

A NEW BULGARIAN SUNFLOWER HYBRID DEA

Penka Peevska, Galin Georgiev*

Dobrudzha Agricultural Institute – General Toshevo 9521, Bulgaria

*ppeevska7@abv.bg

ABSTRACT

Sunflower Dea was developed at Dobrudzha Agricultural Institute – General Toshevo (DAI). It is a male sterile two-linear hybrid derived through interlinear hybridization. The mother is line 217 possessing cytoplasmic male sterility, and the father is line 626 R, a branched fertility restorer. Both parental forms have excellent general and specific combining ability. Hybrid Dea is of medium maturity, growth period 116 – 119 days, plant height 160-165 cm and head diameter 20-23 cm. Absolute seed weight is 58-62 g and oil content is 48-49%. Flowering is 12-14 days. The new hybrid successfully underwent 3-year testing at DAI according to the standard testing practice. The maximum seed yield was 5313 kg/ha, while oil content reached 50 %. It is resistant to economically important diseases and to the parasite *Orobanche*. In 2012 hybrid Dea was submitted for official testing within the structures of the Romanian Varietal Commission at 10 locations. In the first three years it exceeded the Romanian standard with averagely 7,3 % by seed yield. The mean seed yield per ha for the three years of testing was 3387 kg. The hybrid was officially registered in Romania and was enlisted in the European Catalog of Field and Vegetable Crop Varieties.

Key words: Hybrid, Seed yield, Oil yield, Growth period

INTRODUCTION

The main task and priority of contemporary sunflower breeding are the development of high-yielding hybrids resistant to the economically important diseases and parasites. This tendency imposes the necessity to introduce new hybrids meeting the demands of the market. The good hybrid, apart from being high-yielding, should also be adaptive to the changeable biotic and abiotic environmental factors thus revealing its maximum potential under specific conditions. The wide use of sunflower justifies the necessity of increasing the improvement work on this crop, determining the various directions and specificity of tasks in its breeding of (Encheva and Georgiev, 2009; Encheva et al., 2014; Encheva V. *et al.* 2014; Valkova D. *et al.* 2014). The breeding of a new hybrid is a long process which involves collecting and developing of initial material, selection and choice of parental components, testing of the new forms, their registration and distribution. The successful outcome of each breeding project is highly productive genotypes which not only possess valuable properties from a research point of view, but which are also able to find good realization in production (Chamurliyski and Tsenov, 2013; Chamurliyski et al., 2011).

The aim of this investigation was to present a detailed morphological, biological and economic characterization of a modern Bulgarian hybrid (Dea) which meets the requirements for high productivity, resistance and adaptability. It was registered and enlisted in the European Varietal List of 2015. The hybrid is medium early, high-yielding and possesses very good drought resistance.

MATERIAL AND METHODS

Hybrid Dea was developed by the method of inter linear hybridization. It is a male fertile two-linear hybrid. The mother component is line 217 which possesses cytoplasmic male sterility and which has been developed through hybridization between the Bulgarian candidate variety No 72 and line 246 originating from Russian cultivars. By using the methods of selfing and selection, the line was developed as morphologically and genetically homogenous. It is characterized with very good general and specific combining ability.

Its successful use as the mother component in the most recent Bulgarian sunflower hybrids Veleka, Vokil, Divna, Vyara and Gabi confirmed its excellent properties. Its phytopathological evaluation determines it as resistant to the parasite *Orobanche* up to race F, moderately resistant to phoma and alternaria and moderately susceptible to phomopsis.

