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DEVELOPMENT OF SUNFLOWER STERILE *CMS* ANALOGUES ON THE BASE OF DIFFERENT CYTOPLASMIC BACKGROUNDS

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SUMMARY

Thirteen new sterile *cms* analogues on the base of different sunflower *cms* sources have been obtained. The obtained backcrosses have been evaluated for main agronomic traits, including the resistance to the important sunflower pathogens. As a result of this study, the most prospective *cms* analogues were designated for future use in breeding programs.

Key words: sunflower, *cms* source, sterile analogue, disease resistance

INTRODUCTION

At present, the main aim of sunflower breeding is the obtaining of high yield commercial hybrids. Sunflower hybrids are object of breeding attention because of their agronomic and economic advantages over varieties (high productivity, oil content, disease resistance, etc.). The central component of sunflower hybrid development is cytoplasmic male sterility (*cms*). The obtaining of hybrids with high heterosis effect became possible after the discovery of the first *cms* source by P. Leclercq (Leclercq, 1968) and detection of fertility restoration genes by M. Kinman (Kinman, 1970).

Development of sterile *cms* analogues of lines used in sunflower breeding programs for commercial hybrid development is one of the practical applications of *cms* investigations. At present, *cms* PET-1 is a *cms* source which is widely used of in sunflower hybrid development. Such cytoplasmic uniformity presents a potential risk for hybrid sunflower production. Numerous research institutes and international projects are working on this problem (Serieys, 1999). The utilization of different cytoplasmic backgrounds in hybrid development will improve general variability of the sunflower and lessen the threat of epiphytotics. In this connection,

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the aim of this research was to obtaining sterile inbred lines based of different cytoplasmic backgrounds.

MATERIALS AND METHODS

The investigation was conducted under the field conditions during the 1999-2002 period. Eleven *cms* sources from the sunflower genetic collection of the Institute were used. They belonged to the following wild species: *Helianthus argophyllus* (ARG1, ARG3), *H. giganteus* (GIG1), *H. debilis* (DEB1), *H. texanus* (ANT1), *H. praecox* (PRR1, PRH1), *H. fallax* (PEF1), and *H. rigidus* (RIG1, RIG2). Non-identified *cms* sources DCS1 and DCS3 (double-color sterile 1, 3) obtained from ornamental sunflower also were included in the experiment. The fertile inbred line VB1002 was used for transferring pollinator's nuclear factors into the sterile cytoplasms. The line VB1002 is a parent component of commercial heterotic hybrids developed at VIS (Veidelevskij 33, Veidelevskij 46).

To obtain sterile analogues, all *cms* accessions were crossed with fertile line VB1002 and followed by repeated backcrossing. The phenotypic uniformity with VB1002 was obtained in BC_5-BC_6 progenies. The obtained backcrosses were tested under field conditions for the main agronomic traits (1000-seed weight, plant height, leaf area, capitulum and stem diameter, vegetation period duration, husk and oil content). The obtained data were compared with characteristics of the line VB1002, which was used as control.

The estimation of *cms* analogues' resistance to *Sclerotinia sclerotiorum*, *Plasmopara helianthi*, *Phoma helianthi*, *Phomopsis helianthi*, *Verticilliuum helianthi*, rust and *Orobanche cumana* was conducted by rating the attacks after inoculation under the field conditions.

RESULTS AND DISCUSSION

According to the obtained results, all sterile *cms* analogues were mainly similar to the control (Table 1). Still, some distinctions existed. *cms* RIG2 analogue differed from the control in stem diameter and the duration of vegetation period, *cms* GIG1 analogue in plant height, CMG PEF1 analogue in - capitulum diameter, *cms* DCS3 analogue in 1000-seed weight. The backcrosses carrying GIG1, ARG3 and DCS3 germplasms were most similar to the line VB1002. The differences from the control could probably be attributed to the cytoplasmic effect of the *cms* sources. Special investigations on *cms* influence on the sunflower agronomic traits have not been performed at VIS, but numerous investigations conducted at other research centers confirm the positive or negative influence of cytoplasm type (Baldini *et al*., 1991; Matvienko, 1989; Serieys, 1996, 1999).

Table 1: Characteristics of sterile analogues on the base of different *cms* sources (Chepurnaya, 2002)

cms analogue	Plant height, cm	Stem diameter, cm	Leaf area, cm	Capitulum diameter, cm	Duration of vegetation period,	1000-seed weight, g	Husk content, %	Oil content, %
VB1002	144.8±0.61	2.3±0.50	357.9±2.16	20.1±0.51	120	62.2	23.0	62.3
BC_5 RIG1	144.9±0.69	1.6±0.05	637.3±4.16	22.1±0.53	123	56.2	22.4	60.7
BC_5 RIG2	147.8±0.79	1.9±0.04	365.4±7.49	23.1±0.49	121	50.5	22.3	62.8
BC_7 GIG1	146.3±0.75	1.8±0.06	454.7±6.27	22.4±1.02	117	60.6	22.6	60.7
BC_7 PEF1	147.9±0.56	2.1±0.04	331.6±8.32	22.6±0.49	121	59.8	23.1	62.9
BC_5 PRH1	176.5±0.85	1.8±0.49	314.4±8.05	19.7±0.49	110	58.2	23.0	65.6
BC_5 ARG1	154.1±1.44	1.6±0.04	451.1±2.86	19.1±0.36	114	52.0	21.2	62.9
BC_5 ARG3	169.1±0.80	2.2±0.36	463.9±9.78	19.5±0.28	116	56.0	24.3	71.5
BC_5 DCS1	144.0±0.95	1.8±0.06	569.0±7.52	24.5±0.62	120	67.2	25.7	58.2
BC_5 DCS3	147.7±0.98	1.9±0.04	406.7±2.68	21.7±0.04	120	67.9	23.0	55.1
BC_5 DEB1	166.9±0.88	2.2±0.06	528.8±3.36	25.5±0.41	125	82.6	25.4	59.0
BC_6 ANT1	145.0±0.81	2.0±0.48	380.1±4.26	22.0±0.50	112	61.9	21.8	60.8

