

ALPIN – A NEW BULGARIAN SUNFLOWER HYBRID

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Abstract

Sunflower hybrid Alpin was developed at Dobrudzha Agricultural Institute – General Toshevo (DAI). It is a male sterile two-linear hybrid derived through inter-linear hybridization. The mother component is line 2607, which possesses cytoplasmic male sterility, and the father component is line 10681R, a branched fertility restorer. Both parental forms have excellent general and specific combining ability. Hybrid Alpin is early maturing, its vegetative growth duration is 115 – 121 days. Plant height is within the range 145 – 180 cm, and the head diameter – within 18 – 21 days. Thousand kernel weight varies within 53 – 60 g, and the oil content is 45-47 %. The oil is of linoleic type. Protein content in the whole seed is 18 – 20 %. The number of seeds per plant is 1090 – 1250, and their weight is 70 – 75 g. The duration of flowering is 12 – 13 days. In the trial fields of DAI, the hybrid went through two-year testing, showing a maximum yield of 4230 kg/ha, while in Romania the maximum seed yield obtained in the process of official testing was 4513 kg/ha. The hybrid demonstrated high field resistance to the economically important diseases and the parasite *Orobanche*. In 2008, hybrid Alpin was provided to our partners from Saaten Union – Romania; following one-year successful testing in their trial fields, it was submitted for official testing within the system of the State Institute for Variety Testing and Registration – ISTIS, Romania. Averaged for the three years of official testing at 10 locations, the new hybrid exceeded the standard with 8 % by the index seed yield. In 2012, hybrid Alpin was officially registered in Romania with certificate No 1197/10.02.2012 and was enlisted in the European Catalog of Field and Vegetable Crop Varieties.

Key words: Sunflower, Hybrid, Productivity, Testing, Disease Resistance

Introduction

As a result from successful breeding work, a great number of high-yielding sunflower hybrids have been developed at Dobrudzha Agricultural Institute (DAI) (Christov et al., 2009; Encheva et al., 2011; Georgiev and Encheva, 2014; Encheva et al., 2015; Georfiev, 2015; Peevska and Georgiev, 2016; Georgiev, 2016). The breeding work at DAI is in line with the contemporary requirements for sunflower production and with the scientific achievements worldwide, it depends on the collected initial materials, the applied breeding methods and, finally yet importantly, on the potential of the staff involved in the breeding work.

Under the conditions of Bulgaria, the medium early hybrids with duration of the vegetative growth 120 – 125 days are most suitable. Such hybrids have been developed at DAI in the past decade: Valin, Veleka, Vokil, Gabi, Velko, Alpin, Mihaela, Dea, Deveda, Divna, Vyara, Tedi, Lindzi, etc. Early maturing hybrids have also been developed, such as the hybrids Sava and Maritsa, which are being successfully grown in the northern regions of Bulgaria.

Similar to the breeding programs of other field crops, the priorities are genotypes with high adaptability potential (Mihova et al., 2017) and efficiency of the production (Dimitrova-Doneva, 2016).

In the past few years, the volume of the breeding work is increasing in relation to developing herbicide-resistant sunflower hybrids (Encheva et al., 2016; Valkova et al., 2017), which are becoming dominant on the market and the demand for them is getting greater. Such hybrids have

already been developed at DAI; they are now within the system for official testing both in Bulgaria and abroad and their registration and distribution on the market is forthcoming.

The development of good sunflower hybrids is not difficult for us because our collection of parental lines is very rich and variable and is constantly being enlarged, and our breeders are qualified and experienced. Our breeding programs are very well elaborated and are being applied strictly and consistently. Our main problem is that after having developed a new high-yielding hybrid, it is difficult for us to position it well on the market, which requires serious advertising and marketing activities implying mostly serious financial resources. Therefore, we have to provide our research products to other companies with greater marketing and management possibilities.

The aim of this investigation was to present a more detailed morphological, biological and economic characterization of the Bulgarian sunflower hybrid Alpin.

