

A SHORT-CYCLE SUNFLOWER LINE DERIVED FROM INTERGENERIC HYBRIDIZATION *Helianthus* × *Verbesina*

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SUMMARY

A new sunflower (*H. annuus*) introgression line HA-VERB, selected for its considerable earliness of blooming, is described in this paper. The line has been developed after intergeneric hybridization between cultivated sunflower *H. annuus* L. and *Verbesina encelioides* (Cav.) B. & H. var. *exauriculata* Rob. & Greenm. Plants are polycephalic (multiple branched), with reduced plant height. The agronomic and morphological characteristics of the line HA-VERB are reported. The development of inbred line with reduced blooming date appears to be an obvious advantage for increasing the range of potential uses of sunflower genotypes as donors in plant breeding.

Key words: sunflower, intergeneric hybridization, *Verbesina*, wild species,

INTRODUCTION

Wild *Helianthus* species are a rich source of useful genes for the improvement of cultivated sunflower (Miller *et al.*, 1992). However, efforts to introgress useful traits from species of distantly related genera have been limited. Several species in the family *Asteraceae* such as *Tithonia* and *Verbesina* could provide a new source of germplasm and intergeneric transfer of desirable traits seems to be possible (Christov and Vassilevska-Ivanova, 1999; Vassilevska-Ivanova *et al.*, 1999).

The present study represents a product of wide hybridization *Helianthus* × *Verbesina*. This investigation is a part of a research project aimed at broadening the sunflower gene pool by introgressing new genes from diverse sources to meet various challenges affecting sunflower production (Vassilevska-Ivanova *et al.*, 2002).

The purpose of the study reported herein is to describe an early-flowering introgression sunflower line, designated HA-VERB, produced through hybridization *H.*

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annuus × *V. encelioides* and to evaluate its agronomic potential for use in specific plant breeding programs.

MATERIAL AND METHODS

Male sterile plants of the line 2607 (*H. annuus* L.) were pollinated with bulked pollen from *Verbesina encelioides*. A culture of *V. encelioides* was grown from seeds originally obtained from Botanical Gardens in Lisbon. The line 2607 is an inbred line released by Dobroudja Agricultural Institute, Bulgaria. Both parent species have the same number of chromosomes ($2n=2x=34$). Crossing was done using the conventional hybridization method. The resulting F_1 plants were backcrossed to cultivated sunflower. The germplasm line HA-VERB is an F_5 line of selfed plants. The main agronomic characters of HA-VERB were determined by conventional methods.

RESULTS AND DISCUSSION

The line HA-VERB is a result of intergeneric hybridization *Helianthus* × *Verbesina*. The line was considered early-flowering. In general, the blooming takes place much earlier than in its parents (about 43 days), thus showing a considerable reduction in flowering date. The line is multiple-headed, with showy blossoms of extraordinary appeal at the time of full flowering. Plant height of the line is 84.2 cm (Table 1).

Table 1: Agronomic characteristics of HA-VERB, an early-flowering intergeneric sunflower line

Characteristic	Line HA-VERB
Flowering	
Days to bloom (50%)	43
Self-compatibility (%)	90.0
Pollen stainability (%)	87.17
Plant height at flowering (cm)	81.2 (68÷88)
Floral morphology	
Number of ray flowers	30.2 (19÷40)
Length of ray flowers (cm)	4.21 (3÷5)
Maturity	
Head diameter* (cm)	6.3 (4÷8)
Days to maturity (50%)	110
Post harvest	
1000-seeds weight (g)	31.8
* Diameter of the central head	

Plants are self-compatible, seed set is normal in self-pollinated heads. Days from planting to maturity of the line is 110 compared with 130 days for the line

2607. This germplasm line could be used in breeding programs to produce earlier-maturity hybrids. Plants flower well 25 days past the central head because of the axial branching. The extended flower period allows the maintenance of viable pollen, thus solving some problems of synchronizing female receptiveness with pollen availability. All plants obtained were morphologically similar; they were intermediate between *H. annuus* and *H. encelioides*. The line was branched, with a dominant central stem; the branches are upright, the leaves are opposite from the base to the median part of the stem, becoming alternate and gradually smaller above; the leaves and inflorescences are larger than in the wild parent. All plants are as vigorous or nearly as vigorous as the parents. They all show normal fertility, with abundant production of viable pollen. We have not detected any sterile plants. It appears that the wild species (male parent) used in HA-VERB germplasm line carries fertility restoration genes. This line has been established to be a fertility restorer for the *cms* HA89 cytoplasm. The line has not been tested for fertility restoration of other cytoplasms. Intermediacy is evident for some characteristics of floral morphology such as the length and width of ray flowers (Table 1). A tendency to shorten ray flower petals, ranging from 3 to 5 cm, was determined. Thus, phenotypically, the plants resemble the ornamental plant species because of their multi-branched characteristics, reduced plant stature and morphological specificity of ray flowers. The analysis of meiosis showed several irregularities. A high percentage of fast chromosomes (45.9%) was found in metaphase I. In anaphase I and telophase II there were 38.52 and 15.38% meiocytes with lagging chromosomes, respectively. No chromosome bridges and acentric fragments were observed in any of the 150 meiocytes examined. However, it has been established that, even though meiotic irregularities did occur, pollen fertility of the line was very high (87.17% stainable pollen) (Table 1). Our observations strongly support the results presented by Heiser (1962) and Kräuter *et al.* (1991), showing that interspecific hybrids could have high pollen viability (> 90%).

