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NEW SUNFLOWER GENOTYPES WITH RESISTANCE TO DROUGHT, MAIN PATHOGENS AND BROOMRAPE (*OROBANCHE CUMANA)*, CREATED AT NARDI FUNDULEA

Florentina Sаucă*, Gabriel Florin Anton, Elena Petcu

National Agricultural Research & Development Institute Fundulea, 915200 Fundulea, Călăraşi County, Romania
*Corresponding author. E-mail: tina@ricic.ro

ABSTRACT

The development of human society in general depends and is conditioned by the presence of fresh water resources. Certainly, the main cause, which has led to the ascending curve of current needs and consumption, is determined by the demographic explosion and the rapid urbanization process. Therefore, industry and agriculture are among the biggest consumers of water. The real problem is not lack of resources but effective distribution and overall management it is.

In the context of the aforementioned, at NARDI Fundulea was developed in 2010 a program to improve drought resistance and obtain new genotypes through introgression of resistance genes from *Helianthus argophyllus* species in cultivated specie *(Helianthus annuus* L.*)* (Project MAKIS, Financed by the World Bank). *Helianthus argopyllus* is the most interesting species with very pubescent leaves, moderate transpiration and good photosynthetic activity. These characters provide superior water use efficiency compared to cultivated species. For these reasons, it has been used in our research to achieve the above-mentioned goal.

In this project, at NARDI Fundulea has successfully used interspecific immature embryo culture to obtain drought-resistant genotypes and shortening the breeding process by getting two to three generations/year.

Starting with the BC6 generation of self-pollination, the resulted fertile lines (B, maintainer lines) were cross polinated with an androsterility source in order to produce the sterile analogues of these lines (all being B, maintenance, fertile) were performed. After 4-5 generations of sterile plant selection, sterile analogue lines for each of the new creations were obtained. After this, new sunflower hybrids were obtained using certain fertility restoration lines from the NARDI Fundulea collection. The new hybrids were tested in three very different locations and years in terms of rainfall and temperatures during sunflower vegetation (2014-2015-2016).

Based on the results we can conclude that interspecific hybridization may be an additional technique in the breeding of the sunflower and can be successfully used to create new sources of genetic variability to improve germplasm for drought and pathogens resistance.

The newly created genotypes have responded positively to testing under different climatic and soil conditions and can be included in the approval list for both classical and ecological culture conditions.

Key words: sunflower, *Helianthus argophyllus*, interspecific hybridization, drought resistance, diseases resistance.

INTRODUCTION

Wild sunflower species (49 utill now, 12 annuals and 37 perennials) have been in the current practice of sunflower beeding, increasingly due to the huge reservoir of genes for different characteristics favorable to the cultivated species (Vrânceanu, 2000).

Embryo resque techniques have become very useful both for overcoming the post-zygote incompatibility between *Helianthus annuus* and various wild species (Chandler et al., 1978; Krauter et al., 1991) and for accelerating the process of sunflower breeding by generating 2-3 generations/year. Vrânceanu et al. (1980) have obtained interspecies *Helianthus argophyllus* x *Helianthus annuus* descendants usable in breeding for drought resistance of sunflower.

In the context of the above mentioned, at NARDI Fundulea, a breeding program for the improvement of drought resistance and the obtaining of new sunflower genotypes was initiated in 2010 by intrusion of drought resistance genes from the wild species *Helianthus argophyllus* in the genome of the cultivated species *Helianthus annuus* (Saucă and Lazăr, 2016).

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Also the wild species *Helianthus argophyllus* has resistance genes to the pathogens *Phomopsis helianthi* (Saucă, 2010).

Laboratory testing and selection of the hybrid genetic material obtained in F1 was possible using concentrations of 5.0%, 10%, 15%, 20% polyethylene glycol (PEG 6000) that are known to induce water stress (Saucă and Anton, 2017).

Sunflower is considered to be a crop well adapted to drought, due in particular to its strong water absorption capabilities, provided by its well-developed and efficient root system (Serieyes et al., 1988, Baldini et al., 1993). When grown under stress conditions, yield correlates well with the degree of water limitation (Goyne et al., 1978).

Sunflower genotypes obtained from interspecific hybridization were tested in three different localities from Romania for three years. Both the resistance to drought expressed through the yields obtained under the weather conditions specific to the crop areas and the resistance to the most aggressive pathogens (*Plasmopara* sp., *Phomopsis helianthi, Sclerotinia sclerotiorum*) and the *Orobanche cumana* parasite have been studied.