Material and methods

Sunflower hybrid Alpin is a male fertile simple hybrid derived through the method of inter linear hybridization. The mother line 2607 was developed by selection of lines obtained from the Russian variety Birimirets. This line participated as a mother component in the most famous hybrid of DAI Albena, which was a world standard and occupied almost 40 % of the area with sunflower crops in France. Line 2607 was involved in many of our hybrids, such as Merkurij, Magura, Mussala, Michaela, Yana, Rada, etc., as well as in many hybrids developed jointly with our foreign partners, such as San Luka, All Star, Santafe, Alliance, etc. The sunflower hybrids involving mother line 2607 remained longest on the sunflower seed market in the past few decades. Line 2607 possesses exceptionally good combining ability. It is resistant to downy mildew and lodging, tolerant is to rust and moderately susceptible to phoma and phomopsis. It does not have resistance to the parasite *Orobanche*.

The father line of hybrid Albena is the fertility restorer 10681R. It is a branched line rich in pollen and restores the fertility of the hybrid to 100 %. It was obtained by combining conventional and biotechnology breeding methods. The line is resistant to downy mildew races up to 731 and to the parasite broomrape up to race F. It is moderately resistant to phoma, phomopsis and alternaria.

The cross between the two parental lines was first made in 2002, then it went through a 3-year testing in the breeding fields of DAI – two years of control testing and one year in a unified competitive varietal trial. The testing of all sunflower hybrids was carried out according to a technology officially approved for growing of this crop (Georgiev et al., 1997). The hybrid was subjected to testing for two more years at different locations in Bulgaria, and was then provided in 2008 to our partners from company Saaten Union – Romania.

Having gone through one-year testing and demonstrating very good results, it was submitted for official testing within the system of the State Institute for Variety Testing and Registration – ISTIS, Romania. In another three years of successful tests and very good results, hybrid Alpin was officially registered with certificate No 1197/10.02.2012 in the European Catalog of field and vegetable crop varieties.

The description of the morphological traits of the hybrid was done according to the UPOV protocol (2002). The plant pathology characterization was carried out at Dobrudzha Agricultural Institute – General Toshevo. The resistance to downy mildew (*Plasmopara halstedii*) was determined by a standard methodology (Vear, F., Tourvieille, D., 1987) adapted to the working conditions at DAI. The response of the hybrid to races 700 and 731 of the pathogen was presented as percent of resistance. The resistance to grey spots on sunflower (*Phomopsis helianthi*) was evaluated by the method of Encheva, V. & I. Kiryakov, (2002) under field conditions, in an artificial infection field. The type of attack was read one week after full flowering and at stage milk maturity according to the following scale: 0 – no symptoms; 1 – necrotic spot of up to 5 cm in diameter; 2 – necrotic spot larger than 5 cm in diameter; 3 – several necrotic spots merging on the stem; 4 – stem breaking at the place of infection. The testing for black spots on sunflower (*Phoma macdonaldii*) was done under artificial infection field conditions. Inoculation was done at stage budding – full maturity according to the method of Maric et al. (1981). The response of the plants was read at stage yellow-

brown maturity according to a 4-degree scale: 0 – no symptoms; 1 – necrotic spot localized around the petiole; 2 – several necrotic spots merging on the stem; 3 – entire stem covered with necrotic spots or breaking. The attacking rate was determined on the basis of the part of the stem covered with spots of the pathogen (1/3, 2/3, 3/3). The figures in the brackets show the number of spots. The ranking was as follows: 0 – immune; 1 – resistant; 2 – moderately resistant; 3 – moderately susceptible; 4 – susceptible.

The resistance to the parasite broomrape (*Orobancha cumana*) was determined by the method of Panchenko (1975). The evaluation was carried out under greenhouse conditions using the index percent of resistance.

Results and discussion

Morphological description

Applying the UPOV protocol (2002), a morphological description of hybrid Alpin was made (Table 1).

