Selection of sunflower genotypes for Central Brazil

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ABSTRACT

Despite the large availability of suitable areas for sunflower cropping in Central Brazil, few adapted cultivars are available in the market. The objective of this work was to select sunflower genotypes adapted to this important production region. Experiment data from 2006 and 2007 were obtained by the National Sunflower Trials, coordinated by Embrapa Soja. The evaluated traits were seed and oil yields. Commercial hybrids M 734 (Dow AgroSciences) and Agrobel 960 (La Tijereta) were used as controls for hybrid comparison. The open pollinated variety Embrapa 122 (Embrapa) was used as control for variety comparison. Two criteria were used for selection of genotypes: 1) the general mean obtained from different environments; 2) partitioning of general mean in favorable and unfavorable environments (IDMG). The method of the IDMG showed similar results to general mean analyses. The hybrids EXP 1447 and EXP 1446 and the varieties BRSGira 02 e BRSGira 01 had general indication for oil yield, i.e. they showed superior performance in both favorable and unfavorable environments. These varieties had also general indication for grain yield.

Key words: genotype x environment – *Helianthus annuus* – sunflower breeding.

INTRODUCTION

There is an increasing utilization of sunflower in Brazil, due to its use as raw material for ensilage, oil production and to its potential as a new source of energy from biological fuel production. Therefore, the growing area and grain production increased to 94 and 82%, respectively, between 2002/2003 and 2006/2007 crop seasons (Embrapa Soja, 2007b). Most of the 99,000 ha cultivated in 2006/2007 were sown in Central Brazil, following the major summer growing period, mainly in the states of Mato Grosso (22%), Goiás (18%), São Paulo (10%) and Mato Grosso do Sul (10%) (Embrapa Soja, 2007b).

In some Brazilian States, a common agricultural practice is summer double cropping, meaning that the main crop is sown from October to early November, allowing its harvesting by February. Then, a second crop is sown in February/March, taking advantage of the adequate temperature and rainfall conditions. Sunflower is one of the crops suitable for being the second summer crop.

The expansion of the sunflower crop as the second summer crop in Brazil depends on a constant evaluation of new genotypes obtained by selection of superior materials able to express high yield and acceptable quality in the different regions. Thus, the genetic progress of sunflower in Brazil plays an important role to make the necessary economic returns compared to other summer crops more feasible. Despite the large availability of suitable areas for sunflower cropping in Central Brazil, few adapted cultivars are available in the market.

The evaluation and selection of hybrids and varieties of sunflower from several companies are being carried out through the National Sunflower Trials, coordinated by Embrapa Soja and supported by the contribution of public and private institutions. The objective of this work was to select sunflower genotypes evaluated in the Trial Network carried out in 2006 and 2007 in Central Brazil.

MATERIALS AND METHODS

Data from the National Sunflower Trials, coordinated by Embrapa Soja, were used for this work. Trials were installed in 2006 and 2007 in several locations of the states of Goiás, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Rondônia, São Paulo and Distrito Federal (Table 1).

The genotypes were sown in February/March, in a randomized block design with four replicates. Each plot consisted of four rows 6.0 m long, spaced from 0.7 to 0.9 m. Only the two central rows were used for data collection. Plants located up to 0.5 m apart from the extremity of each central row were also

discarded, resulting in a useful area from 7 to 9 m^2 per plot, depending on the space adopted. All the recommended cultural practices were observed to allow an optimum plant development.

The evaluated genotypes were simple and triple hybrids and open pollinated varieties developed by the companies ACA, CATI, Embrapa Soja, Helianthus do Brasil, La Tijereta and SPS. Commercial hybrids M 734 (Dow AgroSciences) and Agrobel 960 (La Tijereta) were used as control for hybrid comparison. The open pollinated variety Embrapa 122 (Embrapa) was used as control for variety comparison. The evaluated traits were grain and oil yields (kg ha^{-1}). Genotype evaluation was carried out during two years in the Final Trials of the First Year of Evaluation (FTF) and in Final Trials of the Second Year of Evaluation (FTS).

