EVALUATION OF SUNFLOWER CULTIVARS FOR CENTRAL BRAZIL

Willyam Stern Porto[1]; Claudio Guilherme Portela de Carvalho[2]*; Ronald José Barth Pinto[1]; Marcelo Fernandes de Oliveira[2]; Ana Cláudia Barneche de Oliveira[2]

[1]*UEM - Depto. de Agronomia, Av. Colombo 5790 - 87020-900 - Maringá, PR - Brasil.*
[2]*Embrapa Soja, C.P. 231 - 86001-970 - Londrina, PR - Brasil.*
**Corresponding author <cportela@cnpso.embrapa.br>*

ABSTRACT: Despite a large availability of areas suitable for sunflower cropping in Central Brazil, few adapted cultivars are available in the market. The objective of this work was to select sunflower cultivars adapted to this important production region. Experimental data from 2000 to 2004 were obtained by the National Sunflower Trials, coordinated by Embrapa Soja. The evaluated traits were grain and oil yields. Two criteria were used for selection of cultivars: i) the general mean obtained from different environments; ii) partitioning of general mean in favorable and unfavorable environments. Partitioning of the general mean allowed to detect the specific environment indicated for each cultivar. For grain yield, the cultivar Helio 251 presented general indication, Milênio and CF 17 could be indicated for favorable environments and ACA 884, ACA 885 and ACA 872 for the unfavorable ones. For oil yield, CF 13, Milênio, DK 4030, Helio 250 and ACA 872 had general indication; AG 966, GH 12, GV 26043, CF 17 and VDH 93 could be indicated for favorable environments, while VDH 488, Helio 251, ACA 884 and ACA 885 for the unfavorable conditions. In 2002, the partition of the general mean was not carried out. In this year, general mean of cultivars Exp 37, AG 962, GV 26048 and AG 967 were overweight the controls for grain yield and the cultivars AG 962, AG 967, GV 26048, AG 972, BRS 191, Guarani were overweight the controls for oil yield.
Key words: *Helianthus annuus*, genetic breeding, interaction genotypes × environments

AVALIAÇÃO DE CULTIVARES DE GIRASSOL PARA O BRASIL CENTRAL

RESUMO: Embora haja uma grande área para o cultivo de girassol no Brasil Central, poucas cultivares adaptadas encontram-se disponíveis no mercado. Esse trabalho teve o objetivo de selecionar cultivares de girassol para essa região de produção de grãos. Os dados foram obtidos da Rede Nacional de Ensaios de Avaliação de Cultivares de Girassol, coordenada pela Embrapa Soja, entre os anos de 2000 e 2004. Os caracteres avaliados foram rendimentos de grão e de óleo. Para a seleção das cultivares, dois critérios foram utilizados: i) a média geral obtida nos diferentes ambientes de teste; ii) a decomposição da média geral em ambientes favoráveis e desfavoráveis. A análise da decomposição da média geral possibilitou detectar para qual tipo de ambiente específico um genótipo poderia ser indicado. Para rendimento de grãos, o genótipo Helio 251 apresentou indicação geral; Milênio e CF 17 foram indicados para os ambientes favoráveis e, para os desfavoráveis, ACA 884, ACA 885 e ACA 872. Para rendimento de óleo, CF 13, Milênio, DK 4030, Helio 250 e ACA 872 tiveram indicação geral; enquanto que AG 966, GH 12, GV 26043, CF 17 e VDH 93 foram indicados para ambientes favoráveis, e VDH 488, Helio 251, ACA 884 e ACA 885 para os desfavoráveis. Em 2002, não foi realizada a decomposição da média geral. Nesse ano, Exp 37, AG 962, GV 26048 e AG 967 destacaram-se para rendimento de grãos e AG 962, AG 967, GV 26048, AG 972, BRS 191, Guarani, para rendimento de óleo.
Palavras-chave: *Helianthus annuus*, melhoramento genético, interação genótipos × ambientes

INTRODUCTION

There is an increasing utilization of sunflower in Brazil, due to its use as raw material for silage, oil production and to its potential as a new source of energy from the biological fuel production. Therefore, grown area and grain production increased 60 and 47%, respectively, between 2002/2003 and 2004/2005 (Reunião, 2005). Most of the 82.000 ha cultivated in 2004/2005 were sowed in Central Brazil, following to

the major summer growing period, mainly in the States of São Paulo (36.7%), Mato Grosso (17.4%), Goiás (10.2%) and Mato Grosso do Sul (8.8%) (Reunião, 2005).

