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PRELIMINARY RESULTS OF TEST CROSS SUNFLOWER HYBRIDS

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SUMMARY

Experimental hybrids were obtained by test cross during a backcross program the purpose of which was the screening of new high oleic lines (HOL) in Metaponto. Seventeen hybrids were evalutated in an experimental field compared with 2 commercial hybrids and a high oleic synthetic line. Several tested hybrids showed good performances comparable with 3 testers. The hybrid 30503 showed high oleic content, an early flowering time and interesting agronomical performances. The hybrid 30602 showed high oil content and high oleic acid rate in their seeds. These results showed that a screening for sunflower high oleic lines and hybrids with competitive performences could be carried out. Several parental HOL lines for South Italy environmental conditions could be obtained.

Key words : *Helianthus annuus* L., high oleic (HOL), backcross, field evaluation

INTRODUCTION

The quality of sunflower (*Helianthus annuus* L.) oil is associated with polyunsaturated fatty acids content. The presence of linoleic acid allows to obtain oil for margarine and salad use. On the other hand, high rate of oleic acid in sunflower oil could be useful to produce a cooking oil for deep frying of potato chips and for industrial utilization. Oils with high and low rate of oleic and linoleic acid, respectively, due to a negative correlation between these fatty acids (Canvin, 1965; Fernandez-Martinez, 1974), show a lower susceptibility to oxidate and a large interest for food industry. Therefore, high oleic (HOL) lines screening is an important goal for sunflower breeders (Benvenuti and Vannozzi, 1988). For these purposes Pervenets sunflower cultivar, obtained by Soldatov (1976) via chemical mutagenesis, was very important and the plant breeders have widely introduced this interesting trait in sunflower gene pool.

Pervenets cultivar has 70-80% oleic acid in their seeds while standard hybrids have 40-45% oleic acid rate. Selected high oleic breeding lines from this cultivar showed a stable content of oleic acid (83%) also when grown at different temperatures (Urie, 1985; Fernandez-Martinez et al., 1986).

After Pervenets' worldwide diffusion, several studies were carried out about inheritance mechanism of high oleic acid content in sunflower oil. Fernandez-Martinez and Knowles (1982) and Miller and Zimmermann (1983) found maternal influence lacking dominance in high oleic control. Different authors reported that a single gene,

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partially dominant (Fick, 1984), or dominant (Urie, 1985), is involved in high oleic trait. Miller et al., (1987) found a second gene (named ml) that modified OL dominant gene expression.

Finally, in their last paper, Fernandez-Martinez et al., (1989) reported that 3 additive genes were involved in high oleic control with major factor modifying high oleic acid content. Therefore all these studies showed that backcross scheme is an adoptable methodology to obtain breeding lines and hybrids.

The aim of our programme is to screen high oleic sunflower hybrids for South Italy environmental condition considering the positive correlation between high temperature (frequently present in South Europe area) and high oleic content in sunflower seed (Fernandez-Martinez et al., 1986). The present paper showed preliminary results of test crosses hybrids and the possibility to obtain competitive genotypes.

MATERIALS AND METHODS

Several high oleic lines (~88-90%) were obtained in South Italy environmental conditions by selfing the synthetic line ND-01 (Vick and Miller, 1984). The derived line named H12 (S_7 selection line) was used for the backcross selection method to obtain different high oleic lines. Seven pairs of cytoplasmic male-sterile (CMS) and three restorer lines (RHA) were used as recurrent parents. Manual emasculation technique was adopted when crosses were made between fertile lines (HA and RHA x H12). After two or three backcrosses, a test cross between BC_2 and BC_3 families and the standard RHA lines was performed. The following table indicates the original nomenclature from North Dakota (the number adopted in Metaponto are indicated between brackets) and different examples of nomenclature for experimental hybrids:

CMS 113	(01)	RHA 265 (01)
CMS 234	(02)	RHA 270 (02)
CMS 300	(03)	RHA 279 (03)
CMS 301	(04)	
CMS 302	(05)	
CMS 303	(06)	
CMS 853	(07)	

Hybrid 2	01	01	the hybrid between BC_2 family obtained from CMS 113 and restorer line RHA 265
Hybrid 3	02	02	BC_3 family from CMS 234 and RHA 270
Hybrid 3	07	03	BC_3 family from CMS 853 and RHA 279