MATERIAL AND METHODS

The genetic material obtained inside of MAKIS 14554 (World Bank Funding) project respectivelly 10 sunflower genotypes obtained after 7 years of breeding were used.

To accelerate the introgression process of drought resistance genes from the wild species to the sunflower cultivated species, immature embryo culture was used both in the first generation of interspecific hybridization, the first generation of backcross and self-pollination.

After the BC6 generation of autofecun-dation, cross was performed with an androsterility source to obtain the sterile analogue (all being B, maintenance, fertile). Thus, could performed hibridization with some fertility restoring lines from the NARDI Fundulea collection (conventional lines but also sulfonylureic herbicide-sunflwoer resistant lines).

The genotypes thus obtained were grown in 2014-2015-2016 in three climatically different ecological zones (Fundulea, Simnic and Stupina), one of them (Stupina) being recognized as "the pole of drought in Romania".

Beside the yield, resistance to the major pathogens (*Plasmopara helianthi, Sclerotinia slerotiorum, Phomopsis helianthi*) and to the degree of infestation with broomrape (*Orobanche cumana*) were analyzed. The yield is expressed in kg/ha and the resistance to patogenis and broomrape was visually appreciated with score from 1 (very resistant) to 10 (very sensitive).

ANOVA was used for statistical interpretation of the results.

RESULTS AND DISCUSSION

Sunflower is in critical phase for water throughout June, July and the first decade of August. The weather data in Figures 1 and 2, recorded in 2014, 2015 and 2016, can be interpreted as follows:

At the meteorological station NARDI Fundulea, in May there was a rainfall average of the three experimental years of 170.6 mm, exceeded with 100.6 mm the normal of the zone. We find May was very rich in precipitation and the air temperature recorded in the shade was lower by 0.8°C compared to the average for 50 years.

In June, rainfall exceeded the multi-annual average by only 4.3 mm but the air temperature was higher by 2.2°C compared to the multiannual average, creating favorable conditions for the development of pathogens *Sclerotinia sclerotiorum* and *Phomopsis helianthi.*

At Simnic, the rainfall in May and June exceeded the multi-annual average by 30.4 and 37.7 mm and were smaller by only 15 mm in July.

It is worrying that in June, July, August and September, the air temperature increased with values between 0.1°C and 1.8°C compared to the multiannual average.

The average temperature over the 3 experimental years increased by 1.8°C in September in all three localities.

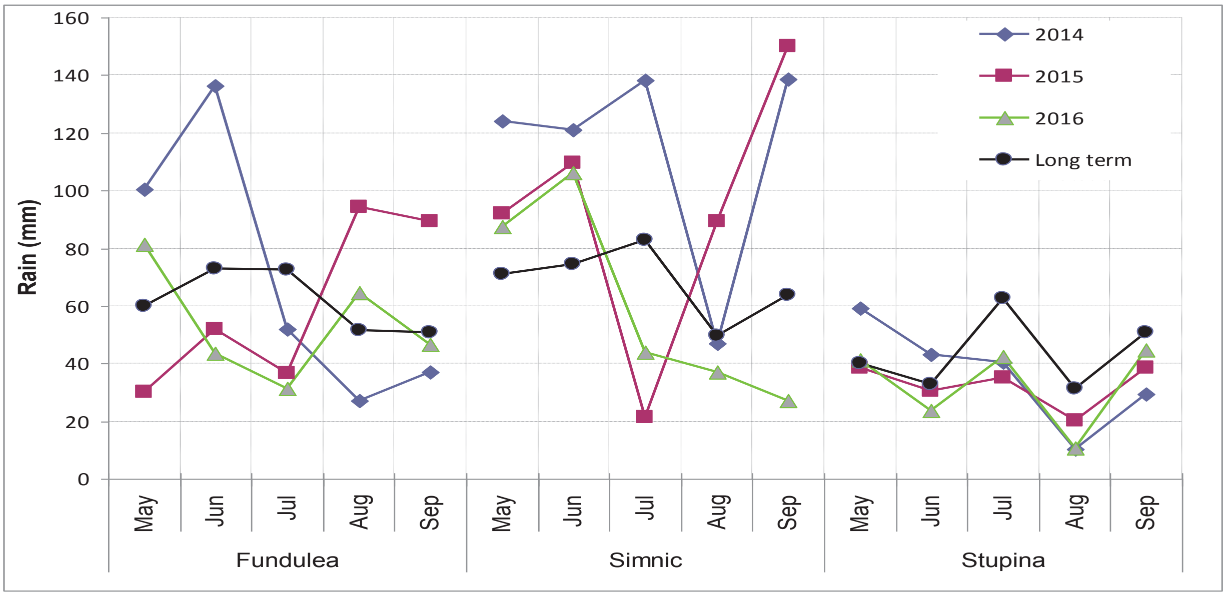

Figure 1. Monthly distribution of rainfall (mm) during the sunflower vegetation period 2014-2016

