 *rin* was 75, 19, 17, 11, 10, 7 and 7% (respectively) higher than that of the best fertile paternal lines. Marketable total productivity of 22 hybrids was above 1 kg/plant and the hybrid Si 1-3 x Prima 1-4 was 29% higher than the best standard hybrid F_1 Semko 18 (Table 3).

High effects of GCA on the total productivity of marketable fruits was recorded in sterile lines Si 1-3 (g_j = 201) and Sf04(20) (g_j = 106), while lines Sv 2-1 (g_j = 232), Si 1-2 (g_j = 175) are found to have low GCA effects. Among fertile lines very high effects of GCA were possessed by the lines Prima 1-4 (g_i = 248), Joker 1-0 *rin* (g_i = 163) and 01-15 (g_i = 142), and low ones - by the lines Khania 1-2 (g_i = 249), Mongal 1-11 *rin* (g_i = 208) and Olga 1-2 (g_i = 122). Maximal variance SCA was recorded in a sterile line Si 1-3 (σ^2_{Sj} = 75253) and a fertile line Prima 1-4 (σ^2_{Si} = 116902) (Table 3).

In 2010, the high effect of heterosis on the total productivity of marketable fruits of the best F_1 hybrids mainly provided high SCA effect in combination with high GCA effects of parental lines, e.g. Si 1-3 x Prima 1-4 (x_{ij} = 1925, g_i = 248, g_j = 201, s_{ij} = 617), Sf04(20) x x 01-15 (x_{ij} = 1288, g_i = 142, g_j = 106, s_{ij} = 181); or high GCA of paternal line with high SCA in the combination: Si 1-2 x Prima 1-4 (x_{ij} = 1307, g_i = 248, g_j = -175, s_{ij} = 375); or high GCA of maternal line with high SCA in the combination: Si 1-3 x Gector 1-1 (x_{ij} = 1222, g_i = -37, g_j = 201, s_p = 199); and in the combination: Sf(04)19 x Bif kr (x_{ij} = 1182, g_i = 72, g_j = 9, s_{ij} = 242) high SCA with average GCA effects.

In 2010 no correlation existed between the total productivity of fertile paternal lines and their GCA effects (r = 0,25 ± 0,34).

In 2011, the marketable total productivity of genotypes was higher than in 2010. The total productivity of the fertile lines ranged from 190 (Joker 1-17) to 1210 g (Bif kr), and the total productivity of hybrids - from 388 (Sv 1-25 x Gector 1-6) to 1870 g (Si 1-31 x Bif kr).

Table 3

Total productivity of F_1 hybrids (g), effect of general combining ability and variance of specific combining ability in a line during 2010

Line		♀										
♂		Si 1-1	Si 1-2	Si 1-3	Sv 1	Sv 2-1	Sv 2-4	Sf04(19)	Sf04(20)	g_i	σ^2_{Si}	$\bar{F}_1 - P_1$
Bif kr	1102	859	730	885	994	769	864	1182	1164	72	24025	-171
RSKT 1-381	457	929	938	959	646	488	842	1074	1007	1	25786	403
Mongal 1-11 *rin*	516	791	312	1021	741	651	728	546	419	-208	35142	135
Joker 1-0 *rin*	608	1213	797	1181	981	845	967	973	1218	163	3275	414
Olga 1-2	674	858	573	586	961	479	482	777	1179	-122	47573	63
01-15	648	1006	583	1035	933	885	1149	1126	1288	142	25935	353
Sunrise 1-5	350	1158	597	940	861	725	847	752	915	-10	11229	499
Khania 1-2	750	774	579	850	701	436	688	353	496	-249	22443	-140
Gector 1-1	596	901	424	1222	835	624	814	877	882	-37	12484	226
Prima 1-4	840	1103	1307	1925	1030	369	1016	1022	1084	248	116902	267
g_j		100	-175	201	9	-232	-19	9	106	u = 859		
σ^2_{Sj}		10973	40012	75253	13093	39726	11249	23794	38267			

Note: LSD_{05} x = 61, LSD_{05} g_j = 37, LSD_{05} g_j = 33. Standards: F_1 Semko 18 = 1498 g/plant, F_1 Server = 944 g/plant, F_1 Slot = 1115 g/plant, F_1 Junior = 1029 g/plant., F_1 Katya = 1197 g/plant., Belyi naliv 241 = 489 g/plant.