Seventeen test cross hybrids and three testers were evaluated in the experimental field at Metaponto (Italy) in 1992. The testers were a high oleic commercial hybrid (Soleado), a standard hybrid (Romsum HS 90) and the original synthetic high oleic line ND-01 from which H12 line was obtained. Experimental design was a randomized complete block with four replications. The plots consisted of seven rows 4 m long with 0.75 m spacing

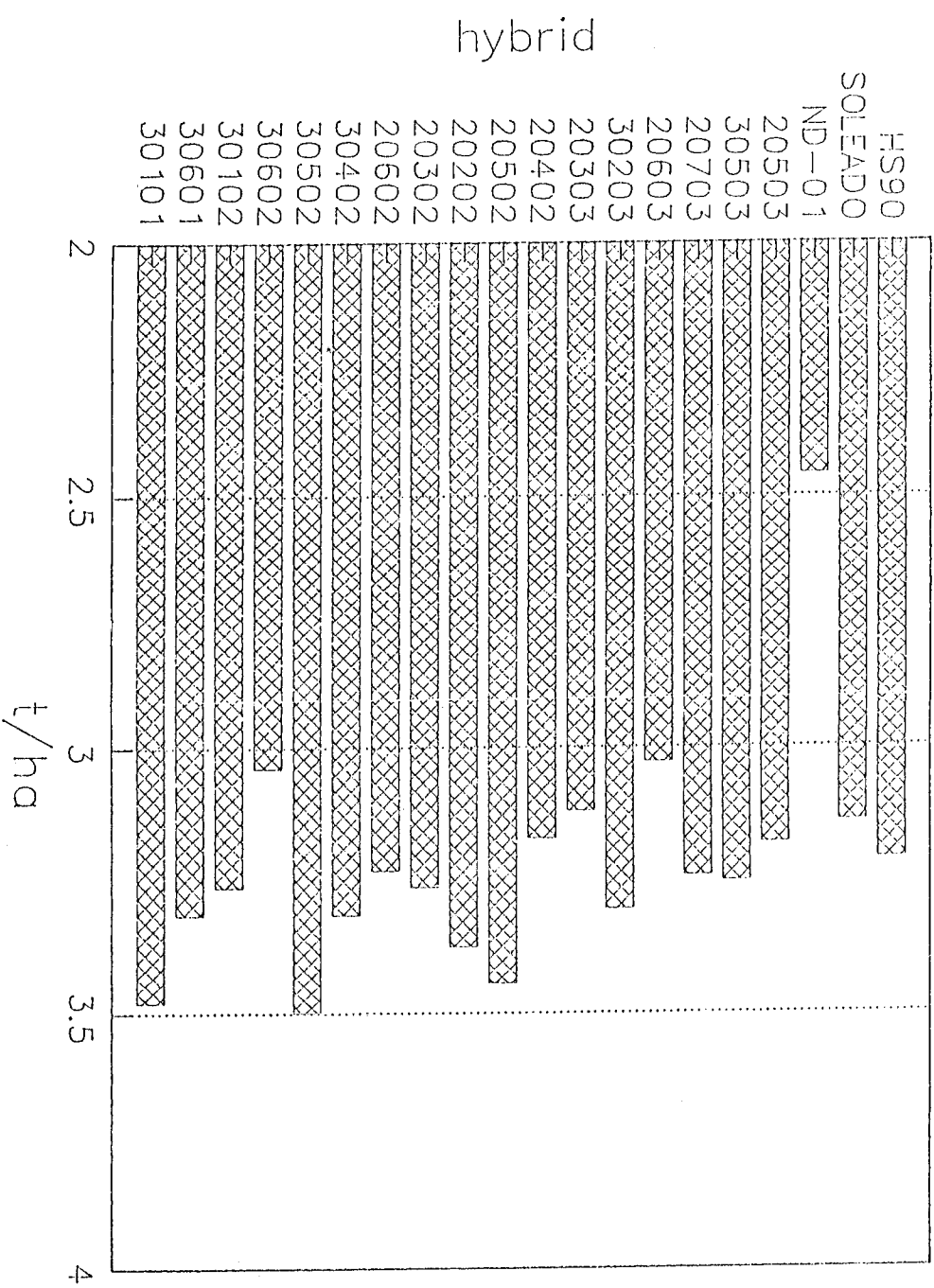

Figure 1. Seed yield of the experimental hybrids compared with the testers

between rows. The theoretical density was 4.4 plants/mq. Weeds were controlled using trifuralin preplant incorporated.

The following traits were evaluated: plant height (cm), stem diameter (mm), head diameter (cm), sterility head diameter (cm), flowering time (days), yield (t/ha), seed weight (gr), oil content (%) and fatty acid composition (%).