Table 1. Altitude and geographical coordinates of the Brazilian Sunflower Trial locations in 2006 and 2007.

State	City	Institution	Latitude	Longitude	Altitude (m)
SP	Piracicaba	ESALQ	22°41'S	47°38'W	546
MT	Campo Novo dos Parecis	Farm	13°40'31S	57°53'31"W	572
	Campos de Júlio	AGROPLANT	13°56'1"	59°07'6"	668
	Campo Verde	UFMT	15°32'48"	55°10'08"	736
MS	Dourados	Embrapa Agropecuária Oeste	21°74'S	54°62'W	293
MG	Patos de Minas	EPAMIG	18°34'44"	46°31'04"	815
DF	Planaltina	Embrapa Cerrados	15°27'10"S	47°36'51"W	1060
RO	Vilhena	Embrapa Rondônia	12°47'12"S	60°03'39"W	600
GO	Rio Verde	FESURV	17°47'0S	50º57'2"	737

The analysis of variance was performed on grain and oil yields for each environment (location and year). As the locations of the trials included in the FTF were not exactly the same ones as those chosen for the FTS, a joint analysis of environment for each group of genotypes was carried out. For this, a test to verify the homogeneity of residual variances was applied. Trials with coefficients of variation higher than 20% (Pimentel Gomes, 1985) were not included in the joint analysis of variance.

Two criteria were used for selection of genotypes: 1) the general mean obtained from different environments; 2) partitioning of general mean in favorable and unfavorable environments. As favorable environments were selected those with a superior general mean and aunfavorable environments those with inferior general mean (Verma et al., 1978).

In the analysis of the general mean, Scott-Knott test at 5% of probability was performed to verify significance of differences between genotypes, as well as the comparison of means between each evaluated genotype and the controls.

The favorable and unfavorable environment means of each genotype were compared to the control mean in each environment, according to the IDMG method (Indication Method – Partitioning of General Mean) (Porto et al., 2007). When the mean of a certain genotype was higher than the control mean in favorable but not in unfavorable environments, this genotype was regarded as being a suitable one for favorable environments, and vice versa. On the other hand, if a certain genotype was superior in both environments, it received a general indication.

The statistical analyses were performed with the Genes software package (Cruz, 2001).

RESULTS AND DISCUSSION

The interaction genotypes x environments was significant in the joint analysis of variance, indicating a different performance of genotypes over the evaluated environments, and pointing out the importance of studies of the yield components in specific environments (Table 2). The experimental accuracy was satisfactory according to classification of Pimentel Gomes (1985), since the coefficients of variation (CV) were lower than 20% for yield components. General means for grain yield over the year were remarkably superior to the approximately 1,360 kg ha^{-1}, observed in Brazilian commercial sunflower crops (Embrapa Soja, 2007b).

In spite of the acceptable values of C.V., significant differences between genotypes, at 5% of probability level, were detected by Scott-Knott test only when a large difference between their means was observed for both evaluated traits (Table 3), as reported by Embrapa Soja (2004, 2006, 2007a). Therefore, selection of sunflower genotypes was made based on the difference between their performance and the mean of controls, so that selected materials were those with means higher than that of controls. None of the hybrids showed means greater than the control (M 734 and AGROBEL 960) for grain yield. For this

trait, the mean for open pollinated variety BRSGira 02 was greater than Embrapa 122 (control). The genotypes that presented a general mean higher than the controls for oil yield were the hybrids EXP 1447 and EXP 1446 and the varieties BRSGira 01 e BRSGira 02. In this analysis, none of the open pollinated varieties was greater than any hybrid. Nevertheless, the use of open pollinated varieties may be meaningful to the farmholders, due to low seed price and less environmental risk (water deficit), once sunflower crop is sown in February/March, at the end of the rainy season.

Table 2. Joint analyses of variance for grain and oil yields (kg ha^{-1}) of sunflower genotypes evaluated in the National Sunflower Trials, coordinated by Embrapa, in 2006 and 2007.