The father component is line 626 possessing Rf fertility restorer genes, which was developed through hybridization of lines 654 R and 620 R, selfing and selection. The line is strongly branched, with specific lemon yellow coloration of the ray flowers and rich in pollen. It has very good general and specific combining ability. It is resistant to downy mildew up to race 731 and to the parasite *Orobanche* up to race F, moderately resistant to phoma, phomopsis and alternaria. The hybrid cross was developed in 2009 and was tested for two years in a competitive varietal trial and in a unified varietal trial, where it exceeded the standard with over 6 %. The testing was carried out after predecessor wheat applying agronomy practices suitable for growing of this crop. The trial plots were each 12 m with standard block design, in three replications of two rows. The plant density was 61220 plants/ha. Three standards were used – San Luka, Brio and PR 64F50. During the growth season all morphological and phenological characters of the hybrid cross were determined according to the UPOV Protocol (2002). The main elements of yield were taken into account: seed yield kg/ha, oil content in seed, %, and oil yield, kg/ha. Phytopathological evaluation of the hybrid and the parental lines was done at DAI – General Toshevo. The resistance to downy mildew (*Plasmopara halstedii*) was determined according to a standard methodology (Vear F., Tourvieille D., 1987) adapted to the working conditions of DAI. The percent of resistance was expressed in the response of the hybrid to races 700 and 731.

The resistance to the parasite broomrape (*Orobanche cumana*) was determined by the method of Panchenko (1975). The evaluation was done under greenhouse conditions using the index percent of resistance. The resistance to gray spots on sunflower (*Phomopsis helianthi*) was determined by the method of Encheva and Kiryakov (2002) under field conditions against artificial infection background. The type of attack was determined one week prior to flowering at stage milk maturity. The following scale was used: 0 – no symptoms; 1 – necrotic spot with diameter up to 5 cm; 2 – necrotic spot with diameter more than 5 cm; 3 – several merged necrotic spots on the stem; 4 – stem broken at the place of infection.

The testing for black spots on sunflower (*Phoma macdonaldii*) was carried out under field conditions against artificial infection background. The inoculation was done at stage budding – beginning of flowering by the method of Maric et al. (1981). The reaction of the plants was read at stage yellow-brown maturity according to a 4-degree scale as follows: 0 – no symptoms; 1 – necrotic spot localized around the petiole; 2 – several necrotic spots on stem; 3 – entire stem covered with necrotic spots or broken.

RESULTS

In 2012 the hybrid cross 217 A x 626 R was provided to Saaten Union – Romania as a candidate hybrid for registration in the European Catalog of Field and Vegetable Crops and for testing within the system of the State Institute for Variety Testing and Registration – ISTIS Romania. Following a three-year testing during 2012 – 2014, it was officially released with certificate No 4935/09.06.2015 under the trade name Dea.

Morphological description

The morphological description was done according to the methodology of UPOV (2002) and is presented in (Table 1).

Table 1. Morphological characteristics of sunflower hybrid DEA

Nº	Traits	Expression	Degree
1.	Hypocotyl:anthocyanin coloration	Absent	1
2.	Hypocotyl:anthocyanin coloration	Absent	1
3.	Leaf: size	Large	7
4.	Leaf: green color	Medium green	5
5.	Leaf: blistering	Weak	3
6.	Leaf: serration	Medium	5
7.	Leaf: shape of cross section	Concave	1
8.	Leaf: shape of distal part	Acuminate	8
9.	Leaf: auricles	Large	7
10.	Leaf: wings	Absent	1
11.	Leaf: angle of lowest lateral veins	Right or nearly right angle	2
12.	Leaf: height of the tip of the blade compared to insertion of petiole (at 2/3 height of plant)	High	7
13.	Stem: intensity of hairiness at the top	Very strong	9
14.	Time of flowering	Medium	5
15.	Ray flower: density	Dense	7
16.	Ray flower: shape	Narrow ovate	2
17.	Ray flower: disposition	Flat	1
18.	Ray flower: length	Medium	5
19.	Ray flower: color	Oringe yellow	4
20.	Disk flower color	Orange	2
21.	Disk flower: anthocyanin coloration of stigma	Absent	1
22.	Disk flower: intensity of anthocyanin coloration of stigma	-	-
23.	Disk flower: presence of pollen	Present	9
24.	Bract shape	Rounded	3
25.	Bract: length of the tip	Long	7
26.	Bract: green color of the external part	Medium	5
27.	Bract: attitude in relation to head	Not embracing or very slightly embracing	1
28.	Plant: natural height	Medium to tall	6
29.	Plant: branching	Absent	1