Height was determinated by averaging ten plants per replication from the ground level to the top of the head. Stem, head and sterility diameter were determinated averaging the characters above indicated from five plants per replication. Flowering time was determinated when 50% of plants per replication came into flower. Seed yield was obtained from the five central rows of each plot by harvesting 10.5 mq. Seed weight was determinated in 5 x 200-seed sample from each replication. Oil content was determinated by Soxlet method and fatty acid composition by gas chromatography using esterification method.

RESULTS AND DISCUSSION

Significant differences between hybrids were observed for all characters as showed in the analysis of variance presented in Table 1. The most important agronomical traits of seventeen hybrids compared with the testers are shown in Table 2 and seed yield performances are represented in Figure 1.

Table 1. Analysis of variance for all variables.

Variable	Probability	Variable	Probability
Plant height	***	Seed yield	***
Stem diameter	**	Seed weight	***
Head diameter	***	Flowering time	***
Sterile head diameter	***		
** and *** significant at the 0.01 and 0.001 probability levels, respectively.			

Regarding plant height, four hybrids (20202, 30102, 30601 and 30101) were over 140 cm and only 20303 was about 1 meter tall. Synthetic line ND-01 showed the best performance for stem diameter trait, while the hybrid 30601 showed as high head diameter. The hybrids 20402 and 30402 and Soleado showed lower sterility head diameters than the field mean, maybe due to high temperature tollerance during pollination and fertilization. Four hybrids (20503, 30503, 20703 and 20603) showed a very early flowering time as compared with the early-medium tester Romsun HS 90.

The seed yields of the experimental hybrids were competitive with two commercial hybrids (Romsun HS 90 and Soleado) widely used in Italy as testers and in particular the hybrid 30502 showed a significant difference in seed yield. The hybrid pool (test cross with 03 as restorer line) with early flowering time showed a high yield performances.

In Table 3 oil content and fatty acid composition data of experimental hybrids are shown; the differences on oleic acid index (% oil content x % oleic acid /100) are presented in Figure 2.

The oil content of the hybrids was comparable with the mean of the testers.The hybrids 30503, 30203, 20703 and 20503 showed more than 41% of oil content. In