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

The expansion of the sunflower crop as the second summer crop in Brazil depends on a constant evaluation of new cultivars obtained by the identification 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 more feasible the necessary economic returns compared to other summer crops.

Since 1989, the evaluation and selection of hybrids and varieties of sunflower from several companies are being made through of the National Sunflower Trials, coordinated by Embrapa Soja and supported by the contribution of public and private institutions. The aim of this work was to select sunflower cultivars evaluated in the Trial Network carried out between 2000 and 2004 in Central Brazil.

MATERIAL AND METHODS

Data were used from the National Sunflower Trials, coordinated by Embrapa Soja. Trials were installed from 2000 to 2004 in several locations of the states of Goiás, Mato Grosso, Mato Grosso do Sul, Minas Gerais, São Paulo and Distrito Federal (Table 1).

The cultivars were sown in February/March, in randomized block designs 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 until 0.5 m apart from the tip 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 cultivars were simple and triple hybrids and open pollinated varieties developed by the companies ADVANTA, CATI, DOW AgroSciences, Embrapa Soja, La Tijereta and HELIANTHUS DO BRASIL. Commercial hybrids M 734 (DOW AgroSciences) and Agrobel 960 (La Tijereta) were used as controls. In 2001, only the hybrid M734 was used as control. The evaluated traits were grain and oil yields. Cultivar evaluation was carried out during two years in the Final Trials of the First Year of Evalua-

Table 1 - Year of assessment, altitude and geographical coordinates of the National Sunflower Trial locations in the period from 2000 to 2004.

State	Location	Year of Assessment1	Latitude	Longitude	Altitude
					m
SP	Cravinhos	2002 (FTF) and 2003 (FTS)	21º20'25"	47º43'46"	788
	Jaboticabal	2003 (FTF)	21º15'17"	48º19'20"	605
	Jardinópolis	2001 (FTS)	21º01'04"	47º45'50"	590
	Manduri	2002, 2003 (FTF) and 2002, 2004 (FTS)	23º00'12"	49º19'19"	710
	São Manuel	2003 (FTS)	22º43'52"	48º34'14"	709
MS	Chapadão do Sul	2003, 2004 (FTS)	18º47'39"	52º37'22"	790
	Dourados	2003, 2004 (FTS)	22º13'16"	54º48'20"	430
MT	Campo Novo do Parecis	2003 (FTF) and 2001, 2003, 2004 (FTS)	13º40'31"	57º53'31"	572
	Jaciara	2001 (FTS)	15º57'55"	54º58'06"	367
	Juscimeira	2002 (FTS)	16º03'02"	54º53'04"	251
	Nova Mutum	2003 (FTF)	13º49'44"	56º04'56"	460
	Primavera do Leste	2000 (FTF)	15º33'32"	54º17'46"	465
GO	Jataí	2002 (FTF) and 2002, 2003 (FTS)	17º52'53"	51º42'52"	708
	Rio Verde	2001 (FTS)	17º46'03"	51º01'50"	836
MG	Uberlândia	2001 (FTF) and 2001 (FTS)	18º55'23"	48º17'19"	863
DF	Planaltina	2002, 2003, 2004 (FTS)	15º35'30"	47º42'30"	1007

[1]FTF - Evaluations made in Final Trials of the First Year of Evaluation and FTS - Evaluations made in Final Trials of the Second Year of Evaluation.

tion (FTF) and in Final Trials of the Second Year of Evaluation (FTS) (Table 1). From 2001 to 2004, eleven, fifteen, ten and six cultivars were evaluated. Evaluations made in 2001, include the experimental data obtained from the Final Trials of First Year of Evaluation 2000 and from the Final Trials of Second Year of Evaluation 2001, with similar procedure for other years of evaluation.