30.	Plant: type of branching	-	-
31.	Plant: natural position of closest lateral head to the central head	-	-
32.	Head: attitude	Half-turned down with straight stem	4
33.	Head: size	Medium	5
34.	Head: shape of grain side	Weakly concave	2
35.	Seed: size	Medium	5
36.	Seed: shape	Narrow ovoid	2
37.	Seed: thickness relative to width	Thin	3
38.	Seed: main color	Dark brown	6
39.	Seed: stripes on margin	Strongly expressed	3
40.	Seed: stripes between margin	Strongly expressed	3
41.	Seed: color of stripes	Brown	3

Biological and economic properties

The sunflower hybrid Dea is medium early, with duration of the growth season 116-119 days. Plant height is within the range 160-165 cm, with head diameter 20-23 cm. The absolute weight of seeds is 58-62 g and oil content is 49-50 %. The oil is of linoleic type. The percent of kernel in seed reaches up to 74-75 %, and the protein in seed is 19-20 %. Seed weight per plant is 78-84 g, and seed number is 1150-1300. The duration of flowering is 12-14 days. The maximum yield obtained in the experimental fields of DAI was 4545 kg/ha, and in neighboring Romania – 5313 kg/ha.

The seed production of the new hybrid allows simultaneous sowing of the two parental lines because their flowering coincides. This is a great advantage with a view of the necessary agronomy practices. The father line 626 R is strongly branched and rich in pollen. The most suitable seed production scheme is 10:2 (mother to father lines), with at least 3-4 well developed bee colonies available per ha.

Preliminary testing at DAI – General Toshevo

Hybrid Dea was subjected to three-year testing in the trial fields of DAI, involving two-year testing in a competitive varietal trial and one-year testing in a unified competitive trial (Table 2).

Table 2. Testing of hybrid DEA at DAI - General Toshevo

Hybrids	Seed yield, kg/ha	% from mean standard	Oil percent, %	Oil yield, kg/ha	% from mean standard
2009 – competitive varietal trial					
Dea	4039	115,5	48,2	1947	121,4
San Luka (st.)	3031	86,7	44,6	1352	84,3
Klarisa (st.)	3317	94,9	49,3	1635	101,9
Brio (st.)	4139	118,4	44,1	1825	113,8
Mean standard	3496	100,0	46,0	1604	100,0
2010 – competitive varietal trial					
Dea	4097	114,5	50,8	2081	118,6
San Luka (st.)	3528	98,6	46,8	1651	94,1
Klarisa (st.)	5319	92,8	53,6	1779	101,4
Brio (st.)	3886	108,6	47,2	1834	104,5
Mean standard	3578	100,0	49,2	1755	100,0
2011 – unified varietal trial					
Dea	3767	106,1	49,1	1850	106,6
San Luka (st.)	3189	89,9	47,1	1502	86,5
Klarisa (st.)	3553	100,1	52,3	1858	107,0
Brio (st.)	3906	110,0	47,3	1848	106,5
Mean standard	3549	100,0	48,9	1736	100,0

During the period of testing, hybrid Dea exceeded the mean standard by seed yield with 6.1 – 15.5 %. The exceeding was highest in 2009 both by seed yield (15.5 %) and oil yield (21.4 %). The exceeding by oil yield for the three years of testing was within 6.6 – 21.4 %.

Both yields were highest in 2010: 4097 kg/ha seed yield and 2081 kg/ha oil yield. In the unified varietal trial, hybrid Dea was compared to the most promising and most productive hybrids of DAI, showing the following results: 6.1 % above the mean standard by seed yield and 6.6 % above the mean standard by oil yield.

The oil content of this hybrid reached 50.8 % and was higher than the standards San Luka and Brio.

Official testing

In 2012 hybrid Dea was provided to Saaten Union – Romania for official three-year testing on the territory of Romania and for registration. The results are given in (Table 3).

