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Foreword

The International Sunflower Association (ISA) and the Argentine Sunflower Association (ASAGIR) are pleased to present this guide to the 18th International Sunflower Conference.

At the time the main objectives for the meeting were defined, organizers aimed to provide a forum for the international sunflower research community with interest in any aspect of science and technology relating to the crop (in its oil-seed and confectionery variants) that would allow all involved to:

- Update knowledge in all fields of sunflower research since the previous conference held at Córdoba, Spain, June 2008;
- Review recent technological advances in sunflower production and identify knowledge gaps that require attention;
- Analyze the status and expectations for current and prospective demands for sunflower products;
- Provide a venue for workshops and special-interest meetings focusing on unresolved research, market, and production issues;
- Provide new generations with an opportunity to interact with global leaders in sunflower research.

The local Program Committee, with the help of the International Steering Committee, has developed a program covering the whole spectrum of relevant topics from genes and genomics through to field agronomy, crop protection, and industry and market issues. The program comprises 14 plenary and 13 invited presentations, 14 short oral presentations, an exhibition of 160 posters that can be visited during each of the first three days of the meeting. In addition, there will be three associated workshops (Bird Damage, Breeding, International Sunflower Genome Initiative), a special-interest presentation of the Global Crop Diversity Trust, and facilities will be available on request for small groups who wish to discuss business or scientific topics.

On the last day of the meeting, the Conference Field Day will be held at the joint INTA-Universidad de Mar del Plata facility in Balcarce. This time the traditional Conference demonstration plots of hybrids from International Sunflower Association member countries and from the host country will be complemented by a broad range of demonstrations of production and management techniques, as well as demonstrations of research techniques in current use by Argentine sunflower research teams.

This Conference has been made possible by the work of many people, by the support of sponsors from both the public and the private sector (sponsors are recognized on the back covers of this guide) and last, but certainly by no means least, those responsible for the lectures, short oral presentations, posters, associated workshops and special interest meetings, and field and laboratory demonstrations that make up the rich and varied bill of fare for this Conference, as reflected in this guide. The Organizing Committee extends their heartfelt thanks to all these individuals and organizations.

ISA and ASAGIR trust that this guide will enable all attendees to have an interesting and fruitful 18th International Sunflower Conference.

Welcome

It has been 27 years since the 11th International Sunflower Conference was held in Mar del Plata, Argentina, March 10-13, 1985. Since then, very many things have changed in the world of sunflower science, technology, and crop production and management. As the global sunflower community reconvenes once again in the same city, its members will have the opportunity to review progress in the last four years, which has been substantial in many areas.

Mar del Plata, a vibrant city located by the sea, with a fishing port, good restaurants, an unusually good choice of golf courses, and kilometers of sandy beaches, together with Balcarce, provide excellent venues for the Conference lectures and Field Day, and will allow attendees to appreciate a unique combination of seas, hills and Pampas. It is a great pleasure for the Organizing Committee to be able to host attendees to this meeting, which we hope will be both enjoyable and fruitful.

Welcome to Argentina, to Mar del Plata and Balcarce, and to the 18th International Sunflower Conference.

| 05-VC-15 |

Application of different methods in the determination of heritability of some quantitative traits in the sunflower (*Helianthus annuus* L.) sinthetic NS-S-1

Radovan Marinković, Milan Jocković, Ana Marjanović-Jeromela, Jovanka Atlagić, Dragana Miladinović, Velimir Radić

Institute of Field and Vegetable Crops, 21000 Novi Sad, Maksima Gorkog 30, Serbia, radovan.marinkovic@ifvcns.ns.ac.rs

ABSTRACT

- The aim of this study was to determine the heritability coefficients in the narrow and broad sense by applying different methods and different progenies for plant height, number of leaves per plant, head diameter and seed yield per plant in the sunflower synthetic NS-S-1 in 2 years of evaluation.
- The narrow sense heritability was estimated according to Mather and Jinks, Verhalen and Murray, Warner, and Griffing. The broad sense heritability was determined according to Mahmood and Kramer, Briggs and Knowles, Mather, Burton, Lawrence and Jinks, Weber and Moorthy and Mather and Jinks.
- Average values of heritability in the broad sense for plant height ranged from 30.06% to 98.87%, while in the narrow sense ranged from 17.35% to 81.86%. The broad sense heritability for number of leaves per plant ranged from 9.08% to 96.10%, while in the narrow sense ranged from 26.15% to 91.93%. Average values of heritability in the broad sense for head diameter and seed yield ranged from 31.39% to 89.99% and 27.42% to 97.88%, while in the narrow sense heritability ranged from 20.69% to 73.90% and 16.18% to 80.64%.
- The highest values of heritability in the broad sense, in all traits were obtained using components of genetic variances from diallel analysis. The lowest values of heritability in the narrow sense for all investigated traits were obtained using the method of Griffing and method of Warner.
- Based on this research it was found that high values of heritability exists for certain traits in the synthetic NS-S-1 and that environment had a great influence on heritability of certain traits.