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 cultivars was carried out. For this, a test to verify the homogeneity of residual variances was applied. In this test, variances were considered as homogeneous when the ratio between the larger and the smaller residual mean square was smaller than 7 (Pimentel Gomes, 1985). Moreover, trials with coefficients of variation higher than 20% (Pimentel Gomes, 1985) and experiments with major problems (birds attacks, drought and serious incidence of plant diseases, like Alternaria) were not included in the joint analysis of variance.

Two criteria were used for selection of cultivars: i) the general mean obtained from different environments; and ii) partitioning of general mean in favorable and unfavorable environments. It was considered favorable environment those with superior general mean and unfavorable one those with inferior general mean (Verma et al., 1978).

In the analysis of the general mean, Duncan test ($P < 0.05$) was performed to verify significance of differences among cultivars, as well as the comparison of means among each evaluated cultivar and the controls. The favorable and unfavorable environment means of each cultivar were compared with 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 cultivar is higher than the control mean in favorable but not in unfavorable environments, this cultivar is regarded oneself as fitted for favorable environments, and vice versa. On the other hand, if a certain cultivar is superior in both environments, its indication is general. The partitioning of the general mean was not calculated when the number of favorable and unfavorable environments was equal or less than three. The statistical analyses were performed with the software Genes (Cruz, 2001).

RESULTS AND DISCUSSION

The interaction cultivars × environments was significant in the joint analysis of variance, indicating a different performance of cultivars over the evaluated environments, and pointing out the importance of studies of yield components in specific environments (Table 2). The presence of G × E interaction in sunflower yield tests has also been reported by Embrapa (1996; 1997; 1998; 1999; 2000); Lu'Quez et al. (2002) and De la Vega & Chapman (2006). The experimental accuracy was satisfactory according the classification of Pimentel Gomes (1985), since the coefficients of variation (CV) were comprised between 11.83% and 14.33% for grain yield and between 12.23% and 14.51% for oil yield. General means for grain yield over year were remarkable superior to the approximately 1500 kg ha^{-1}, observed in Brazilian commercial agriculture, according to data from CONAB (2005).

In spite of the acceptable values of CV, differences among cultivars were detected by Duncan test ($P < 0.05$) only when a large difference among their means was observed for both evaluated traits (Table 3), as reported by Embrapa (1996; 1997; 1998; 1999; 2000). Therefore selection of sunflower cultivars was made based on the difference between their performance and the mean of controls, so that selected ma-

Table 2 - Joint analyses of variance for grain and oil yields (kg ha^{-1}) of sunflower cultivars evaluated in the National Sunflower Trials, coordinated by Embrapa, in the period from 2000 to 2004.

Year[1]	Yield (kg ha^{-1})					
	Grain			Oil		
	QMGA[2]	CV[3]	Mean[4]	QMGA	CV	Mean
2001	211,209.45**	12.44	1863.71	51,440.64**	13.41	819.37
2002	371,927.69**	11.83	1702.46	50,324.94**	12.23	662.92
2003	326,407.84**	12.18	1901.23	57,947.50**	13.75	751.02
2004	178,296.76**	14.33	2054.87	34,646.46**	14.51	824.28

**Significant at 1% for F test. [1]Evaluations made in 2001 (sowing date on February/March) include the experimental data obtained in the Final Trials of First Year of Evaluation 2000 and Final Trials of Second Year of Evaluation 2001, with similar procedure for other years of evaluation. [2]QMGA: Mean square for the interaction cultivars × environments. [3]CV: Coefficient of variation (%). [4]General mean, in kg ha^{-1}.

Table 3 - Means of sunflower cultivars evaluated in the National Sunflower Trials, coordinated by Embrapa, between 2000 and 2004, for grain and oil yields.