Table 1. Morphological characteristics of sunflower hybrid Alpin

№	Traits	Expression	Degree
1.	Hypocotyl:anthocianin coloration	Present	9
2.	Hypocotyl:anthocianin coloration	Strong	7
3.	Leaf: size	Medium	5
4.	Leaf: green color	Medium	5
5.	Leaf: blistering	Medium	5
6.	Leaf: serration	Coarse	7
7.	Leaf: shape of cross section	Flat	3
8.	Leaf: shape of distal part	Acuminate	7
9.	Leaf: auricles	Medium	5
10.	Leaf: wings	Absent	1
11.	Leaf: angle of lowest lateral veins	Right or nearly right	2
12.	Leaf: height of the tip of the blade compared to insertion of petiole (at 2/3 height of plant)	Medium	5
13.	Stem: intensity of hairiness at the top	Medium	5
14.	Time of flowering	Medium	5
15.	Ray flower: density	Medium	5
16.	Ray flower: shape	Narrow ovate	2
17.	Ray flower: disposition	Flat	1
18.	Ray flower: length	Medium	5
19.	Ray flower: color	Orange yellow	4
20.	Disk flower color	Orange	2
21.	Disk flower: anthocyanin coloration of stigma	Present	9
22.	Disk flower: intensity of anthocyanin coloration of stigma	Weak	3
23.	Disk flower: presence of pollen	Present	9
24.	Bract shape	Rounded	3
25.	Bract: length of the tip	Medium	5
26.	Bract: green color of the external part	Medium	5
27.	Bract: attitude in relation to head	Slightly embracing	2
28.	Plant: natural height	Medium	5
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 convex	4
35.	Seed: size	Medium	5
36.	Seed: shape	Broad ovoid	3
37.	Seed: thickness relative to width	Medium	5
38.	Seed: main color	Black	7
39.	Seed: stripes on margin	Weakly expressed	2
40.	Seed: stripes between margin	Weakly expressed	2
41.	Seed: color of stripes	Grey	2

Biological and economic properties

Hybrid Alpin is early maturing, with duration of the vegetative growth 115 – 121 days. Plant height is within 145-180 cm, and the head diameter is 18-21 cm. Thousand kernel weight varies within 53 – 60 g, and oil content is 45-47 %. Oil is of linoleic type. The protein content in the whole seed is 18-20%. The number of seeds per plant is 1090 – 1250, and their weight – 70-75 g. The duration of flowering is 12 – 13 days. In the experimental fields of DAI, the hybrid demonstrated a maximum yield of 4230 kg/ha, and in the process of official testing in Romania, the maximum seed yield was 4513 kg/ha.

The seedproduction scheme of Alpin is 10:2 (mother line : father line). Since the mother line is early flowering, it is recommended to plant the father lines 6-7 days earlier to ensure simultaneous flowering of the two lines. Furthermore, in order to ensure more pollen, a third row of the father line can be planted during the sowing of the female line, between the two rows already planted earlier. For higher yields in seedproduction, 3-4 well developed bee colonies are recommended per hectare.

Productivity

Official testing

Hybrid Alpin was provided for the first time to company Saaten Union – Romania in 2008, when its testing began there. After showing very good results during the first year of testing, it was subjected to official testing. Table 2 shows the results.

Table 2. Results from the official testing of hybrid Alpin

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
1.Troian	Standart	2649	100	2961	100	3556	100	
	Alpin	2671	101	3502	118	3610	102	107
2.Tecuci	Standart	3647	100	4103	100	3921	100	
	Alpin	4148	114	3723	91	3762	96	100
3.Rm.Sarat	Standart	3988	100	3468	100	4418	100	
	Alpin	4407	111	4188	121	4513	102	111
4.Portaresti	Standart	2196	100	3355	100	3063	100	
	Alpin	2546	116	3513	105	3529	115	112
5.Peciu Nou	Standart	2580	100	2244	100	3928	100	
	Alpin	3476	135	3083	137	3606	92	121
6.Negresti	Standart	2761	100	4285	100	4174	100	
	Alpin	3958	143	4156	97	4120	99	113
7.MirceaVoda	Standart	3618	100	2901	100	3780	100	
	Alpin	2920	81	3875	134	3593	95	103
8.Inand	Standart	3578	100	3049	100	3253	100	