Key words: narrow (h^2_a) and broad (h^2_b) sense heritability, plant height, number of leaves per plant, head diameter and seed yield

INTRODUCTION

In the population of sunflower plants differ among themselves in the head diameter, height, leaf area, number of flowers and seeds per head, 1000 seed weight, etc. The differences in terms of some quantitative traits, among observed plants, partly are owed to the influence of genetic factors and in part the impact of environmental factors. For breeders is very important to know the part of genetic variance in the total phenotypic variance, because of its size depends selection of a particular method.

Part of the overall variance in the offspring, for observed feature in a specific population, which is the result of genetic factors is called heritability (Lush, 1945). So, heritability refers to the population, variety, synthetic or F_2 generation. Heritability is divided into two forms: in the narrow (h^2_a) and broad (h^2_b) sense. The broad sense heritability is of less practical importance for breeders because it can not be effectively used in the evaluation of breeding values. For breeders is of greater importance heritability in the narrow sense, as it indicates how much phenotypes of parents are safe indication of their own genotypes. The narrow sense heritability provides information on the additive variability, which allows to evaluate the effect of selection for the studied trait.

Heritability of a property is not a constant value for each selected sample under study but can be changed depending on the degree of genetic homogeneity in the studied population and the level of variable environmental conditions. Proper performance of the heritability of a property is available only as a result of studying the properties in the various combinations and in different conditions of cultivation in one or more years.

The aim of this study was to determine the heritability coefficients in the narrow and broad sense using different methods and different progenies for plant height, leaf number per plant, head diameter and seed yield per plant in sunflower synthetic NS-S-1 in 2 years of evaluation.

MATERIALS AND METHODS

For this study were chosen seven crosses between five inbred lines of sunflower: C1 (NS-MA-1 MA x-NS-2), C2 (NS-MA-1 MA x-NS-3), C3 (NS-MA-2 x NS-MA-3), C4 (NS-MR-2 MR-NS x-4), C5 (NS-MR x NS-3-MA-4), C6 (NS-MA-3 x-NS-MA 5) and C7 (NS-4-MR x NS-MA-5). Besides the inbred lines and F_1 generations backcrosses were made with both parents (BC1 and BC2) and F_2 generations. On plants of inbred lines and F_1 generations that served as mothers stamens were removed manually in the early morning hours to avoid any self-fertilization.

The experiment was set up as a randomized block design in three replicates at the experimental field of the Institute of Field and Vegetable Crops Novi Sad at the Rimski Sancevi. Material was hand-sown in the well prepared soil in the optimal time, following scheme 70x30 cm. Crop thinning was carried out in stage of 2-3 leaves. Parental lines and F_1 generations were sown in 4 rows while F_2 generations and backcrosses in 8 rows. During the vegetation the common agrotechnical measures were applied. Number of leaves per plant was established in flowering, plant height (cm) and head diameter (cm) were measured in physiological maturity and seed yield per plant was determined in the laboratory. The data were recorded on 20 plants per replicate in parental lines and F_1 generations and on 60 plants per replicate in backcrosses and F_2 generations.

Heritability in the broad and narrow sense was estimated for 2 years for plant height, number of leaves per plant, head diameter and seed yield in the sunflower synthetic NS-S-1. The narrow sense heritability was estimated according to methods of Mather and Jinks (1971), Verhalen and Murray (1969), Griffing (1956), using the components of genetic variances from diallel analysis and Warner (1952) who used variances of F_2 generations and backcrosses. The broad sense heritability was estimated using the variances of parents, F_1 and F_2 generations according to methods of Mahmood and Kramer (1951), Briggs and Knowles (1967), Mather (1949), Burton (1951), Lawrence and Jinks (1973), Weber and Moorthy (1952) and using the components of genetic variances from diallel analysis according to Mather and Jinks (1971). The heritability estimates were categorized as suggested by Robinson et al. (1949) (0-30% = low; 31-60% = moderate; above 60% = high).

RESULTS

Our results are shown in tables 1 and 2. Heritability estimates for plant height ranged from 30.06% to 98.54% in first year of experiment, while in the second year it ranged from 60.17% to 98.87%. The narrow sense heritability was slightly lower and ranged from 32.38% to 81.86% and from 17.35% to 77.20% in the first and second year, respectively. The broad sense heritability for number of leaves per plant estimated from 57.47% to 96.10% during first year and from 9.08% to 78.72% in the second year, while the narrow sense heritability ranged from 36.08% to 91.93% in the first year and from 26.15% to 71.26% during second year. Head diameter estimates in the broad sense heritability were from 49.77% to 87.50% and from 31.39% to 89.99% in the first and second year, respectively. The narrow sense heritability for head diameter ranged from 34.52% to 73.90 and from 24.11% to 59.79% in 2 years. Seed yield heritability values ,in the broad sense, ranged from 27.42% to 97.88% in the first year, while in the second year it ranged from 59.60% to 73.10%. Seed yield estimates for the narrow sense heritability ranged from 32.85% to 76.00% and from 16.18% to 80.64% in the first and second year, respectively.