Grain yield (kg ha^{-1})							
2001[1]		2002		2003		2004	
Cultivar[2]	Mean[3]	Cultivar	Mean	Cultivar	Mean	Cultivar	Mean
M 734 (H)	2046.46 a	Exp 37 (H)	1981.78 a	M 734 (H)	2152.36 a	M 734 (H)	2381.04 a
MILENIO (H)	2028.32 a	AGB 962 (H)	1968.56 ab	Helio 251 (H)	2043.74 ab	AG 960 (H)	2197.59 b
CF 17 (H)	1950.65 a	GV 26048 (H)	1865.03 abc	ACA 884 (H)	1988.37 ab	V 10034 (H)	2070.32 c
CF 13 (H)	1896.36 a	AGB 967 (H)	1725.45 abcd	ACA 872 (H)	1951.09 ab	Helio 358 (H)	1986.26 d
DK 4030 (H)	1885.57 a	M 734 (H)	1713.49 abcd	Helio 250 (H)	1919.29 ab	Multissol (V)	1938.98 d
GH 12 (H)	1881.52 a	Guarani (H)	1685.43 abcd	ACA 885 (H)	1911.18 ab	Embrapa 122 (V)	1755.00 e
VDH 93 (H)	1867.09 a	AG 960 (H)	1681.96 abcd	V 80198 (H)	1855.87 ab	-	-
AG 966 (H)	1859.40 a	Exp 36 (H)	1670.70 bcd	AG 960 (H)	1819.18 ab	-	-
GV 26043 (H)	1852.70 a	AGB 972 (H)	1663.50 cd	V 90064 (H)	1738.43 ab	-	-
VDH 488 (H)	1831.48 a	IAC Uruguai (V)	1641.30 cd	Catissol (V)	1632.81 b	-	-
HT 3 (H)	1401.28 b	BRS 191 (H)	1610.90 cd	-	-	-	-
-	-	Exp 38 (H)	1609.78 cd	-	-	-	-
-	-	Exp 33 (H)	1584.63 cd	-	-	-	-
-	-	Catissol (V)	1431.89 d	-	-	-	-
General mean	1863.71	General mean	1702.45	General mean 1	901.23	General mean	2054.86
Control mean	2046.46	Control mean	1697.72	Control mean 1	985.77	Control mean	2289.31
Oil yield (kg ha^{-1})							
2001		2002		2003		2004	
Cultivar	Mean	Cultivar	Mean	Cultivar	Mean	Cultivar	Mean
CF 13 (H)	901.37 a	AGB 962 (H)	821.89 a	Helio 250 (H)	827.41 a	AG 960 (H)	930.41 a
MILENIO (H)	894.42 a	AGB 967 (H)	804.60 ab	M 734 (H)	808.92 a	M 734 (H)	903.26 ab
DK 4030 (H)	864.60 a	GV 26048 (H)	720.32 abc	ACA 872 (H)	791.46 a	Helio 358 (H)	884.50 b
AG 966 (H)	859.78 a	AGB 972 (H)	711.24 abcd	Helio 251 (H)	776.45 a	V 10034 (H)	796.06 c
GH 12 (H)	855.21 a	AG 960 (H)	709.09 abcd	ACA 884 (H)	758.76 a	Multissol (V)	734.78 d
M 734 (H)	821.29 a	BRS 191 (H)	704.37 abcde	ACA 885 (H)	747.38 a	Embrapa 122 (V)	696.65 e
VDH 488 (H)	819.91 a	Guarani (H)	696.70 abcde	V 80198 (H)	745.37 a	-	-
GV 26043 (H)	812.00 a	M 734 (H)	659.69 bcde	AG 960 (H)	736.53 a	-	-
CF 17 (H)	791.02 a	Exp 33 (H)	621.56 cdef	V 90064 (H)	685.59 a	-	-
VDH 93 (H)	779.51 a	Exp 36 (H)	615.11 cdef	Catissol (V)	632.32 a	-	-
HT 3 (H)	613.99 b	Exp 38 (H)	611.63 cdef	-	-	-	-
-	-	Catissol (V)	555.49 def	-	-	-	-
-	-	IAC Uruguai (V)	549.58 ef	-	-	-	-
-	-	Exp 37 (H)	499.61 f	-	-	-	-
General mean	819.37	General mean	662.92	General mean	751.02	General mean	824.28
Control mean	821.29	Control mean	684.39	Control mean	772.72	Control mean	916.83