In Stupina, in all experimental years was noticed a rainfall deficit (less with 48.9 mm) compared to the multiannual average, while the temperature increased except in May (Figure 2).

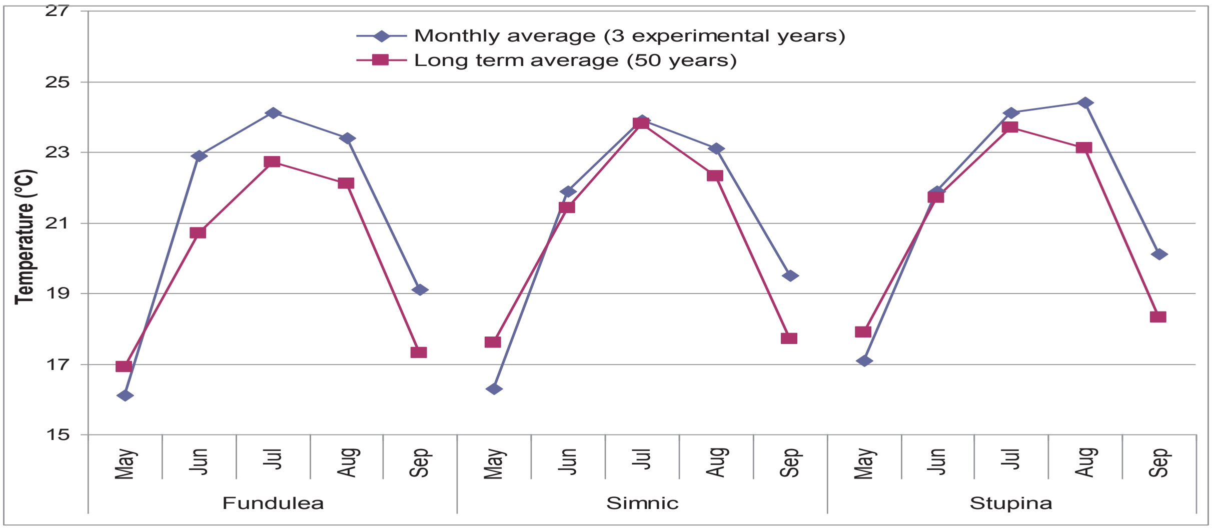

Figure 2. The air temperature in the shade during 2014-2015-2016 recorded in three localities

The characterization of the sunflower genotypes obtained at the Fundulea INCDA on disease resistance and the *Orobanche* parasite is shown in Table 1.

Two of the genotypes studied (H 21d and H-30d) were superior to the control concerning *Plasmopara* resistance, three genotypes (H 21d, H 24d and H 30d) were very resistant to *Sclerotinia* and two (H 17d and H 21D) were very resistant to broomrape infestation (Table 1). All genotypes were more resistant to *Phomopsis helianthi* compared to the control (Table 1).

Effect of experimenting year showed significant difference at P<0.01 for the yields of studied genotypes. The localities were significant at level of P<0.01 and also the interaction between years and localities influenced significantly the studied trait (Table 2).

Table 1. Description of genotypes regarding the resistance to *Plasmopara* spp., *Phomopsis helianthi, Sclerotinia sclerotiorum* and *Orobanche cumana*

No.	Genotype	Resistance to *Plasmopara* sp.	Resistance to *Phomopsis helianthi*	Resistance to *Sclerotinia sclerotiorum*	Resistance to *Orobanche* sp.
1	H 16d (19)	6 (MR)	2 (FR)	5 (MR)	4 (R)
2	H 17d (20)	5 (MR)	1 (FR)	4 (R)	2 (FR)
3	H 21d (26)	2 (FR)	2 (FR)	2 (FR)	2 (FR)
4	H 23d (27)	8 (S)	5 (MR)	5 (MR)	3 (R)
5	H 24d (29)	4 (R)	1 (FR)	2 (FR)	3 (R)
6	H 26d (31)	5 (R)	3 (R)	5 (R)	3 (R)
7	H 27d (32)	9 (FS)	4 (R)	10 (FS)	4 (R)
8	H 28d (34)	10 (FS)	4 (R)	8 (S)	4 (R)
9	H 30d (33)	2 (FR)	2 (FR)	2 (FR)	3 (R)
10	**Control**	**4 (R)**	**10 (FS)**	**6 (MR)**	**4 (R)**

FR = very resistant; R = resistant; MR = medium resistant; S = sensitive; FS = very sensitive.