Table 4

Total productivity of F_1 hybrids (g), effect of general combining ability and variance of specific combining ability in a line during 2011

Line		♀												
♂		Si 1-25	Si 1-31	Si 1-33	Si 1-36	Sv 1-23	Sv 1-25	Sv 2-41	Sv 2-43	Sf04(19)	Sf04(20)	g_i	σ^2_{si}	$\bar{F}_1 - P_1$
Olga 1-1	938	929	1210	1112	1542	447	514	691	1122	1160	834	-11	39413	18
01-15	543	946	1403	1052	984	839	1340	1043	1309	885	1562	169	113122	593
Sa 1-3643 *rin*	295	810	1671	1011	1264	622	652	724	718	1221	1360	38	40433	710
Prima 1-4	747	1211	1657	1374	1749	543	868	776	645	1562	1631	235	51180	455
Bif kr	1210	915	1870	1087	1497	619	758	806	764	1631	1133	141	69616	-102
Sunrise 1-32	882	1159	1446	1125	1682	498	549	642	699	996	1180	31	36044	116
Renome 2-2	861	885	895	1610	1243	864	621	866	661	1261	1297	53	33328	159
1677-1	510	1185	743	1267	1410	562	843	714	749	942	1570	32	53569	489
Sunrise 1-1	504	813	1007	1229	1436	543	700	593	692	997	1290	-37	9347	426
Joker 1-14	489	1002	1160	1174	1133	626	857	842	992	1051	1175	34	12858	512
Gector 1-9 *rin*	616	940	1066	1359	1018	592	734	531	884	1002	974	-57	13229	294
Joker 1-0 *rin*	297	817	1082	1825	1284	546	571	919	793	871	846	-12	53744	658
Gector 1-6	908	794	1266	1583	1330	452	384	672	618	851	1013	-71	28342	-12
Joker 1-17	190	526	993	1263	1038	388	518	453	559	836	783	-231	7347	546
RSKT 1-381	554	1210	990	1336	1112	853	772	608	639	1103	918	-13	29044	400
Khania 1-2	612	855	647	1408	1217	730	590	508	450	1314	834	-112	49764	243
Mongal 1-11 *rin*	569	703	966	1097	1034	455	681	590	461	1089	768	-183	9560	215
g_j		-43	214	322	326	-368	-264	-262	-217	137	161	u = 967		
σ^2_{sj}		17115	73918	66996	38737	18096	26520	8472	35214	38310	40991			

Note: LSD_{05} x = 92, LSD_{05} = 50, LSD_{05} g_j = 39. Standards: F_1 Semko 18 = 863 g/plant, F_1 Server = 764 g/plant, F_1 Slot = 757 g/plant, F_1 Junior = = 951 g/plant, F_1 Katya = 1147 g/plant, Belyi naliv 241 = 437 g/plant.

The total productivity of 28 hybrid combinations was higher than in the best fertile lines and the best standard hybrid F_1 Katya. E.g., the total productivity of hybrids Si 1-31 x x Bif kr, Si 1-33 x Joker 1-0 *rin,* Si 1-36 x Prima 1-4, Sf04(19) x Bif kr and Sf04(20) x x 01-15 was 63, 59, 52, 42 and 36% (respectively) higher than that of the best standard hybrid F_1 Katya.

In 2011, high effects of GCA were found in sterile lines Si 1-36 (g_j = 326), Si 1-33 (g_j = 322), Si 1-31 (g_j = 214) and Sf04(20) (g_j = 161), while lines Sv 1-23 (g_j = -368), Sv 1-25 (g_j = -264), Sv 2-41 (g_j = -262), Sv 2-43 (g_j = 17) demonstrated low GCA effects.

Among fertile lines, very high GCA effects were shown by the lines Prima 1-4 (g_i = 235), 01-15 (g_i = 169) and Bif kr (g_i = 141), and low - by the lines Joker 1-17 (g_i = -231), Mongal 1-11 *rin* (g_i = -183) and Khania 1-2 (g_i = -112). Maximal variance SCA effect was seen in a sterile line Si 1-31 (σ^2_{Sj} = 73918) and a fertile line 01-15 (σ^2_{Si} = 113122) (Table 4).