Table 3. Results from the official testing of hybrid “DEA”

Region	Hybrids	Yield kg/ha	% from stan dard	Yield kg/ha	% from stan dard	Yield kg/ha	% from stan dard	Relative yield according to the standard, averaged for 3 years
		2012		2013		2014		
1.Troian	Standard	1999	100	3821	100	1868	100	
	Dea	2030	102	3683	96	2366	127	108
2.Tecuci	standard	3154	100	4316	100	3393	100	
	Dea	3125	99	3511	81	3227	95	92
3.Rm.Sarat	standard	2124	100	4531	100	3292	100	
	Dea	2906	137	5313	117	3292	112	122
4.Portaresti	standard	2492	100	3487	100	3763	100	
	Dea	3437	138	4564	131	4614	123	131
5.Peciu Nou	standard	2873	100	3363	100	3230	100	
	Dea	3567	110	3470	103	3421	119	111
6.Negresti	standard	3057	100	4408	100	4201	100	
	Dea	2553	84	4043	92	3882	92	89
7.Mircea Voda	standard	2204	100	2698	100	4580	100	
	Dea	3123	142	3172	118	4958	108	123
8.Inand	standard	2441	100	3507	100	2495	100	
	Dea	2529	104	3578	102	2658	107	104
9.Dalga	standard	3801	100	4055	100	3518	100	
	Dea	3777	99	4367	108	3767	107	105
10.Cogealac	standard	1981	100	2240	100	2716	100	
	Dea	2496	126	2135	95	2059	76	99
Средно от 10 пункта	standard	2648	100	3642	100	3234	100	
Averaged from 10 locations	Dea	2954	112	3783	104	3424	106	109

The official testing of new hybrids in Romania is carried out at ten locations representative for almost all soil-and-climate regions suitable for growing of field crops.

Two Romanian hybrids were involved as standards. During the second and third year hybrid Daniel was used as a standard, and during the first year – hybrid Alex.

During the first year of official testing the new hybrid Dea gave a mean yield from all locations 2954 kg/ha, which was a 12 %-exceeding, the highest during the three-year testing. The low yield of kg per da was due to the unfavorable conditions in 2012 related to very high air temperatures for a long period of time and to the long-lasting drought during almost the entire growth season. Nevertheless, hybrid Dea demonstrated the best results among all tested hybrids in that year and performed as resistant to drought and high air temperatures.

During the second year the exceeding of the standard was with 4 % at seed yield 3783 kg/ha, which was the highest result from the official three-year testing. During the third year the exceeding was 6 %, the seed yield being 3424 kg/ha.

The highest seed yield was 5313 kg/ha from location Rm.Sarat in 2013, and the lowest - 2030 kg/ha from Troian in 2012. The highest exceeding of the standard with 12 % was at location Mircea Voda in 2012.

In seven out of ten locations hybrid Dea showed results exceeding the standard with up to 31 %. For the three years of testing, Dea exceeded the standard with 9 % and this was the main reason for its official registration and enlisting in the European catalog of field and vegetable crops.

Phytopathological characterization

The evaluation of the resistance of the hybrid to economically important diseases and the parasite *Orobanche* were carried out in the infection fields of DAI. The results from them are presented in (Table 4).

Table 4. Phytopathological evaluation of sunflower hybrids in artificial infection field at DAI – General Toshevo

Hybrid	Phomopsis helianthi		Phoma macdonaldi		Plasmopara helianthi		Orobanche cumana
	Attacking rate	Rank	Attacking rate	Rank	Resistance to race 700, %	Resistance to race 731, %	Resistance to races A-F, %
San Luka	3/3(3)	3	1/3(1)	1	100.0	92.9	100.0
Diabolo	2/3(2)	2	1/3(1)	1	100.0	90.5	100.0
Brio	1/3(1)	1	0	0	100.0	100.0	100.0
PR64F50	1/3(1)	1	0	0	100.0	100.0	100.0
Dea	1/3(1)	1	0	0	100.0	60.0	100.0

Hybrid Dea was resistant to the fungal pathogen *Phomopsis helianthi*. To the other important leaf pathogen *Phoma macdonaldi* the hybrid demonstrated immune reaction.