Source of variation	Df	MS (Grain yield)	MS (Oil yield)
Block/ environment	54	185,735.156	44,818.04
Genotype (G)	15	3,700,641.79**	742,973.81**
Environment (E)	17	22,279,347.24**	4,309,501.67**
GxE	255	355,287.11**	74,515.86**
Residue	810	80,284.86	16,737.52
Mean		2,021	885
C.V.(%)		14.01	14.61

** Significant at 1% of probability for F test.

Table 3. Partition of means of sunflower genotypes evaluated in favorable and unfavorable environments for grain and oil yields (kg ha^{-1}), from experiments carried out in 2006 and 2007.

	Grain Yield (Kg ha^{-1})				Oil Yield (Kg ha^{-1})		
Genotype	Mean	FM[5]	UM[5]	Genotype	Mean	FM[5]	UM[5]
M 734 (H)[1,2]	2,328 a[4]	2,950 a	1,830 a	Exp 1447 (H)[1]	1,059 a[4]	1,304 a	864 a
Agrobel 960 (H)[2]	2,289 a	2,830 a	1,856 a	Agrobel 960 (H)[2]	1,043 a	1,315 a	825 a
BRSG 10 (H)	2,243 a	2,774 a	1,818 a	Exp 1446 (H)	1,039 a	1,309 a	823 a
Exp 1447 (H)	2,200 a	2,752 a	1,759 a	M 734 (H)[2]	946 a	1,160 a	775 a
ACA 886 (H)	2,196 a	2,709 a	1,786 a	BRSGira 09 (H)	903 b	1,123 b	726 a
Exp 1446 (H)	2,183 a	2,725 a	1,750 a	BRSGira 11 (H)	902 b	1,166 a	691 b
SPS 4561 (H)	2,069 a	2,626 a	1,623 a	ACA 861 (H)	887 b	1,062 b	747 a
BRSG 09 (H)	2,054 a	2,497 b	1,700 a	BRSGira 10 (H)	884 b	1,105 b	707 b
BRSG 11 (H)	2,033 a	2,560 a	1,612 a	ACA 886 (H)	872 b	1,048 b	732 a
ACA 861 (H)	2,011 a	2,463 b	1,650 a	SPS 4561 (H)	863 b	1,069 b	699 b
HELIO 256 (H)	1,976 a	2,372 b	1,658 a	HELIO 256 (H)	854 b	1,046 b	701 b
BRSG 08 (H)	1,929 a	2,442 b	1,518 b	BRSGira 08 (H)	846 b	1,047 b	685 b
BRSGira 02 (V)	1,881 a	2,308 b	1,540 b	BRSGira 02 (V)	830 b	1,050 b	655 b
Embrapa 122 (V)[3]	1,735 a	2,214 b	1,351 b	BRSGira 01 (V)	788 b	1,002 b	617 b
BRSGira 01 (V)	1,671 a	2,079 b	1,345 b	Embrapa 122 (V)[3]	744 b	959 b	571 b
BRSGira 03 (V)	1,543 a	1,905 b	1,253 b	BRSGira 03 (V)	695 b	873 b	552 b
GM[6]	2,021	2,513	1,628	GM[6]	885	1,102	711
HCM[6]	2,308	2,890	1,843	HCM[6]	994	1,238	800
VCM[6]	1,735	2,214	1,351	VCM[6]	744	959	571

[1]H: hybrid and V: open pollinated variety.
[2]Control for hybrid comparison.
[3]Control for variety comparison.
[4]Means followed by the same letter did not differ significantly at the Scott-Knott test (P≤0.05).
[5]FM = mean in favorable environments; UM = mean in unfavorable environments.
[6]GM = general mean; HCM = hybrid control mean and VCM = variety control mean.

For selection of sunflower genotypes, the general means of grain and oil content from different environments are commonly used (Embrapa Soja, 2004, 2005 and 2006), although the specific adaptation of the favorable and unfavorable environments should be taken into account. In this study, the method of the IDMG showed results similar to general mean analyses. The hybrids EXP 1447 and EXP 1446 and the varieties BRSGira 02 e BRSGira 01 gave a general indication for oil yield. These varieties also gave a general indication for grain yield.

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