[1]Evaluations made in 2001 (sowing date on February/March) include the experimental data obtained in the Final Trials of First Year of Evaluation 2000 and Final Trials of Second Year of Evaluation 2001, with similar procedure for others years of evaluation. [2]H = hybrid and V = open pollinated variety. [3]Means followed by the same letter did not differ at the Duncan test ($P \leq 0.05$).

terials were those with means higher than that of controls. This criterion is rigorous whereas it causes a greater strictness in discriminating cultivars in comparison with selection based on results from the Duncan test, therefore it reduces the number of selected cultivars. Despite this constraint, this criterion has been used by the Brazilian Ministry of Agriculture, Livestock and Food Supply (MAPA) for the registration of new soybean, wheat and bean cultivars. No criterion was established for sunflower up to now.

In the period of 2000-2004, the cultivars that presented a general mean higher than the controls for grain yield were Exp 37, AG 962, GV 26048, AG 967, Helio 251 and ACA 884. For oil yield, the best culti-

vars were CF 13, Milênio, DK 4030, AG 966, GH 12, AG 962, AG 967, GV 26048, AG 972, BRS 191, Guarani, Helio 250, Helio 251 and ACA 872. Only cultivars AG 962, AG 967, GV 26048 and Helio 251 presented a better performance for the two evaluated components of yield (Table 3). Thus, cultivars not always had a good performance for both traits. The use of cultivars with outstanding performance in only one of the evaluated components depends on the farmer preference at the time of choice a hybrid variety and also must be based on the effective politics of trade by the sunflower industry. Currently, industries grant a bonus for cultivars whose oil content is above 40%. When the bonus is paid, farmers prefer hybrids with higher oil content then those with higher grain yield.

From 2000 to 2004, the National Sunflower Trials evaluated simple and triple hybrids and open pollinated varieties. In this period, no open pollinated va-

Table 4 - Partition of means of sunflower cultivars evaluated in favorable and unfavorable environments for grain and oil yields, from experiments carried out from 2000 to 2004.

