

## Research Article

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# New form cultivated sunflower (*Helianthus annuus* L.) with resistance to the herbicides Pulsar and Express

<https://doi.org/10.1515/helia-2020-0007>

Received April 28, 2020; accepted November 12, 2020;

published online November 30, 2020

**Abstract:** New traits that are useful for the cultivated sunflower can be received by applying classical breeding methods. A new form sunflower that is resistant to herbicides Pulsar and Express was obtained by hybridization between the sunflower mutant M-95-674 and the line HA 425. Test results from the period 2017–2019 confirm the resistance to both herbicides. This resistance can be transferred into other classical selected lines.

**Keywords:** hybridization; mutant; new traits; sunflower.

## Introduction

Classical breeding methods are used in the process of creating genetically resistant forms of sunflower to many diseases and pests (Christov 1990, 2013; Pustovoit 1975; Skoric 2012, etc.). The received new sunflower materials are also enriched with many other useful traits such as the development of resistance to certain herbicides (Al-Khatib and Miller 2000; Miller and Al-Khatib 2002, 2004, etc.). This study aims to use lines, obtained by different methods, for hybridization and to create new sunflower forms which will be carriers of resistance, possibly simultaneously to two or more herbicides, to some diseases and the parasite broomrape.

## Materials and methods

Mutant line M-95-874 B and line HA 425 B were used as the maternal and paternal form in respect. The mutant M-95-874 is a form obtained from dry dormant seeds of sunflower cultivar VNIIMK 8931

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irradiated with 150 Gy gamma rays (Co 60) (Christov 1996). Some of the morphological characteristics of it are controlled by recessive genes. The leaves and the leaf petiole have a specific form, different from that of the majority of sunflowers. This defines the mutant as an ornamental plant. M-95-874 is resistant to broomrape, race E. The line HA 425 is an IMI type and is resistant to the herbicide Pulsar (Miller and Al-Khatib 2002).

The study was initiated twice. The first hybridization between the two lines was done in 2005, and the first treatment of  $F_2$  plants took place in 2007.  $F_2$  plants were divided into two groups and treated separately with Pulsar and Express. Some of the results from this study were published (Christov et al. 2008). In 2015, old seeds of mutant M-95-874 were used for the second hybridization. Three plants were isolated and manually castrated. They were pollinated with pollen from line HA 425. In 2017, the newly produced  $F_2$  plants were again equally split into two sets and separately sprayed with both herbicides. The utilized doses of the herbicides were – for Express 5 g/dka, for Pulsar – 120 ml/dka.

The aim of hybridization between these two lines is to obtain new combinations of important characteristics, in addition to the morphological changes of some of the features in mutant M-95-874.

## Results and discussion

The results for the treatment of  $F_2$  plants (second generation in 2017, obtained from the cross made in 2015), are shown in Table 1.

From the data in Table 1, it can be seen that the number of surviving plants after treatment is large. These results suggest that sunflower lines resistant to both Pulsar and Express can be created from the obtained breeding material. The test results received in 2018 and 2019 of the third and fourth hybrid generation are similar or better to those of 2017. Tables 2 and 3 summarize the results of the 2019 test and the morphological features found in the plants of some of the numbers.

**Table 1:** The results from the treatment of  $F_2$  plants with Express and Pulsar, 2017.

From	Treated plants with Express			Treated plants with Pulsar		
	Field number	Treated, $n$	Alive, $n$	Field number	Treated, $n$	Alive, $n$
$F_1$ – plant 1	394	16	13	578	19	11
$F_1$ – plant 2	395	13	12	579	21	18
$F_1$ – plant 3	396	17	15	580	16	10
$F_1$ – plant 4	397	22	15	581	16	11
$F_1$ – plant 5	398	–	–	582	12	11
$F_1$ – plant 6	399	–	–	583	9	9
$F_1$ – plant 7	400	17	12	584	22	17

**Table 2:** The results from the test of plants from the fourth hybrid generation treated with herbicide Express, 2019.

Field number – Pedigree	Number treated plants	Alive, <i>n</i>	Feature
256 – 394/17	16	15	Leaves similar to M-95-874
257 – 394/17	5	5	Leaves similar to M-95-874
258 – 396/17	13	13	
259 – 396/17	20	20	
260 – 397/17	16	16	
261 – 395/17	13	11	

**Table 3:** The results from the test of plants from the fourth hybrid generation treated with herbicide Pulsar, 2019.

Field number – Pedigree	Number treated plants	Alive, <i>n</i>	Feature
839 – 578/17	17	17	
840 – 579/17	17	15	Leaves similar to M-95-874
841 – 580/17	16	16	Leaves similar to M-95-874
842 – 581/17	17	17	
843 – 581/17	15	15	
844 – 582/17	15	14	
845 – 583/17	16	16	

In 2017, to answer the question “how to inherit the resistance to two herbicides” new crosses were made between the resistant plants with field numbers 396 and 397 from the group treated with Express and the not resistant B lines. The line which was not resistant to herbicides was used as the maternal form. The disk flowers of the inflorescences of the plants were castrated manually. The obtained F1 plants were treated with the herbicide Pulsar. The results are presented in Table 4.

In Table 5 are shown the results obtained by the treatment of F<sub>2</sub> plants with herbicide Pulsar.

**Table 4:** The results from the treatment of  $F_1$  plants with Pulsar, 2018.

<b>F<sub>1</sub> plant from a cross</b>	<b>Number treated plants</b>	<b>Alive, <i>n</i></b>
(539 B × 397/17)	7	3
(526 B × 397/17)	4	1
(011 B × 396/17)	25	19
(88 B × 396/17)	15	7
(352 B × 396/17)	20	14
(105 B × 397/17)	13	7
(53 B × 397/17)	2	1

**Table 5:** The results from the treatment of  $F_2$  plants with Pulsar, 2019.

<b>Field number</b>	<b>From cross</b>	<b>Number treated plants</b>	<b>Alive, <i>n</i></b>
664	(539 B × 397/17)	11	7
665	(526 B × 397/17)	4	0
666	(011 B × 396/17)	14	10
667		11	9
668		12	12
669		14	1
670	(88 B × 396/17)	12	4
671		13	13
672		14	14
673		12	11
674	(352 B × 396/17)	16	11
675		2	0
676		8	5
677		6	5
678		6	6
680	(105 B × 397/17)	11	11
681		10	7
682		6	6
683	(53 B × 397/17)	8	8

The received results are very good. Plants with features characteristic of mutant M-95-874 were obtained in numbers 677 and 678. They also stand out with larger seeds.

Other variants of research have been laid down to check and evaluate the breeding material created so far. The study continues.

## Conclusions

From the hybridization between the sunflower mutant M-95-874 and the line HA 425, and the study of the obtained hybrid material, it was found that a large part of the new plant forms shows resistance to two herbicides simultaneously – Pulsar and Express. The first results derived so far also show that resistance can be transmitted in not resistant to herbicides B lines using the classical breeding selection.

**Author contribution:** All the authors have accepted responsibility for the entire content of this submitted manuscript and approved submission.

**Research funding:** None declared.

**Conflict of interest statement:** The authors declare no conflicts of interest regarding this article.

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