	Alpin	3782	106	3153	103	3351	103	104
9.Dalga	Standart	4170	100	3162	100	3606	100	
	Alpin	4342	104	3841	122	3623	101	109
10.Cogealac	Standart	1899	100	2879	100	2898	100	
	Alpin	2353	124	3164	110	2388	82	105
Averaged from 10 locations	Standart	3108	100	3240	100	3659	100	
	Alpin	3489	112	3619	112	3609	99	108

The official testing was carried out for 3 years at 10 locations, using hybrid Alex as a standard during the first and second year, and hybrid Daniel, the higher-yielding of the two standards, during the second year. Table 3 presents only the data on the seed yield per ha, which is the determining index for the registration of new sunflower hybrids. The seed yield of the new hybrid Alpin varied during the three year within 2353 – 4513 kg/ha. The mean values were highest during the second year of the official testing 3619 kg/ha; in that year, the exceeding of the standard was with 12 %, averaged for all locations. Averaged for all three years, the new hybrid exceeded the standard at all 10 testing locations. During the entire 3-year period, Alpin exceeded the standard with 8 %, and this was the main reason for its official registration and enlisting in the European Catalog of field and vegetable crop varieties.

Phytopathological characterization

The phytopathological evaluation was carried out in the infection field of DAI, where all new materials are subjected to testing for the economically important diseases and the parasite broomrape together with the commercial hybrids most widely distributed in Bulgaria, used as standards at the national Executive Agency of Variety Testing, Field Inspection and Seed Control. For the purposes of comparison, phytopathological evaluation of the most recent hybrids of DAI was also done. The results are presented in Table 3.

Table 3. Phytopathological evaluation of sunflower hybrids in artificial infection field at DAI – General Toshevo.

Hybrid	<i>Phomopsis helianthi</i>		<i>Phoma macdonaldi</i>		<i>Plasmopara helianthi</i>		<i>Orobanche cumana</i>
	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
Perfekt	1/3(1)	1	1/3(1)	1	84.5	-	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
Meldimi	2/3(2)	2	1/3(1)	1	100.0	90.0	100.0
Valin	2/3(2)	2	1/3(1)	1	95.0	75.0	100.0
Mihaela	2/3(2)	2	1/3(1)	1	100.0	100.0	100.0
Gabi	1/3(1)	1	0	0	100.0	100.0	100.0
Alpin	2/3(2)	2	1/3(1)	1	100.0	100.0	100.0
Veleka	1/3(1)	1	0	0	100.0	100.0	100.0
Vokil	1/3(1)	1	0	0	100.0	90.0	100.0
Velko	1/3(1)	1	0	0	100.0	100.0	100.0
Dea	1/3(1)	1	0	0	100.0	70.0	100.0
Sevar	1/3(1)	1	0	0	100.0	100.0	100.0

Hybrid Alpin, similar to Diabolo and Meldimi, is moderately resistant to the fungal pathogen *Phomopsis helianthi*, like other more recent hybrids of DAI (Michaela and Valin). It demonstrated higher tolerance to this disease than San Luka.

To the other important leaf pathogen *Phoma macdonaldi*, Alpin exhibited resistance similar to the Bulgarian hybrids San Luka, Perfekt, Michaela and Valin, and the foreign hybrids Diabolo and Meldimi. The other genotypes presented in Table 3 showed immune type of reaction.

Hybrid Alpin demonstrated full resistance to downy mildew *Plasmopara helianthi* (to the two investigated races).

The resistance to the parasite *Orobanche cumana* the resistance was 100%, as well as the resistance of almost all other hybrids involved in the investigation.

Conclusions

The new Bulgarian sunflower hybrid Alpin is clearly distinct, homogenous and stable;

It has very good adaptability and realizes its high potential under variable soil and climatic conditions;

It demonstrated high field resistance to the economically important diseases and the parasite *Orobanche*;

It was officially registered in Romania and was enlisted in the European catalog of field and vegetable crop varieties.

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