The mean values for the diameter of the central head and 1000 seed weight are given in Table 1. It is evident that HA-VERB genotype has a low 1000 seed weight, which sufficed for 31.8 g. It may be noted rather low 1000 seed weight of the male component *Verbesina encelioides* (2.2 g) that has a considerable genetic effect on this characteristic. This could be a reason why 1000 seed weight of HA-VERB line is comparatively low. Besides, the low seed weight is typical of branched genotypes having, in general, smaller seeds, compared with the unbranched female (TSW=55.3 g for line 2607).

The main objectives of the present study were to describe the germplasm line obtained by crossing *Helianthus* × *Verbesina*. The agronomic potential and performance of the cross show that, although this is a small part of investigations concerning intergeneric relationships in the *Compositae*, the studied genotype provides a good representation of the currently available sunflower breeding material. The time of blooming serves as an effective isolation mechanism since there was no

overlap in blooming with other sunflower species and cultivars. On the other hand, the so-called short-cycle sunflower cultivars can reduce the problem of low fertility of the head caused by high summer temperatures, or help avoid the attacks by pathogens such as *Sclerotinia sclerotiorum* (Lib.) de Bary and *Botrytis cinerea* Pers., ex. Fr., and thus contribute to good productivity. The general tendency of the line reported here, to have a reduced number of days to flowering thus affecting the days to maturity, could contribute to genetic improvement in sunflower.

The potential importance of transferring useful genes from wild to cultivated species should be given due attention. Using conventional crossing and backcrossing procedures, we were successful in obtaining hybrid plants between distantly related species. In this case, the HA-VERB germplasm will allow sunflower breeders to incorporate relatively unexploited *Verbesina encelioides* into their breeding programs. Finally, this material could be of interest for cytogenetic and molecular investigations to determine precisely the process of introgression.

CONCLUSIONS

This study shows that intergeneric hybridization *Helianthus* × *Verbesina* can create valuable plant material, such as the line HA-VERB with significantly early blooming. The intermediacy of the genotype was confirmed by the analyses of main morphological and agronomic traits. The obtained plant material seems to be appropriate for breeding programs aimed at the development of modern cultivated sunflowers.

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LÍNEA DE GIRASOL DE CORTO CICLO DERIVADA POR LA HIBRIDIZACIÓN INTERGENÉRICA ENTRE *Helianthus* × *Verbesina*

RESUMEN

En el elaborado está descrita una nueva línea de girasol de corto ciclo (*H. annuus*) HA-VERB seleccionada sobre la base de una significativa disminución de tiempo hasta la floración. La línea fue creada por la hibridización intergenérica entre el girasol cultivado *H. annuus* L. y *Verbesina enceliodes* (Cav.) B. & H. var. *exauriculata* Rob. & Greenm. Las plantas tenían varias cabezas (tipo ramificado), con altura disminuida. Se dan las características agronómicas y morfológicas de la línea HA-VERB. La creación de la línea consanguínea con la fecha de floración más temprana, tiene obvias ventajas para un crecimiento potencial de beneficio de genotipos de girasol en el programa de selección.

CROISSANCE PRÉCOCE DE LA LIGNÉE DE TOURNESOL DÉRIVÉE DE L'HYBRIDATION INTER GÉNÉRIQUE *Helianthus* × *Verbesina*

RÉSUMÉ

Cet article décrit une nouvelle lignée précoce de tournesol (*H. annuus*) HA-VERB, sélectionnée pour la diminution considérable de son temps de floraison. La lignée a été développée après une hybridation inter générique entre le tournesol de culture *H. annuus* L. et *Verbesina enceliodes* (cav.) B. & H. var. *exauriculata* Rob. & Greenm. Les plantes étaient polycéphales (à multiples branches) et présentaient une hauteur réduite. L'article rapporte les caractéristiques agronomiques et morphologiques de la lignée HA-VERB. La création d'une souche pure à floraison précoce semble être un avantage évident pour l'augmentation potentielle des utilisations des génotypes de tournesol comme donneurs dans la culture des plantes.