Grain yield (kg ha^{-1})											
2001[1]				2003				2004			
Cultivar[2]	GM[3]	UM[4]	FM[5]	Cultivar	GM	UM	FM	Cultivar	GM	UM	FM
M 734 (H)	2046.46	1721.82	2479.32	M 734 (H)	2152.36	1 766.16	2538.55	M 734 (H)	2381.04	1880.14	3007.17
MILENIO (H)	2028.32	1572.94	2635.49	Helio 251 (H)	2043.74	1 691.40	2396.07	AG 960 (H)	2197.59	1860.04	2619.54
CF 17 (H)	1950.65	1453.43	2613.61	ACA 884 (H)	1988.37	1 727.43	2249.31	V 10034 (H)	2070.32	1811.65	2393.66
CF 13 (H)	1896.36	1525.70	2390.57	ACA 872 (H)	1951.09	1 667.56	2234.64	Helio 358 (H)	1986.26	1641.19	2417.60
DK 4030 (H)	1885.57	1590.35	2279.19	Helio 250 (H)	1919.29	1 569.24	2269.34	Multissol (V)	1938.98	1584.40	2382.22
GH 12 (H)	1881.52	1441.79	2467.82	ACA 885 (H)	1911.18	1 703.99	2118.38	EMB 122 (V)	1755.00	1471.26	2109.69
VDH 93 (H)	1867.09	1485.54	2375.83	V 80198 (H)	1855.87	1 567.44	2144.29	-	-	-	-
AG 966 (H)	1859.40	1500.46	2338.00	AG 960 (H)	1819.18	1 447.22	2191.15	-	-	-	-
GV 26043 (H)	1852.70	1516.78	2300.60	V 90064 (H)	1738.43	1 377.21	2099.65	-	-	-	-
VDH 488 (H)	1831.48	1582.96	2162.84	Catissol (V)	1632.81	1 425.58	1840.04	-	-	-	-
HT 3 (H)	1401.28	1144.01	1744.32	-	-	-	-	-	-	-	-
General mean	1863.71	1503.25	2344.32	General mean	1901.23	1 594.32	2208.14	General mean	2054.85	1708.11	2 488.31
Control mean	2046.46	1721.82	2479.32	Control mean	1985.77	1 606.69	2364.85	Control mean	2289.31	1870.09	2 813.35
Oil yield (kg ha^{-1})											
2001				2003				2004			
Cultivar	GM	UM	FM	Cultivar	GM	UM	FM	Cultivar	GM	UM	FM
CF 13 (H)	901.37	724.20	1137.60	Helio 250 (H)	827.41	679.54	1049.23	AG 960 (H)	930.41	786.92	1217.40
MILENIO (H)	894.42	719.29	1127.92	M 734 (H)	808.92	682.11	999.13	M 734 (H)	903.26	747.88	1214.01
DK 4030 (H)	864.60	747.33	1020.95	ACA 872 (H)	791.46	662.00	985.66	Helio 358 (H)	884.50	723.46	1206.57
AG 966 (H)	859.78	682.66	1095.94	Helio 251 (H)	776.45	656.92	955.76	V 10034 (H)	796.06	650.99	1086.20
GH 12 (H)	855.21	667.35	1105.69	ACA 884 (H)	758.76	683.31	871.93	Multissol (V)	734.78	613.44	977.44
M 734 (H)	821.29	716.42	961.13	ACA 885 (H)	747.38	668.51	865.68	EMB 122 (V)	696.65	598.31	893.33
VDH 488 (H)	819.91	725.72	945.50	V 80198 (H)	745.37	628.10	921.27	-	-	-	-
GV 26043 (H)	812.00	676.40	992.80	AG 960 (H)	736.53	601.75	938.69	-	-	-	-
CF 17 (H)	791.02	602.74	1042.05	V 90064 (H)	685.59	554.92	881.60	-	-	-	-
VDH 93 (H)	779.51	622.85	988.39	Catissol (V)	632.32	510.63	814.86	-	-	-	-
HT 3 (H)	613.99	496.92	770.08	-	-	-	-	-	-	-	-
General mean	819.37	671.08	1017.09	General mean	751.01	632.77	928.38	General mean	824.27	686.83	1099.15
Control mean	821.29	716.42	961.13	Control mean	772.72	641.93	968.91	Control mean	916.83	767.40	1215.70

[1]Evaluations made in 2001 include the experimental data obtained in the Final Trials of First Year of Evaluation 2000 and Final Trials of Second Year of Evaluation 2001, in the same way, for many years of evaluation. Partition of the general mean was not performed in 2002, because in those experiments the number of favorable environments was less than four. [2]H = hybrid and V = open pollinated variety. [3]GM = general mean. [4]UM = average in unfavorable environments. [5]FM = average in favorable environments.

riety was greater than the control mean (Table 3). These values varied from 3.3% (IAC Uruguai in 2002) to 23.3% (Embrapa 122 in 2004) for grain yield and from 18.2% (Catissol in 2004) to 24.0% (Embrapa 122 in 2004). Nevertheless, the use of open pollinated varieties may be meaningful for the farmholders, due to low seed price and less environmental risk (water deficit), when sunflower crop is sown on February/March.

For selection of sunflower cultivars normally used general means of grain and oil content from different environments (Embrapa, 1996; 1997; 1998; 1999; 2000). Although it should be taken into account the specific adaptation of the favorable and unfavorable environments (Ramalho et al., 1993; Cruz & Regazzi, 1994; Lu'Quez et al., 2002; De la Vega & Chapman, 2006). In this study, the method of the IDMG allowed to detecting cultivars for a specific environment (Table 4). For grain yield, only the cultivar Helio 251 had general indication. Milênio and CF 17 would be indicated for favorable environments and ACA 884, ACA 885 and ACA 872 for the unfavorable ones. For oil yield, CF 13, Milênio, DK 4030, Helio 250 and ACA 872 had general indication; AG 966, GH 12, GV 26043, CF 17 and VDH 93 would be indicated for favorable environments, while VDH 488, Helio 251, ACA 884 and ACA 885 for the unfavorable conditions. The IDMG analysis was not performed in 2002, because in those experiments the number of favorable environments was less than four. Some cultivars that did not present a superior average in comparison with the controls had good performance in specific environments. For instance, cultivar ACA 885 was indicated for unfavorable environments for grain and oil yields (Table 4), although its general average was smaller than one of the controls.