The resistance of hybrid Dea to downy mildew on sunflower *Plasmopara helianthi*, race 700 was 100 %, and to the most recent race 731 its resistance was moderate.

To the parasite *Orobanche cumana* the resistance was 100%.

CONCLUSIONS

- Hybrid Dea is clearly distinct, uniform and stable.
- It was officially registered in Romania and was enlisted in the European catalog of the field and vegetable crop varieties.
- It possesses very good adaptability and realizes its high potential under variable soil-and-climatic conditions.
- The hybrid is resistant to drought and high temperatures.
- It is also resistant to the economically important diseases and the parasite *Orobanche*.

LITERATURE

- Valkova D. 2013. Investigation on *Helianthus* species as sources of important breeding traits. Ph.D. Thesis 200 pp (Bg).
- Georgiev, D., P. Petrova, D. Genchev, P. Dimitrova, G. Sabev, N. Nankov, T. Tonev, G. Milev, V. Encheva, I. Kiryakov, 1997. Technology for production of sunflower and field bean, Agricultural Academy, IWS “Dobrudzha” near General Toshevo, 4-8 (Bg).
- Georgiev G., Peevska P., Shindrova P., Penchev E. 2012. Production potential and resistance to downy mildew and orobanche of experimental sunflower hybrids using line 217 as mother component. Field Crops Studies, vol VIII-2, p. 283-290 (Bg).
- Georgiev G., Encheva V. Veleka – a new Bulgarian sunflower hybrid. Field Crops Studies, 2014, Vol. IX-1, 79-87 (Bg).
- Encheva V., Georgiev G. 2009. Study and characterization of hybrid materials for resistance to the cause agents of grey (*Phomopsis helianthi*) and black (*Phoma macdonaldi*) spots on sunflower. Agricultural Academy. Plant breeding sciences, 46, p. 342-345 (Bg).
- Encheva, Y., G. Georgiev, N. Nenova, D. Valkova, G. Georgiev and M. Christov, 2014. Developing of sunflower lines and hybrids resistant to herbicides. Field Crops Studies, Vol. IX-1, 57-68 (Bg).
- Mihova G., D. Dimova, 2012. Characterization of the yield components in various fodder barley forms. Field crops studies, vol. VIII-1, 23-36 (Bg).
- Mihova G., 2012. Phenological peculiarities of winter barley under the conditions of North-East Bulgaria. Res. Com. of Institute of Agriculture – Karnobat, No 1, 17-32 (Bg).
- Nenova N., G. Georgiev, M. Drumeva, E. Penchev, 2012. Vokil and Veleka – promising sunflower hybrids. Agricultural science 45, No. 4, 25-29 (Bg).
- Panchenko, A. Y., 1975. Agricultural Science Newsletter, No 2 (Ru).
- Tahsin, N., 2012. Productivity of oilseed sunflower hybrid depending on the soil type. Agricultural sciences, IV. No 11, 27-32 (Bg).
- Chamurliyski, P., N. Tsenov, I. Stoeva, 2011. Productivity and quality of modern Bulgarian bread wheat varieties (*Triticum aestivum* L.), FCS 7, №2; p-p 233-241
- Chamurliyski, P., N. Tsenov, 2013. Yield stability of contemporary Bulgarian winter wheat cultivars (*Triticum aestivum* L.) in Dobrudzha. Agricultural Science and Technology, vol. V, № 1, p-p 16-21
- Christov M, Piskov A, Encheva J, Valkova D, Drumeva M, Nenova N, Nikolova V, Encheva V, Shindrova P, Petrov P and Georgiev G, 2009. Developing sunflower hybrid cultivars with increased productive potential, resistant to economic important for the country diseases and parasite broomrape using classical and biotechnological methods. Современные научные проблемы создания сортов и гибридов масличных культур и технологии их выращивания. Сборник тезисов международной конференции (4-6 августа, 2009 г., Запорожье). Украинская Академия Аграрных Наук, Институт масличных культур. Запорожье, 80-82.