Table 1. Average estimates of heritability for some quantitative traits in the sunflower (*Helianthus annuus* L.) sinthetic NS-S-1 in the first year of evaluation

	Methods	Traits							
		Plant height		Number of leaves per plant		Head diameter		Seed yield per plant	
		h^2_a	h^2_b	h^2_a	h^2_b	h^2_a	h^2_b	h^2_a	h^2_b
1	Mahmood and Kramer (1951)		54.30-79.40 X=68.32		50.31-66.73 X=58.35		40.57-62.69 X=52.08		15.13-78.19 X=46.66
2	Briggs and Knowles (1967)		54.28-79.39 X=68.31		50.29-65.25 X=57.47		40.33-62.63 X=51.64		0.0-78.17 X=43.21
3	Mather (1949)		33.97-69.61 X=53.79		52.31-67.71 X=59.04		38.46-61.32 X=50.98		0.0-78.95 X=38.06
4	Burton (1951)		0.0-73.49 X=30.06		39.39-74.41 X=62.21		23.44-62.85 X=49.77		0.0-80.51 X=27.42
5	Lawrence and Jinks (1973)		23.10-70.58 X=48.88		51.69-68.94 X=59.84		54.20-70.99 X=63.28		23.74-84.21 X=53.40
6	Weber and Moorthy (1952)		39.38-69.75 X=59.72		53.16-68.20 X=60.14		40.26-60.05 X=50.63		9.01-78.99 X=46.21
7	Mather and Jinks (1971)	80.62	98.54	90.28	96.10	49.22	87.50	76.00	97.88
8	Verhalen and Murray (1969)	81.86		91.93		73.90		69.56	
9	Griffing (1956)	42.98		36.08		34.52		36.14	
10	Warner (1952)	0.0-76.99 X=32.38		27.09-60.64 X=43.99		4.90-54.17 X=36.71		0.0-74.13 X=32.85	

Table 2. Average estimates of heritability for some quantitative traits in the sunflower (*Helianthus annuus* L.) sinthetic NS-S-1 in the second year of evaluation

	Methods	Traits							
		Plant height		Number of leaves per plant		Head diameter		Seed yield per plant	
		h^2_a	h^2_b	h^2_a	h^2_b	h^2_a	h^2_b	h^2_a	h^2_b
1	Mahmood and Kramer (1951)		19.61-81.00 X=62.10		0.0-59.89 X=38.26		0.0-66.05 X=41.93		34.84-90.58 X=67.00
2	Briggs and Knowles (1967)		15.66-80.29 X=61.03		0.0-59.87 X=36.94		12.72-65.99 X=43.50		37.07-90.39 X=60.57
3	Mather (1949)		26.72-83.43 X=60.17		0.0-48.03 X=21.34		0.0-56.59 X=35.63		21.06-86.71 X=59.60
4	Burton (1951)		48.85-89.71 X=70.56		0.0-42.16 X=9.08		0.0-55.99 X=31.39		6.61-79.75 X=60.56
5	Lawrence and Jinks (1973)		45.04-87.57 X=73.15		2.75-61.02 X=37.12		11.11-69.94 X=50.71		40.79-90.03 X=69.70
6	Weber and Moorthy (1952)		30.85-84.51 X=72.64		0.0-47.05 X=26.44		0.0-57.21 X=37.44		40.50-87.76 X=65.45

7	Mather and Jinks (1971)	76.40	98.87	62.68	78.72	24.11	89.99	32.99	73.10
8	Verhalen and Murray (1969)	77.20		71.26		59.79		80.64	
9	Griffing (1956)	36.26		41.03		20.69		16.18	
10	Warner (1952)	0.0-78.34 X=17.35		0.0-97.50 X=26.15		0.0-78.34 X=39.17		1.24-82.65 X=41.76	

DISCUSSION

High values of heritability indicate that genetic variance plays a major part in total variance, contra to low values which indicate that environmental variance is of importance.

Average values of heritability in the broad and narrow sense for plant height were moderate to high. Our results are in agreement with the ones reported by Khan (2001), Saravanan et al. (1996) and Mijić et al. (2009) who also found moderate to high values in the broad sense heritability for this trait.

Number of leaves per plant showed that heritability values in first year were moderate to high in both, broad and narrow, sense while in the second year values were low to high. Because the values are very different we can only conclude that this property is also strongly influenced by the environment. Sujatha et al. (2002) and Sridhar et al. (2006) reported high values of heritability in the broad sense for this trait which indicates that phenotypic expression is mostly determined by inheritance.

Head diameter showed moderate to high heritability in the broad sense, while in the narrow sense it was low to moderate. Similar values in the broad sense heritability were reported by Khan et al. (2001) but Safavi et al. (2011) reported very low value of heritability for this trait.

The broad sense heritability estimates for seed yield were low to high in the first year, while in the second year it was moderate to high. Khan et al. (2008) also reported high values while Mijić et al. (2009) and Safavi et al. (2011) reported low values of heritability for this trait. Estimates for the narrow sense heritability were low to high, for two years. Seed yield is complex trait and variable values of heritability can be explained by significant genotype/environment interaction.

Our results showed that there are high values of heritability for certain traits in the sunflower sinthetic NS-S-1 and that environment plays important role in heritability of certain traits, i.e., the phenotypic expression is highly dependent on environmental conditions.

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