

Krasela – the first Bulgarian sunflower hybrid, resistant to broomrape (race H) and stable yield potential under limited moisture conditions

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Abstract

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Plant responses to stress are an increasingly frequent subject of research investigations, especially if the stress factors are biotic and abiotic. The parasite broomrape can reduce sunflower yields to zero levels, and as climate change intensifies, droughts are getting longer, affecting agriculture and human livelihoods. In the breeding programs of Dobrudzha Agricultural Institute – General Toshevo main objective is to create drought-resistant and disease-resistant hybrids sunflower. The aim of this study is to make a complete characterization of the conventional sunflower hybrid Krasela and its reaction to the resistance of the parasite *Orobanche cumana* Wallr. (race H) in a particularly dry and middle wet year. There are a different Ecological experiments in different regions of Bulgaria /three points – Brashlen, Radnevo and Selanovtsi/ and Ukraine /2 points – Zaporozhye and Kirovograd/. The indicators “seed yield”, “oil yield” compared to the relevant standard during the years of testing and the resistance of the hybrid to diseases – mildew, thoma, thomopsis, and the parasite *Orobanche cumana* are observed and traced. Over the years of the study, hybrid Krasela has shown stable yields, even in the particularly dry year – 2020 and the middle wet 2019 year.

Keywords: hybrid; sunflower; biotic and abiotic stress factors; *Orobanche cumana* Wallr.

Introduction

The Earth's climate is in constant change, and so has the crops development conditions. A crop moves from one phase to another in its development, as a result of reaching certain temperature sums. In the recent years we have been constantly speaking of a drastically changing climate, mainly referred to as the Global Warming. Some conclusions drawn from this research are that the rise of air temperatures during the XX century has been the highest in comparison with previous centuries, as the 1906–2005 year period, the medium air temperature has been 0.74°C higher. From the beginning of XX century, the rain over North Europe has risen with 10 to 40%, while the rain over some regions in South Europe (Bulgaria amongst them) has declined up to 20%. The most notable drought was during the year 2000. Those regions include Dobrudzha and

the south regions of northwest Bulgaria. The breeding programs of Dobrudzha Agricultural Institute – General Toshevo are include to create drought and diseases resistant sunflower hybrids. Nowadays the breeding puts into practice a large number of hybrids and varieties with high genetic potential, combined with good qualitative characters. The market proposes huge performance of sunflower hybrids. Therefore, the producer has to possess a disposable information for biological and economic qualities of every product with aim to establish the correct variety structure in the region, where the relevant hybrid will be planted. This is a prerequisite factor for avoiding some of the stress factors and guarantee for success. Developing of high productive sunflower hybrids is the main priority of present intensive agriculture.

The present hybrids combine high seed yield, low moisture content at harvesting, resistance to stress factors as

drought, high temperatures, diseases and broomrape. Their seeds are distinguished with high oil content and they are much in demand by crushing industry. Improving of qualities of commercial hybrids is strongly connected to their breeding. Many breeding programs were directed to market supply with various hybrid seeds. The main factor, determined the obtaining of high and qualitative seed yield is the correct alternative of suitable hybrids for each region. They have to insure the high yield in combination with high oil content, resistance or tolerance to the most important diseases, pests and parasites. It is very difficult or almost impossible all these characters to be included in one hybrid. This is a main purpose in the research programs of the breeding centers.

In Dobrudzha Agricultural Institute – General Toshevo is increasing the amount of breeding work related to the creation of such hybrids sunflower (Encheva, V. & Kiryakov, I., 2002; Encheva et al., 2016; Valkova et al., 2017). We already have an extremely rich and diverse collection of parent lines, created both through the methods of classical selection and their combination with various biotechnological methods (Encheva et al., 2014; 2015; Nenova et al., 2014; Nenova et al., 2016). All this is a valuable starting breeding material, which is the reason why in the last decade the institute has created a large number of highly productive lines and hybrids of sunflower, which have been officially recognized and are already distributed over large areas (Georgiev & Encheva, 2014; Georgiev et al., 2015; Georgiev, 2015, 2016, 2017; Peevska & Georgiev, 2016).

