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AGRONOMIC CHARACTERISTIC OF A DWARF GERMPLASM SUNFLOWER LINE

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SUMMARY

A new sunflower (*Helianthus annuus* L.) dwarf line, HA-ARG-1, has been developed after interspecific hybridization between cultivated sunflower *H. annuus* and wild annual silver-leaf sunflower *H. argophyllus*. Plants were selected for reduced height and multiple branching characteristics. The agronomic, morphologic and oil content characteristics of the line were analyzed. Isolation of similar dwarfed lines illustrates the importance of using the wild sunflower germplasms in the development of specific plant material which can be used in sunflower breeding and hybrid development programs.

Key words: ***H. annuus*, *H. argophyllus*, dwarf sunflower, interspecific hybridization, sunflower, wild species**

INTRODUCTION

A series of biotic and abiotic stresses continue to limit the productivity of cultivated sunflower. Wild species of *Helianthus* genus are an important reservoir of useful genes and can be exploited both to broaden the existing narrow genetic base and to enrich the existing varieties with desired agronomically important traits.

Our laboratory has been engaged in the analysis of interspecific and intergeneric relationships within the genus *Helianthus*. The present work is a portion of a sunflower research program the objective of which is the utilization of wild relatives of the *H. annuus* in order to broaden the genetic variability of the cultivated genotypes. We have placed considerable emphasis on evaluating wild species of sunflowers for traits that might be useful in the improvement of cultivated types. In our previous report, we dealt with the results of hybridization of cultivated sunflower *H. annuus* L. with silver-leaf sunflower *H. argophyllus* Torr. & Gray (Vassilevska-Ivanova *et al.*, 1998).

The purpose of this study was to describe a dwarf inbred line, designated as HA-ARG-1, developed after interspecific hybridization *H. annuus* × *H. argophyllus*, and to evaluate it as an promising germplasm for use in breeding programs.

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MATERIAL AND METHODS

Line HA-ARG-1 is the result of interspecific hybridization. Male-sterile plants of line 1234 (*H. annuus* L.) were pollinated with bulked pollen from wild annual species *H. argophyllus*, accession E-006, collected near Sofia, Institute of Genetics, Bulgarian Academy of Sciences, Bulgaria. Line 1234 is an inbred line released by the Dobroudja Agricultural Institute, Bulgaria. Both parents - *H. annuus* and *H. argophyllus* - have a diploid chromosome number (2n=2x=34). F_1 germplasm line HA-ARG-1 is an F5-line of selfed plants. The main agronomic characteristics of the HA-ARG-1 line were determined by standard methods. The fatty acid composition and oil percentage were determined by gas chromatography (Рушковский, 1957).

RESULTS AND DISCUSSION

Figure 1: A new sunflower (Helianthus annuus L.) dwarf line, HA-ARG-1.

Line HA-ARG-1 was morphologically intermediate to its parents in appearance, although the cultivated type appears to be predominant. The line was selected for its reduced height averaging 71.6 cm. This trait is particularly important as a sunflower characteristic. Suggested advantages of the reduced height plant types include greater resistance to lodging and easier cultivation and harvest (Herring, 1985; Jambhulkar, 2002). Thus, short plant height is an important objective in sunflower breeding. Table 1 makes evident the positive correlation between flowering time and height, indicating that short lines flower comparatively earlier than normal height sunflowers. These results generally support those from other studies (Toms, 1992; Toms and Pooni, 1995). All plants were multiple-headed with a large central head. The line had yellow disc flowers and was rather highly fertile, producing 93.2% viable pollen. The high degree of fertility of this line would of course

enhance the success of crossing. These data are in agreement with cytological observations of pollen mother cells (PMC). The analysis of meiosis in line HA-ARG-1 showed a low percentage of meiocytes with irregularities averaging 11.6%. No evidence of bridges and acentric fragments was observed at anaphase. In addition, line HA-ARG-1 was self-compatible. Plants flowered well for about 25 days past apical head because of their axially branching (Figure 1). The extended flowering makes line HA-ARG-1 a desirable initial material for some breeding programs. It is well known that branched plants are often used in hybrid production, as they help to provide viable pollen for an extended period of time, thus helping to avoid some problems of synchronizing the female receptivity with pollen availability.

Table 1: Agronomic characteristics of a dwarf interspecific sunflower line HA-ARG-1

Characteristic	Line HA-ARG-1
Flowering:	
Days to bloom (50%)	68
Self-compatibility (%)	90.0
Pollen stainability (%)	93.2
Plant height at flowering (cm)	71.6
Maturity:	
Head diameter* (cm)	8.6
Post harvest:	
1000-seeds weight (g)	47.5
Oil content (%)	45.44
Linoleic acid (%)	61.85
Oleic acid (%)	28.8
Stearic acid (%)	3.0
Palmitic acid (%)	6.35

*diameter of apical head

Line HA-ARG-1 has fertility restoration genes for *cms* 1234, HA 300 and HA 341 cytoplasms. The line has not been tested for fertility restoration of other cytoplasms. It is highly probable that *H. argophyllus* contains restoration genes for other cytoplasms because of the generally high frequency of restorer genes in the wild species, especially annual species (Seiler, 1987). It is necessary to test the restorer potential of the line against a larger and more diverse set of *cms*-lines.