Simultaneously we tested the obtained *cms* analogues for resistance to the main sunflower pathogens (Table 2). The majority of the lines were attacked by *Sclerotinia sclerotiorum*, *Phomopsis helianthi*, *Phoma helianthi* and *Verticillium helianthi*. It was indicated that sterile plants carrying ARG3 germplasm were affected only by *Phoma helianthi*. The *cms* DCS1 analogue was affected by capitulum rot and *Verticillium helianthi*. The sterile analogues on the base of *cms* RIG2 and ARG1 were resistant to *Phomopsis helianthi*. The analogues with *cms* RIG1, RIG2, GIG1, PEF1, ARG1, DCS3 and ANT1 showed complete resistance to *Verticillium helianthi*.

Table 2: Evaluation of sterile *cms*-analogues for pathogen resistance (2002)

cms analogue	Rot		*Phoma helianthi*	*Phomopsis helianthi*	*Verticillium helianthi*	Rust	*Plasmopara helianthi*	*Orobanche cumana*
	root	head						
VB1002	-	+	+	+	+	-	-	-
BC_5 RIG1	+	+	+	+	-	-	-	-
BC_5 RIG2	-	+	+	-	-	+	-	-
BC_7GIG1	-	+	+	+	+	-	-	+
BC_7 PEF1	+	+	+	+	-	-	-	-
BC_5 PRH1	-	+	+	+	+	+	-	-
BC_5 ARG1	-	+	+	-	-	-	-	-
BC_5 ARG3	-	-	+	-	-	-	-	-
BC_5 DCS1	-	+	-	-	+	-	-	-
BC_5 DCS3	-	+	+	+	-	-	-	-
BC_5 DEB1	+	-	+	+	+	+	-	-
BC_6 ANT1	+	+	+	+	-	-	-	-

Note: + infection existed
- disease resistance

The obtained results permitted to confirm that all sterile *cms* analogues with positive characteristics of the line VB1002 transferred into them were important breeding material. The lines carrying ARG1, ARG3, DCS1 and RIG2 germplasms were estimated as most suitable for breeding purposes (Table 3).

Table 3: Characteristics of best sterile *cms* analogues of inbred line VB1002

Line	Duration of vegetation period, days before		Plant height, cm	Leaf quantity (on 1 plant)	1000-seed weight, g	Oil content, %
	flowering	maturity				
VB1002	56	120	145	23-25	62.2	62.3
BC_5 ARG1	55	114	154	24-27	52.0	62.9
BC_5 ARG3	58	116	169	24-27	56.0	71.5
BC_5 DCS1	55	120	144	22-25	67.2	58.2
BC_5 RIG2	57	121	148	23-25	50.5	62.8

It should be noted that utilization of resistant *cms* DCS1 analogue in breeding programs is problematic because of negative restoration reaction (Chepurnaya *et al.*, 2002; Chepurnaya and Pershin, 2000). In addition to good agronomic characteristics, the *cms* ARG3 analogue showed complex resistance to all major sunflower pathogens except *Phoma helianthi*.

The sterile analogues on the base of *cms* RIG2 and ARG1 were very similar to the control regarding their agronomic traits. However, they were affected by *Phoma helianthi* and *Sclerotinia sclerotiorum*. The search for restoring lines will not complicate breeding process because of PET1-like behavior of *cms* ARG1, ARG3 and RIG2 (Chepurnaya, 2002; Chepurnaya and Pershin, 2000).

CONCLUSIONS

The results of this investigation showed that all sterile analogues obtained on the base of different cytoplasmic backgrounds are alternative materials, necessary for sunflower hybrid breeding and seed production aims. The lines carrying the ARG1, ARG3 and RIG2 germplasms have the most important agronomic values and permit to solve major difficulties in sunflower hybrid production.

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FORMACIÓN DE LOS *CMS* ESTÉRILES DE LAS LÍNEAS DE GIRASOL ANÁLOGAS A BASE DE DIFERENTES FUNDAMENTOS GENÉTICOS

RESUMEN

Trece nuevas líneas estériles *cms* de girasol análogas, se han formado a base de diferentes fuentes de *cms*. Se hizo la evaluación de los cruzamientos reversibles, obtenidos para las principales características agronómicas, incluyendo la resistencia a los patógenos más importantes en girasol. A base de los resultados obtenidos, se identificaron las líneas *cms* análogas, con más perspectiva para la utilización en los programas de mejoramiento en el futuro.

DÉVELOPPEMENT DE LIGNES STÉRILES ANALOGUES DE TOURNESOL *CMS* FONDÉES SUR LES DIFFÉRENTES BASES CYTOPLASMIQUES

RÉSUMÉ

Treize nouvelles lignes stériles analogues de tournesol *cms* ont été créées à la base de différentes sources de *cms*. Une évaluation est faite sur les croisements interactionnels pour les principaux traits agronomiques, incluant la résistance aux pathogènes de tournesols les plus importants. Prenant en considération les résultants obtenus, les lignes analogues de tournesol *cms*, les plus perspectives ont été identifiées pour être utilisées dans les futurs programmes de tournesol cultivé.