Table 2. The analyses of variance for sunflower yield

Source of variance	SP	GL	S2	F value and significance
Factor A (Year)	3798966	2	1899483	52.85***
Error A	143752.5	4	35938.13	-
Factor B (Locality)	58481480	2	29240740	724.08***
Interaction A x B	14084720	4	351180	87.19***
Error B	484598	12	40383.17	-
Factor C (Genotype)	7026736	9	780748	24.46***
Interaction A x C	3890971	18	216165	7.60***
Interaction B x C	4783669	18	265759.4	9.35***
Interaction A x B x C	4417394	36	122705.4	4.32***
Error C	4605458	162	28428.75	-

Under meteorological conditions from Fundulea (relatively favorable for superior sunflower yield) five of studied genotypes were significant and significantly superior as compared with the control: H 21d (25); H 24 (29); H 26d (31); H 28d (34) and H 30d (33), (Figure 3).

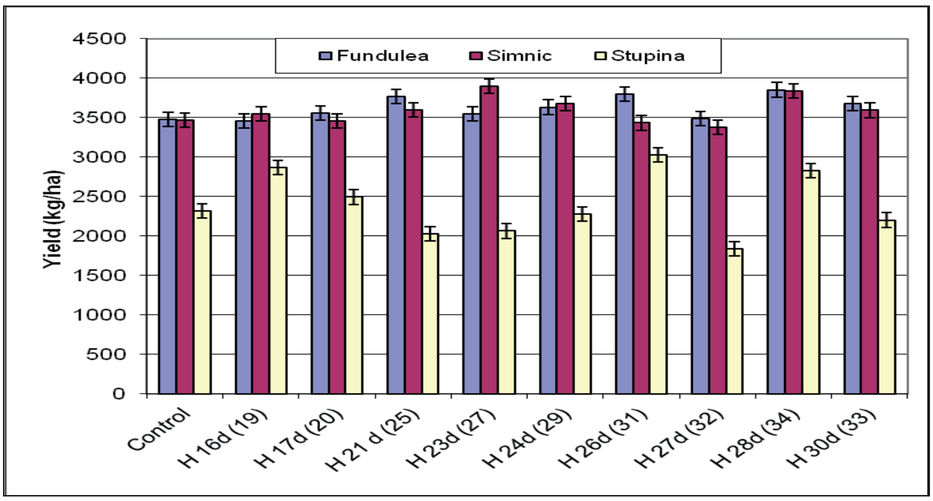

Figure 3. The average sunflower yield at Fundulea, Simnic and Stupina

Under Simnic conditions (average annual precipitation was better (301.5 l/ m^2) and rainfall was much better distributed), the newly created genotypes were evidenced by statistically significant, very significant and distinctly positive yields. Compared to control yields the highest genotypes were revealed: H 21d (25); H 23d (27); H 24d (29); H 28d (34) and H 30d (33).

At Stupina, a locality considered to be the "drought pole" in Romania, our genotypes behaved very well even though the achieved yields were significantly and significantly reduced compared to the yields obtained at Fundulea and Simnic.

We consider that the soil category in the experimental areas is very important, also. In Fundulea and Simnic there is cambic chernozem soil and in Stupina the soil is sandy.

This enables us to affirm that newly created interspecific lines have the ability to use water efficiently in critical periods and are more tolerant to drought and heat.

Four genotypes were noted in Stupina: H 16d (19), H 17d (20), H 26d (31) and H2 8d (34) as more productive compared to the control in all 3 experimental years.

CONCLUSIONS

Based on the results we can conclude that interspecific hybridization may be an additional technique in the breeding of the sunflower and can be successfully used to create new sources of genetic variability to improve germplasm for drought and pathogens resistance.

The newly created genotypes have responded positively to testing under different climatic and soil conditions and can be included in the approval list for both classical and ecological culture conditions.

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