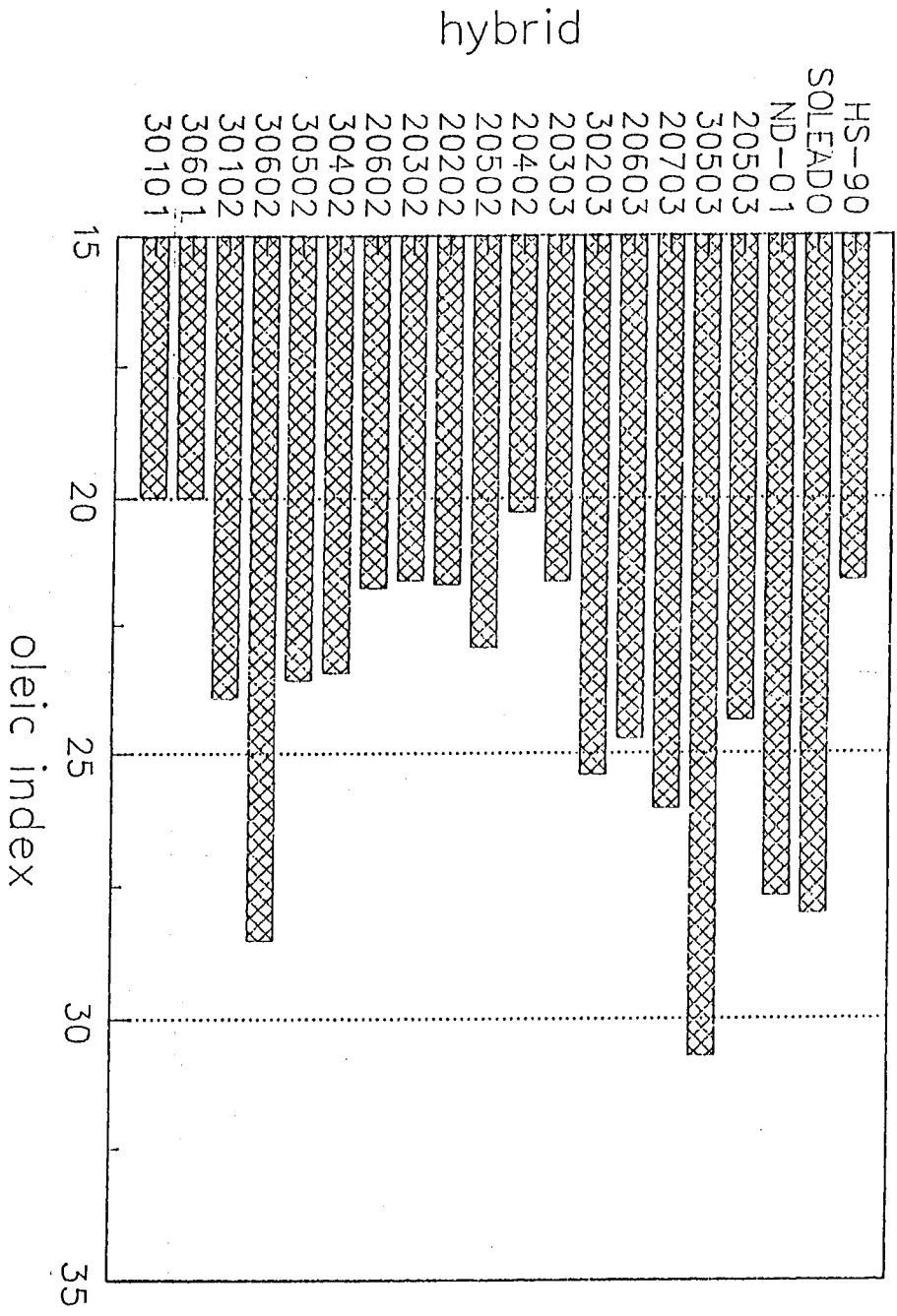

Figure 2. Oleic index of the experimental hybrids compared with the testers

particular the hybrid 30503 exceeded 43% oil content, more than 3% and 7% as compared with the commercial standard and high oleic hybrids, respectively.

Oleic acid content showed a large variability betweeen hybrids tested, therefore the hybrids 30503 and 30602 presented oleic acid content comparable with Soleado. The oleic acid index indicated that 30503 and 30602 could be interesting hybrids. The hybrid 30503 showed high seed yield, seed weight and oil content and early flowering time.

The hybrid 30602 showed high oleic acid content, later flowering time and low seed weight. The hybrid 30503 showed a high sterility head diameter, probably due to a

Table 2. Plant height, flowering time, stem diameter, head diameter, sterile head diameter, seed weight and seed yield of 20 hybrides tested and ordered by flowering time.

Hybrid	Plant height cm	Flowering time gg	Stem diameter mm	Head		Seed weight gr	Seed yield t/ha
				Diameter cm	Sterile cm		
20503	117,2 fg	52,5	12,8 bc	18,5 eg	3,5 ab	70,3 bc	3,18 ab
30503	118,2 fg	53,0	12,8 bc	19,8 bf	3,9 a	71,3 bc	3,25 ab
20703	124,7 de	53,2	13,7 ab	19,9 be	3,1 ad	75,4 b	3,24 ab
20603	120,5 ef	53,7	12,8 bc	18,8 eg	3,1 ad	68,8 cd	3,03 b
30203	128,5 de	54,5	13,6 ab	20,0 bd	3,6 ab	71,8 bc	3,30 ab
20303	103,2 h	54,7	12,7 bc	17,9 g	2,9 be	74,4 bc	3,12 ab
20402	126,7 de	54,7	13,1 ad	18,7 eg	1,7 g	61,0 eg	3,17 ab
HS 90	118,3 gf	55,0	13,4 ac	19,1 cg	3,1 ad	71,5 bc	3,21 ab
20502	131,5 de	55,7	12,9 bc	19,6 bf	2,6 cf	63,1 df	3,44 ab
20202	152,7 ab	56,2	13,1 ad	19,9 bd	2,2 eg	63,9 de	3,37 ab
20302	122,2 de	56,2	12,8 bc	20,8 ab	2,3 eg	58,8 eh	3,26 ab
20602	135,5 ed	56,2	12,2 cd	19,4 bg	1,9 fg	56,8 gh	3,23 ab
30402	135,7 cd	56,7	13,0 ad	19,0 dg	1,6 g	64,5 de	3,31 ab
30502	137,0 cd	56,7	12,4 bc	19,8 be	2,3 eg	63,7 df	3,50 a
Soleado	117,5 fg	57,5	12,2 cd	18,5 eg	1,7 g	57,8 gh	3,14 ab
30602	128,5 ed	57,5	12,1 d	20,6 ad	3,2 ac	53,0 hj	3,04 ab
30102	145,2 bc	58,0	13,0 ad	19,4 bg	2,1 ef	54,8 hi	3,26 ab
ND 01	115,2 hg	58,2	14,2 a	18,1 fg	2,3 ef	82,0 a	2,46 c
30601	154,7 ab	58,5	13,2 ad	21,8 a	2,7 cf	48,9 j	3,31 ab
30101	160,7 a	59,7	13,6 ab	20,8 ac	2,8 bf	51,4 ij	3,48 ab
Means	129,9	56,0	13,0	19,5	2,7	64,1	3,22
Minim.	103,3	52,5	12,1	17,9	1,6	48,9	2,46
Max.	160,7	59,7	14,2	21,8	3,9	82,0	3,50
LSD 5%	13,0	1,2	1,0	1,4	0,7	5,3	3,7
LSD 1%	17,3	1,6	1,4	2,7	1,0	7,0	5,0
C. V.	7,1	1,5	5,6	5,2	20,5	5,8	8,2