The aim of the present study is to make a detailed characteristics of newly registered conventional Bulgarian hybrid of newly registered Bulgarian hybrid Krasela, resistance to *Orobanche* and the response in the particularly dry year 2020 and moderately dry year – 2019.

Material and Methods

Hybrid Krasela (Figure 1) is a single cross hybrid, developed on the method of interlinear hybridization (217A x N44R/). The maternal line 217A was obtained by crossing of experimental hybrid N:72 and line 246, created from Russian cultivars, self-pollination and selection. The mother line was characterized with good general and specific combining ability. It is resistant to broomrape, race F, middle resistant to phoma, alternaria and phomopsis. During the last several years it was a maternal component of newly registered hybrids Veleka, Vokil, Linzi, Deveda, etc.

The paternal component of hybrid Krasela is the branched line-restorer of fertility N44R. That line was obtained using the method of induced parthenogenesis from the experimental hybrid 509×523, self-pollination, embryo culture and se-



Fig. 1. Hybrid Krasela

lection. It is resistant to downy mildew, race 731 and resistant to broomrape, race H. It is middle resistant to phomopsis and alternaria, resistant to phoma.

Results and Discussion

Morphological description

Morphological description of hybrid Krasela on UPOV (2002) was done. The described characters were presented on Table 1.

Values for cultivation and use (VCU) of hybrid Krasela

It is a fact that climate change has direct effects on the plant productivity. Tables 3 and 4 show the results of the seed yield for the two years during which the rainfall is very low and insufficient for the vegetative period (Table 2). During the two drought years, the hybrid Krasela did not show its maximum productive potential, but still gave a stable yield of 320–413 kg. and this hybrid can be offered to farmers in dry years such as 2019 and 2020.

Biochemical and phytopathological characteristics of hybrid Krasela

The oil content in the seeds of the Krasela hybrid is not affected by drought conditions. This is shown in Tables 5

Table 1. Morphological characteristics of sunflower hybrid Krasela

Traits	Expression	Degree
1. Hypocotyl: antocianic pigmentation	Absent	1
2. Hypocotyl: intensity of antocianic pigmentation	Absent	1
3. Leaf: size	Medium	5
4. Leaf: color	Medium green	4
5. Leaf: blistering	Weak	3
6. Leaf: serration	Very coarse	7
7. Leaf: share of cross section	Flat	2
8. Leaf: shape of distal part	Very strong	7
9. Leaf: auricles	Very large	2
10. Leaf: wings	Weakly present	2
11. Leaf: angle of lateral veins	Obtuse	3
12. Leaf: height of the tip of the blade compared to insertion of petiole (at 2/3 height of plant)	Present	3
13. Stem: intensity of hairiness at the top	Strong	7
14. Time of flowering	Medium to late	6
15. Ray flower number	Medium	5
16. Ray flower shape	Ovoid	2
17. Ray floret:disposition	Medium	5
18. Ray flower length	Medium	5
19. Ray flower color	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	Absent	1
23. Disk flower presence of pollen	Present	9
24. Bract shape	Rounded	3
25. Bract length of the tip	Medium	5
26. Bract color of the external part	Medium green	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: posture at ripeness	Half-turned down	7
33. Head: size	Medium to Large	6
34. Head: shape of grain side	Convex	3
35. Seed: size	Medium to large	6
36. Seed: shape	Ovoid elongated	2
37. Seed: thickness	Medium to thick	5
38. Seed: main color	Black	7
39. Seed: stripes on margin	Weakly present	2
40. Seed: color of stripes	Weakly present	2

and 6. For both years the oil content in the seeds is 45.6% and 47.6%. The excess over the average standard is 6.6% for the two years. In addition to productive indicators, breeders must also create disease- and parasite-resistant varieties and hybrids. Climate change also affects the race composition of pathogens. Plant pathologists have always considered

environmental influences in their studies of plant diseases: the classic disease triangle emphasizes on the interactions between plant hosts, pathogens and the environment. The Krasela hybrid is resistant to the *Orobanche cumana*- race H. This is the only Bulgarian hybrid resistant to this race and can grow to areas that are highly infected with the *Oro-*