- De La Vega, A.J. and Hall, A.J.,2002. Effect of planting date, genotype and their interaction on sunflower yield: I. Determinants of oil-corrected grain yield. *Crop Sci.* 42:1191-1201.
- De La Vega, A.J. and Hall, A.J.,2002. Effect of planting date, genotype and their interaction on sunflower yield: II. Components of oil yield. *Crop Sci.* 42:1202-1210.
- Encheva V. and I. Kiryakov, 2002. Method for evaluation of sunflower resistance for *Diaporthe (Phomopsis) helianthi* Munt. Cnet. Et al. *Bulgarian Journal of Agricultural Science* 8:219-222.
- Encheva J, Shindrova P, Encheva V and Penchev E, 2011. Sunflower hybrid Yana, developed with mutant restore line R 12003, *Field Crops Studies*, Vol. VII – 1, 71-81.
- Encheva V, J. Encheva, N. Nenova, D.Valkova, G. Georgiev, P. Peevska, G. Georgiev and P. Shindrova. 2014. Sunflower lines and hybrids, resistance to economic important for Bulgaria pathogens, developed by applying classical and biotechnological methods. *Balkan Agriculture Congress*, 8-11.09. 2014, Edirne, Turkey. *Turkish Journal of Agricultural and Natural Sciences*. Sp. issue: 1, p.p. 1254-1257.
- González, J., Mancuzo, N., Ludueña, P.2013. Sunflower yield and climatic variables. *HELIA*, 36,Nr. 58, p.p.69-76.
- Georgiev G., P. Peevska, E. Penchev, 2013. Testing of new Bulgarian sunflower hybrids under the conditions of North-East Bulgaria. I. Productivity and traits related to productivity. *Agricultural Science and Technology*. Volume 5, Number 4, 371-375.
- Georgiev G, P. Peevska , E. Penchev , 2014. Testing of new Bulgarian sunflower hybrids under the conditions of North-East Bulgaria.
- II. Phenological specificity. *Agricultural Science and Technology*. Volume 6, Number 4, 403-408.
- González, J., Mancuzo, N., Ludueña, P.2013. Sunflower yield and climatic variables. *HELIA*, 36,Nr. 58, p.p.69-76.
- Marinković, R., Jocković, M., Marjanović-Jeromela, Ana, Jocić, S., Ćirić, M., Čanak, P. and Radeka, I., 2011. Stability evaluation of new sunflower (*H. annuus* L.) hybrids. *In: Proc.52nd meeting of oil processing industry: "Production and processing of oilseeds"*, Herceg Novi, Montenegro, June 5-10, 2011. *Business association "Industrial plants"*, Novi Sad,Serbia. 52: 53-62.
- Mehmet Demir Kaya and Ozer Kolsarici, 2011. Seed yield and oil content of some sunflower (*Helianthus annuus* L.) hybrids irrigated at different growth stages. *African Journal of Biotechnology* Vol. 10(22), p.p. 4591-4595.
- UPOV, 2002. Protocol for distinctness uniformity and stability tests (*Helianthus annuus* L.)European Union Community plant variety office, 10-28.
- Valkova D., Nenova N., Georgiev G., Encheva V., Emil Penchev, Julia Encheva. 2014. Seed component diversity of hybrid forms, originated from wild *Helianthus* species. *Balkan Agriculture Congress*, 8-11.09. 2014, Edirne, Turkey. *Turkish Journal of Agricultural and Natural Sciences*. Sp. issue: 2, p.p. 1590-1595.
- Vear F. and D. Tourvielle, 1987. Test the resistance au Mildiou chez le tournesol. CETIOM. *Information techniques*, vol. 98, pp. 19-20.