The diameter of apical head and 1000-seed weight were also recorded as important yield characteristics. Head size of line HA-ARG-1, as shown in Table 1, averaged 8.6 cm. Obviously, there was a weak correlation between plant height and head diameter. As expected, 1000-seed weight was comparatively low and it amounted to 47.5 g. Nevertheless, the value was inside the range of commercially grown sunflower cultivars, where it varies from 40 to 100 g. Consequently, to characterize potential breeding application of line HA-ARG-1, its fatty acid composition and oil percentage were determined. In typical cultivars, normal seed contains linoleic (18:2) and oleic (18:1) acids as the main components of reserve lipids (Dorell,

1978). The total amount of saturated fatty acids (palmitic and stearic) in normal sunflower oil is around 10% (Fernandez-Martinez *et al.*, 1997). The fatty acid composition and oil percentage of line HA-ARG-1 is shown in Table 1. In spite of the reduced plant height, the levels of linoleic and oleic acids were as in typical sunflower cultivars, *i.e.*, 61.85 and 28.8%, respectively. The oil percentage was also inside the range of standard cultivars.

Wild species of sunflower have proven extremely useful in the development of improved cultivated sunflower hybrids and varieties (Seiler, 1988). This paper presents the results from a recent investigation involving crosses between cultivated sunflower *H. annuus* and wild *H. argophyllus*. The latter one was chosen from annual section *Helianthus* because of the number of useful traits such as salt tolerance, resistance to downy mildew and some races of rust, tolerance to several insects including the sunflower beetle and the sunflower midge, altered fatty-acid composition, Rf-genes, etc. (Thomson *et al.*, 1981). Thus, in the course of improvement program aimed at obtaining new genetic variation using interspecific hybridization, line HA-ARG-1 was developed. The significant attribute of the plants was the reduction in plant height. Apparently, this line might be evaluated as a dwarf sunflower line because of its short stature. Moreover, HA-ARG-1 possesses high crossability and genes for restoration fertility (Vassilevska-Ivanova and Tcekova, 2003). It would be an advantage to have short stature varieties that are resistant to lodging and stalk breakage. This line could be a valuable novel source of dwarfing genes for developing high yielding varieties and hybrids.

CONCLUSIONS

The analysis of the new sunflower line for the main morphological characteristics and yield components showed that the line possessed clear-cut characteristics of a dwarf line. It was concluded that interspecific hybridization between *H. annuus* and wild annual *H. argophyllus*, followed by a cycle of breeding, introduces an important source of variability for increasing the range of potential uses of wild sunflowers. The dwarf sunflower line reported herein could be a valuable material both for genetic studies and breeding purposes.

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CARACTERÍSTICAS AGRONÓMICAS DE LA LÍNEA DE GIRASOL CON GERMOPLASMA PARA EL TIPO DE CRECIMIENTO ENANO

RESUMEN

Se ha obtenido una nueva línea de girasol enana (*Helianthus annuus* L.), HA-ARG-1. La línea se ha creado por la hibridización interespecies entre el girasol cultivado *H. annuus* y el girasol anual salvaje *H. argophyllus*. Las plantas fueron elegidas sobre la base de la altura reducida y la múltiple ramificación. Son investigadas las características agronómicas y morfológicas y el contenido de aceite en la nueva línea. El aislamiento de las líneas enanas similares demuestra la importancia de utilización de la germoplasma salvaje de girasol en la creación del material vegetal específico, que puede utilizarse en la selección y programas de creación de híbridos de girasol.

CARACTÉRISTIQUES AGRONOMIQUES D'UNE LIGNÉE NAINE DE GERME PLASME DE TOURNESOL

RÉSUMÉ

Le HA-ARG-1, une nouvelle lignée naine de tournesol (*Helianthus annuus* L.) a été obtenue. La lignée a été développée après une hybridation interspécifique entre le tournesol de culture *H. annuus* et le tournesol sauvage annuel *H. argophyllus*. Les plantes ont été sélectionnées pour leur hauteur réduite et leurs embranchements multiples. Les caractéristiques agrono-miques, morphologiques et le contenu d'huile de cette lignée ont été analysés. L'isolation de lignées naines semblables illustre l'importance de l'utilisation des germes plasmes du tournesol sauvage dans le développement de matériel végétal spécifique pouvant être utilisé dans les programmes de culture et d'hybridation du tournesol.