In 2011, the effect of SCA on the total productivity ranged from 478 (Si 1-36 x 01-15) to 548 g (Si 1-31 x Bif kr and Si 1-33 x Joker 1-0 *rin).* No correlation was observed between the total productivity of fertile paternal lines and their GCA effects (r = 0,39 ± 0,24).

A significant effect of heterosis on the total productivity of the best F_1 hybrids mainly provided high SCA effect in combination with high GCA effects of parental lines, e.g., Si 1-31 x Bif kr (x_{ij} = 1870, g_i = 141, g_j = 214, s_{ij} = 548), Si 1-36 x Prima 1-4 (x_{ij} = 1749, g_i = 235, g_j = 326, s_{ij} = 221), Sf04(19) x Bif kr (x_{ij} = 1631, g_i = 141, g_j = 137, s_{ij} = 386); or high GCA effects of maternal line with high SCA effect, e.g., Si 1-33 x Joker 1-0 *rin* (x_{ij} = 1825, g_i = -12, g_j = 322, s_{ij} = 548), Si 1-36 x Sunrise 1-32 (x_{ij} = 1682, g_i = 31, g_j = 326, s_{ij} = 358), Si 1-31 x Sa 1-3643 *rin* (x_{ij} = 1671, g_i = 38, g_j = 214, s_{ij} = 452).

Conclusions

1. When breeding hybrid tomatoes for early productivity fertile (01-15, RSKT 1-381) and sterile (Sf04(19), Sf04(20), Si 1-33, Si 1-36) lines with high GCA should be used.

2. Between the early productivity of paternal lines and their GCA effects, a very high correlation was observed (r = 0,92 ± 0,14 in 2010; r = 0,88 ± 0,12 in 2011); it allows to predict the value of fertile paternal lines in early yields.

3. Maximum effect of heterosis on early productivity was found in combination Sf04(20) x 01-15, which outperformed the best standard hybrid F_1 Junior by 23% in 2010 and 178% in 2011.

4. When breeding hybrid tomatoes for productivity improvement, fertile (Prima 1-4, 01-15, Bif kr) and sterile (Si 1-31, Si 1-33, Si 1-36, Sfl)4(19), Sf04(20)) lines with high GCA should be used.

5. No correlation existed between the total productivity of fertile paternal lines and their GCA effects (r = 0,25 ± 0,34 in 2010; r = 0,39 ± 0,24 in 2011).

6. Hybridization of sterile and fertile lines of determinate tomato allows to develop F_1 hybrids, the total productivity of which considerably exceeds the best standards F_1 Semko 18 and Fj Katya. E.g., a hybrid combination (Si 1-31 x Bif kr), (Si 1-36 x Prima 1-4), (Si 1-36 x Sunrise 1-32), (Si 1-31 x Sa 1-3643 *rin),* (Si 1-31 x Prima 1-4), (Sf04(19) x x Bif kr), (Si 1-33 x Gector 1-6), (Sf04(20) x 01-15) and (Si 1-36 x Olga 1-1).

7. In both years, a positive correlation was observed between the early and the total productivity (r = 0,64 ± 0,09 in 2010; r = 0,65 ± 0,06 in 2011).

References

1. *Avdeev Y.I.* Tomato breeding. Kishinev: Shtiincza, 1982. 280 p.
2. *Dospekhov B.A.* Methods of field experiment. Moscow: Kolos, 1979. 416 p.
3. Optimization of vegetable growing technologies in the field and greenhouse conditions / A.V. Kryuchkov [et al.]. D.V. Patsuriya (Ed.). Moscow: Publishing house of RSAU-MTAA, 2011. 308 p.
4. *Pivovarov V.F.* Current trends in vegetable breeding. Materials of the presentation at the 1st international conference of All-Russian Research Institute of Vegetable Breeding and Seed Production RAAS. Moscow, 2008. Vol. 1. P. 38–50.
5. *Savchenko V.K.* Method of evaluation of combining ability of genetically different sets of parental forms // Methods of genetics-based selection and genetic experiments. Minsk: Nauka i tekhnika, 1973. P. 48–78.
6. *Savchenko V.K.* Genetic analysis in netlike test crossings. Minsk: Nauka i tekhnika (Science and technology), 1984. 223 p.