CONCLUSIONS

For grain yield, the cultivar Helio 251 presents general indication, Milênio and CF 17 would be recommended for favorable environments and ACA 884, ACA 885 and ACA 872 would be indicated for the unfavorable environments when sowed on February/March. For oil yield, CF 13, Milênio, DK 4030, Helio 250 and ACA 872 present general indication; AG 966, GH 12, GV 26043, CF 17 and VDH 93 would be indicated for favorable environments, while VDH 488, Helio 251, ACA 884 and ACA 885 would be indicated for the unfavorable ones, when sowed at the same date.

REFERENCES

COMPANHIA NACIONAL DE ABASTECIMENTO - CONAB. **Acompanhamento da safra 2004/2005**. Brasília: CONAB. Available at http://www.conab.gov.br. Accessed 15 Nov. 2005.

CRUZ, C.D. **Programa Genes**: versão Windows; aplicativo computacional em genética e estatística. Viçosa: UFV, Imprensa Universitária, 2001. 648p.

CRUZ, C.D.; REGAZZI, A.J. **Modelos biométricos aplicados ao melhoramento genético**. Viçosa: UFV, Imprensa Universitária, 1994. 390p.

DE LA VEGA, A.J.; CHAPMAN, S.C. Defining sunflower selection strategies for a highly heterogeneous target population of environments. **Crop Science**, v.46, p.136-144, 2006.

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA - EMBRAPA. **Informes da avaliação de genótipos de girassol da Rede Oficial, 1995/1996 e 1996**. Londrina: EMBRAPA, CNPSo, 1996. 85p. (Documentos, 98).

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA - EMBRAPA. **Informes da avaliação de genótipos de girassol da Rede Oficial, 1996/1997 e 1997**. Londrina: EMBRAPA, CNPSo, 1997. 116p. (Documentos, 110).

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA - EMBRAPA. **Informes da avaliação de genótipos de girassol da Rede Oficial, 1997/1998 e 1998**. Londrina: EMBRAPA, CNPSo, 1998. 92p. (Documentos, 122).

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA - EMBRAPA. **Informes da avaliação de genótipos de girassol da Rede Oficial, 1998/1999 e 1999**. Londrina: Embrapa Soja, 1999. 99p. (Documentos, 122).

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA - EMBRAPA. **Informes da avaliação de genótipos de girassol, 1999/2000 e 2000**. Londrina: Embrapa Soja, 2000. 92p. (Documentos, 151).

LU´QUEZ, J.E.; AGUIRREZÁBAL, L.A.N.; AGÜERO, M.E.; PEREYRA, V.R. Stability and adaptability of cultivars in non-balanced yield trials. Comparison of methods for selecting 'high oleic' sunflower hybrids for grain yield and quality. **Journal of Agronomy and Crop Science**, v.188, p.225-234, 2002.

PIMENTEL GOMES, F. **Curso de estatística experimental**. 13.ed. São Paulo: USP-ESALQ, 1985. 468p.

PORTO, W.S.; CARVALHO, C.G.P.; PINTO, R.J.B. Adaptabilidade e estabilidade como critérios para seleção de genótipos de girassol. **Pesquisa Agropecuária Brasileira**, v.42, p.491-499, 2007.

RAMALHO, M.A.P.; SANTOS, J.B.; ZIMMERMANN, M.J.O. **Genética quantitativa em plantas autógamas**; aplicações ao melhoramento do feijoeiro. Goiânia: UFG, 1993. 271p.

REUNIÃO NACIONAL DE PESQUISA DE GIRASSOL, 16., Londrina, 2005. **Ata...** Londrina: Embrapa Soja, 2005. 111p.

VERMA, M.M.; CHAHAL, G.S.; MURTY, B.R. Limitations of conventional regression analysis: a proposed modification. **Theoretical and Applied Genetics**, v.53, p.89-91, 1978.

Received December 19, 2006
Accepted September 03, 2007