Note: Means with the same letter are not significantly different.

Table 3. Oil percentage, fatty acids composition and oleic index of hybrids tested.

Hybrid	Oil percentage	Oleic acid	Oleic index	Palmit. acid	Stearic acid	Linoleic acid
20202	37,68 eg	57,68 fj	21,73 fh	4,79	4,30	31,20
20302	39,75 bf	54,46 gj	21,65 fh	5,08	3,96	34,64
20303	40,43 ae	53,60 hj	21,67 fh	4,45	3,51	36,94
20402	38,70 cg	52,41 j	20,28 gh	5,21	3,75	37,07
20502	39,20 bf	58,52 fi	22,94 eh	5,45	4,62	28,74
ND 01	32,60 i	84,92 a	27,69 ad	3,53	4,10	5,14
20503	41,33 ac	58,96 fh	24,37 ef	5,01	4,20	29,06
20602	37,25 fg	58,53 fi	21,80 fh	5,43	4,44	29,10
20603	40,65 ad	60,85 ef	24,73 df	5,96	4,63	25,54
20703	41,63 ab	62,63 ef	26,07 be	5,85	4,36	24,63
HS 90	40,83 ad	53,02 ij	21,65 fh	5,80	3,95	34,51
30101	33,58 hi	59,55 fg	19,99 h	4,92	4,72	28,13
30102	34,38 hi	69,60 cd	23,93 ef	4,64	4,10	18,94
30203	41,83 ab	60,77 ef	25,42 ce	5,73	4,60	26,05
30402	35,93 gh	65,23 de	23,43 eg	6,23	4,96	20,15
Solead	35,95 gh	77,93 b	28,02 ac	3,73	5,39	10,29
30502	39,80 be	59,21 fh	23,57 ef	6,92	4,87	25,55
30503	43,21 a	71,08 c	30,71 a	5,05	4,50	17,83
30601	34,05 hi	58,73 fi	20,00 h	4,30	4,50	30,34
30602	38,15 dg	74,74 bc	28,52 ab	4,28	3,65	15,46
Means	38,34	62,62	23,91	5,12	4,35	25,46

Note: Means with the same letter are not significantly different.

particular susceptibility to high temperature during flowering time. This negative trait was present in all the hybrid with the (03) restorer line. On the other hand RHA 279 line (03) showed a good general combining ability as indicated in seed yield, early flowering time, seed weight and plant height performances of hybrids obtained from restorer line indicated above. These results are first information regarding combining ability and other features of a germoplasm collection available in Metaponto. In particular, the agronomical data suggest that it is possible to screen competitive hybrids in South Italy environmental conditions. At present, several backcross segregant populations are in screening to obtain interesting high oleic hybrids.

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REFERENCES

Benvenuti, A. and Vannozzi G.P., 1988. Obiettivi e risultati del miglioramento genetico del girasole. Atti colture oleaginose, Pisa.

Canvin, D.T., 1965. The effect of temperature on the oil content and fatty acid composition of the oils from several oil seed crops. Can. J. Bot. 43: 63-69.

Fernandez-Martinez, J., 1974. Variability in the fatty acid composition of the seed oil of *Helianthus* species. M.S. Thesis. University of California, Davis. 63 p.

Fernandez-Martinez, J. and Knowles, P.F., 1982. Maternal and embryo effects on the oleic and linoleic acid contents of sunflower oil. 241-243 In: Proc. 10th Int. Sunflower Conf., Surfers Paradise, Australia.