ОЦЕНКА КОМБИНАЦИОННОЙ СПОСОБНОСТИ СТЕРИЛЬНЫХ И ФЕРТИЛЬНЫХ ЛИНИЙ ДЕТЕРМИНАНТНОГО ТОМАТА С ГЕНАМИ УСТОЙЧИВОСТИ *(I_2,V_E, M,)* ПО ТОВАРНОЙ РАННЕЙ И ОБЩЕЙ ПРОДУКТИВНОСТИ

Г.Ф. Монахос, Динь Суан Ту

(РГАУ-МСХА)

Аннотация: представлены результаты оценки общей и специфической комбинационной способности материнских стерильных (функциональная мужская стерильность типа Врбычанский низкий) линий (8-и е 2010 г. и 10-и в 2011 г.) детерминантного томата с групповой устойчивостью к трем наиболее вредоносным заболеваниям (фузариоз, вертициллез и южная нематода) и фертильных отцовских линий (10-и в 2010 г. и 17-и в 2011 г.). Оценка была проведена в системе скрещивания двух разных групп генотипов. В 2010 г. изучено 80 F_1 гибридов, в 2011 г. 170 F_1 гибридов и 6 стандартов. Показано высокое проявление гетерозисного эффекта по ранней и общей продуктивности в сравнении с родительскими формами и лучшими стандартами. Гибридизация стерильных и фертильных линий детерминантого томата позволяет получить F_1 гибриды, значительно превосходящие по общей продуктивности товарных плодов наиболее урожайные стандартные гибриды F_1 Семко 18, F_1 Катя. Это комбинации Си 1-31 **x** *Биф кр, Си 1-36* **x** *Прима 1-4, Си 1-36* **x** *Санрайз 1-32, Си 1-31* **x** **x** *Са 1-3643 rin, Си 1-31* **x** *Прима 1-4, Сф04(19)* **x** *Биф кр, Си 1-33* **x** *Гектор 1-6, Сф04(20)* **x** **x** *01-15, Си 1-36* **x** *Ольга 1-1. При селекции на раннюю продуктивность предложено использовать стерильные линии Си 1-33, Си 1-36, Сф04(19) и Сф04(20), и фертильные линии 01-15, РСКТ 1-381, обладающие высокой ОК по этому признаку. Выявлена высокая корреляция между ранней продуктивностью отцовских линий и их ОКС (0,92 ± 0,14 в 2010 г., 0,88 ± 0,12 в 2011 г.). В оба года наблюдалась средняя положительная корреляция между ранней и общей продуктивностью (0,64 ± 0,09 в 2010 г., 0,65 ± 0,06 в 2011 г.). Выделены и ре-*

комендованы для использования в селекции высоко урожайных F_1 гибридов стерильные линии Си 1-31, Си 1-33, Си 1-36, Сф04(19) и Сф04(20), и фертильные линии Прима 1-4 и Биф кр, обладающие высокой ОКС по общей продуктивности товарных плодов. Высокий гетерозисный эффект по ранней продуктивности обусловлен сочетанием высокой ОКС родительских линий, а высокий гетерозисный эффект по общей продуктивности товарных плодов - высокой ОКС родительских линий или высокой ОКС одного из родителей в сочетании с высокой СКС.

Ключевые слова: линии, гибрид, ОКС, СКС, томат, продуктивность.

Монахос Григорий Федорович - к. с.-х. н., директор Селекционной станции имени Н.Н. Тимофеева (127550, г. Москва, ул. Пасечная, 5, тел.: 8(903)-615-18-91, e-mail: breedst@,mail.ru).

Динь Суан Ту - аспирант кафедры селекции и семеноводства садовых культур РГАУ-МСХА имени К.А. Тимирязева (127550, г. Москва, ул. Прянишникова, 37, e-mail: dinhxtir@gmail.com).

Dr. **Grigory Fedorovich Monakhos** - Ph.D. in Agricultural Sciences, Director of the Breeding Station named after N.N. Timofeev (ul. Paseclmaya, 5, Moscow 127550 Russian Federation; phone +7(903)615-1891; e-mail: brccdst@mail.ai).

Dinh Xuan Tu - postgraduate student. Dept, of Breeding and Seed Growing, Russian State Agrarian University named after K.A. Timiryazev (ul. Pryanishnikova, 37, Moscow 127550, Russian Federation e-mail: dinhxt@gmail.com)