Table 2. Climatic characteristics for 2019 and 2020 for the period March – September

Month	Year	Place	Precipitation, mm/m ²
March-September	2019	Selanovci	233.4
		Brashljin	279.2
		Radnevo	281.6
Average			264.7
March-September	2020	Selanovci	319.6
		Brashljin	263.2
		Radnevo	209.3
Average			264.0

banche pathogen. Radnevo is a region in Bulgaria where the soils are most infected with the most aggressive races *Orobanche*. These data show that even in drought the hybrid has given stable yields close to the standards.

Conclusion

Climate changes mostly affect agricultural production. Research on the climate change impact on plant disease has led to a new aim: to create a drought-resistant sunflower, highly productive hybrid with genes that control diseases, conducive to high temperatures and low soil moisture. Hybrid Krasela is a conventional hybrid and middle early hy-

Table 3. Seed yield, kg/da – 2019

Hybrid	Selanovci		Brashljin		Radnevo		Average	
	kg/da	%	kg/da	%	kg/da	%	kg/da	%
Standard (NK Brio+LG5662)	485	100.0	425	100.0	357	100.0	423	100.0
NK Brio	482	99.4	473	111.1	389	109.0	448	106.0
LG5662	488+++	100.6	378+++	88.9	325	91.0	397	94.0
Krasela	403	83.1	441	103.6	396	110.9	413	97.8
GD, 5%	22.86	4.71	26.56	6.24	37.62	10.53		
GD, 1%	30.45	6.28	35.37	8.31	50.09	14.02		
GD, 0.1%	39.68	8.18	46.10	10.84	65.29	18.28		

Table 4. Seed yield, kg/da – 2020

Hybrid	Selanovci		Brashljin		Radnevo		Average	
	kg/da	%	kg/da	%	kg/da	%	kg/da	%
Standard (NK Brio+LG5662)	392	100.0	365	100.0	302	100.0	353	100.0
NK Brio	383	97.8	391	107.1	257	84.9	343	97.3
LG5662	401	102.2	339	92.9	348++	115.1	362	102.7
Krasela	363	92.6	353	96.8	246	81.2	320	90.8
GD 5%	6.46	1.65	21.02	5.76	33.65	11.14		
GD 1%	8.64	2.20	28.10	7.70	44.98	14.89		
GD 0.1%	11.32	2.89	36.85	10.1	58.99	19.53		

Table 5. Oil content, % – 2019

Hybrid	Selanovci		Brashljin		Radnevo		Average	
	%	St %	%	St %	%	St %	%	St %
Average standard (NK Brio+LG5662)	44.30	100.0	43.95	100.0	48.60	100.0	45.62	100.0
NK Brio	49.10	110.8	45.90	104.4	50.10	103.1	48.37	106.0
LG5662	39.50	89.2	42.00	95.6	47.10	96.9	42.87	94.0
Krasela	46.30	104.5	48.30	109.9	48.30	99.4	47.63	104.4

Table 6. Oil content, % – 2020

Hybrid	Selanovci		Brashljin		Radnevo		Average	
	%	St %	%	St %	%	St %	%	St %
Average standard (NK Brio+LG5662)	45.50	100.0	41.55	100.0	43.75	100.0	43.60	100.0
NK Brio	47.80	105.1	43.00	103.5	45.00	102.9	45.27	103.8
LG5662	43.20	94.9	40.10	96.5	42.50	97.1	41.93	96.2
Krasela	48.10	105.7	44.60	107.3	44.20	101.0	45.63	104.7

brid. It has a stable yield during the dry years and the content of oil in the seeds is about 47%. The hybrid is resistant to downy mildew (race 731) and broomrape (race H) and middle resistant to phoma and phomopsis. The hybrid needs no special requirements for cultivation.

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