Fernandez-Martinez, J., Jimenez Ramirez, A., Dominguez Gimenez, J. and Alcantara, M., 1986. Influencia de la temperatura en el contenido de acido oleico y linoleico del aceite de tres genotipos de girasol. Grasas y Aceites, Vol.37, Fasc. 6, 326-331.

Fernandez-Martinez, J., Jimenez, A., Dominguez, J., Garcia, J.M., Garces, R. and Mancha, M., 1989. Genetic analysis of the high oleic acid content in cultivated sunflower. Euphitica, vol.41, n.1-2, 39-51.

Miller, J.F. and Zimmerman, D.C., 1983. Inheritance of high oleic fatty acid content in sunflower. In: Proc. Sunflower research workshop. Bismark, ND pp.10.

Miller, J.F., Zimmerman, D.C. and Vick, B.A., 1987. Genetic control of high oleic acid content in sunflower oil. Crop Science, vol.25, n.5, 923-926.

Soldatov, K.I., 1976. Chemical mutagenesis in sunflower breeding. Proc. 7th Int. Sunflower Conf., Krasnodar, URSS.

Urie, A.L., 1985. Inheritance of high oleic acid in sunflower. Crop Science 25, 986-989.

Vick, B. and Miller, J.F., 1984. Release of ND-01, a high oleic acid synthetic. In: Proc. Sunflower research workshop. Bismark, ND pp.8-9.

SELECCION PARA GIRASOL CON ALTO OLEICO EN LAS CONDICIONES AMBIENTALES DEL SUR DE ITALIA: EVALUACION EN CAMPO DE HIBRIDOS

RESUMEN

La selección de genotipos con alto nivel de ácido oleico (HOL) es un importante objetivo para mejoradores de girasol (Benvenuti y Vanozzi, 1988). El objetivo de este trabajo fue coleccionar genotipo de girasol adaptados al ambiente del Sur de Italia.

Los híbridos experimentales fueron obtenidos por test-cross durante un programa de retrocruzamiento con el propósito de seleccionar híbridos HOL en Metaponto. Setenta híbridos comparados con tres tartas fueron evaluados en un campo experimental para comportamiento agronómico y composición de ácidos grasos.

Los híbridos 30503 y 30603 mostraron un buen comportamiento en comparación con dos híbridos comerciales y una línea sintética comercial alto oleico. El híbrido 30503 mostró alto contenido de alto oleico y otras buenas características pero presentó alta esterilidad. El híbrido 30602 presentó contenido normal de aceite y caracteristicas agronómicas y alto contenido de ácido oleico. Selcción para el carácter alto oleico medante un esquema de retrocruzamiento se llevará a cabo. Diferentes líneas parentales HOL (cms HA y RHA) adaptadas a las condiciones ambientales del Sur de Italia serán obtenidas.

SELECTION POUR LES HAUTES TENEURS EN ACIDE OLEIQUE DANS LES CONDITIONS ENVIRONNEMENTALES DU SUD DE L'ITALIE: EVALUATION AU CHAMP D'HYBRIDES TEST CROSS

RÉSUMÉ

La sélection de génotypes à haute teneur en acide oléique (HOL) est un objectif important pour les sélectionneurs de tournesol (Benvenuti C., Vannozzi, 1988). Le but de ce travail est de sélectionner des génotypes de tournesol adaptés à l'environnement du Sud de l'Italie.

Au cours d'un programme de back crosses ayant pour objectif la sélection d'hybrides HOL à Metaponto, des hybrides expérimentaux ont été obtenus par test-cross. 17 hybrides ont été comparés avec 3 testeurs et évalués en champ expérimental à la fois pour les performances agronomiques et la composition en acides gras.

Les hybrides 30503 et 30602 ont montré des niveaux de performance intéressants par rapport à deux hybrides commerciaux et une variété synthétique commerciale à haute teneur en oléique. L'hybride 30503 présentait une teneur en acide oléique élevée ainsi que de bonnes performances, mais montrait une stérilité importante du capitule. L'hybride 30602 se caractérisait par une teneur en huile et des caractères agronomiques normaux et une teneur élevée des graines en acide oléique. La méthode du back-cross peut être applicable à la sélection des fortes teneurs en acide oléique. Différentes lignées parentales HOL (CMS, HA et RHA) adaptées aux conditions environnementales du Sud de l'Italie pourront être obtenues.