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CROP MANAGEMENT PRACTICES AND ENVIRONMENTAL EFFECTS ON HULLABILITY IN SUNFLOWER HYBRIDS

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SUMMARY

The objective of this investigation was to evaluate the effects of different crop management practices during three years of experimentation on sunflower cultivars characterised by different hull anatomy, in order to study the 'environment x genotype' interaction on hullability. The experiments were conducted from 1991 to 1993 at the Pisa University Experimental farm (latitude 43° and 41' North, longitude 10° and 23' East), adopting three different combinations of water level and nitrogen availability and three different cultivars, Oscar, Viki and Euroflor of *Helianthus annus* L. The cv. Euroflor, characterised by thin hulls and high achene oil content, showed an unusual, positive relationship between seed oil content and hullability, thus offering breeders the possibility of overcoming the barrier of simultaneously improving these two characteristics. However, at the same time, considerable attention must be given to the pedo-climatic environmental conditions. In fact, this cultivar significantly improved its hullability with crop management practices which favoured light water and nitrogen deficits during grain-filling period, while in contrast the other two earlier cultivars had better hullability characteristics with good water and nitrogen supplies.

Key words: Hullability, hull anatomy, pedo-climate condition, crop management practices, sunflower.

INTRODUCTION

As it is almost certain that the seed meal remaining after oil extraction from sunflower *Helianthus annuus* L. achenes will play an increasingly prominent role in animal feedstuffs, it is essential to improve its qualitative characteristics. In fact, the mean protein content of sunflower seed meal obtained from non-hulled seed is low, at about 30 to 33% (Denis et al., 1994), with a high fibre and low energy content which limits its use in the diets of non-ruminants (particularly,

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weaning pigs). In this type of animal, even moderate levels of sunflower seed meal reduces intake and digestive efficiency (Piva, 1992). Theoretically, with the modern sunflower genotypes, if part (60%) of the hull is removed by hulling before oil extraction, the protein content of the seed meal should increase to 40%, which appears to be a reasonable objective (Burghart, 1992). For these reasons, the hullability characteristic should be considered as the factor capable of making the greates contribution to an improvement in the qualitative-nutritional characteristics of sunflower meal. Previous studies have demonstrated that of the numerous factors involved in the expression of hullability, the genetic influence seems to be one of the most important, as confirmed by the high values of narrow heritability (up to 0.96) obtained in many studies (Denis, 1994 a; Baldini et al., 1994; Denis et al., 1994 b, Denis et al., 1994 c). This genetic influence is due to the hull anatomy of the achene, which varies with genotype, and is particularly dependent on the organisation of the alternation between two types of sclerenchymatic bulks of cells and their relative width, itself strongly related to the level of spliting of the sclerenchyma by the lines of non-lignified cells which seem to favour achene hulling (Beauguillame and Cadeac, 1992a). Many studies on the hull anatomy of a wide range of cultivated sunflower hybrids have shown that different achene pericarpic characteristics are related to hullability (Beauguillame and Cadeac, 1992b); in contrast, Denis et al., (1994), with experimental genetic material in different environments, found that the correlations between genotype differences in the pericarpic characteristics and hullability were too weak to be used alone in hullability breeding programmes, demonstrating a possible 'enotype x environment' interaction on the expression of hullability.

The main hurdle to improving hullability is its negative linkage with seed-oil content, which still represents the main sunflower product today (Baldini et al., 1994). In fact, to date, of the many genotypes analysed, including experimental and cultivated hybrids, inbred lines and cultivars, no genotype has demonstrated high hulability associated with high seed oil content, with the exception of isolated data still requiring confirmation (Denis, 1994a; Denis et al., 1994b). This suggests that genetic studies on seed characteristics are nor sufficient to give useful indications for improving hullability and seed oil content at the same time. In fact, it is necessary to consider the influence of the environment, i.e., both climatic conditions and crop management practices, on seed characteristics such as density and the degree of lignification of the sclerenchima cell layer which have considerable effects on hullability (Merrien et al., 1992; Beauguillame and Cadeac, 1992a; Denis, 1994). The present work aimed to evaluate the effect of different pedo-climatic conditions and crop management practices during three years of experimentation on three sunflower hybrids with different hull anatomy, in order to investigate the 'environment x genotype' interaction on hullability.

MATERIALS AND METHODS

The experiment was perfomed in 1991, 1992 and 1993 at the Pisa University Experimental Farm at S. Piero a Grado (altitude 2 m), 15 km from Pisa, Italy. This region has a Mediterranean climate with mild, rainy winters and hot, dry summers with high evaporation rates (Figures 1a-1c). Soil type at the site was a deep alluvial sandy-clay texture.

Three treatments were adopted for the experiment, involving different levels of water and nitrogen availability and in particular: E1N1, high water and nitrogen availability; E1N0, high water availability and a low level of nitrogen; E0N0, low water and nitrogen availability.

The high water availability treatment was assured by overhead sprinkler irrigation when the ETR values were equal to the ETM during the crop cycle of each year of experimentation, maintaining the available soil water approximately 80% above field capacity. Soil moisture content was monitored at sowing time, at flowering and at the end of the experiment by gravimetric analysis of the top 1.2 m of soil (at intervals of 0.30 m). The amount of irrigation was calculated on the basis of 120 cm (after flowering), assumed to equal the rooting depth of the sunflowers. The bulk density and water retention at a moisture potential of -20 KPa (field capacity) and -1500 KPa (plant wilting point) by a pressure plate of the soil were determined in the laboratory and averaged 27.3% and 11.5% by volume. Ground water levels during the study period were more than 2 m below the soil surface. The low water availability treatment was obtained by not irrigating. The total amount of water used was determined by the water balance method: water use = soil water at sowing time + rainfall + irrigation - soil water remaining at the end of the experiment.

The treatment with high nitrogen availability was obtained by the application at planting of 80 kg N/ha and later a further 120 kg N/ha, giving a total of 200 kg/ha, while nitrogen fertilizer (urea) was not applied in correspondence with the treatments with the low level of nitrogen. Each year, nitrogen soil tests were performed before sowing time.

Three commercial sunflower hybrids, Viki, Euroflor and Oscar were used, differing in their origin and most of their characteristics, mainly in terms of the anatomical characteristics of the transversal architecture of the hull of the achenes, which vary considerably between cultivars and play an important role in the mechanical resistance to the hulling process (Beauguillaume and Cadeac, 1992b; Denis et al., 1994b).

On 26 May 1991, 3 May 1992 and 26 April 1993, seeds were sown following a split-plot experimental design, with water and nitrogen levels as main treatments and genotypes as sub-treatments in 4 replicates. Each experimental unit consisted of four rows 7 m long at a spacing of 0.7 m. After emergence, seedlings were thinned to reach a final planting density of about 6 plants m^{-2}. In all plots,

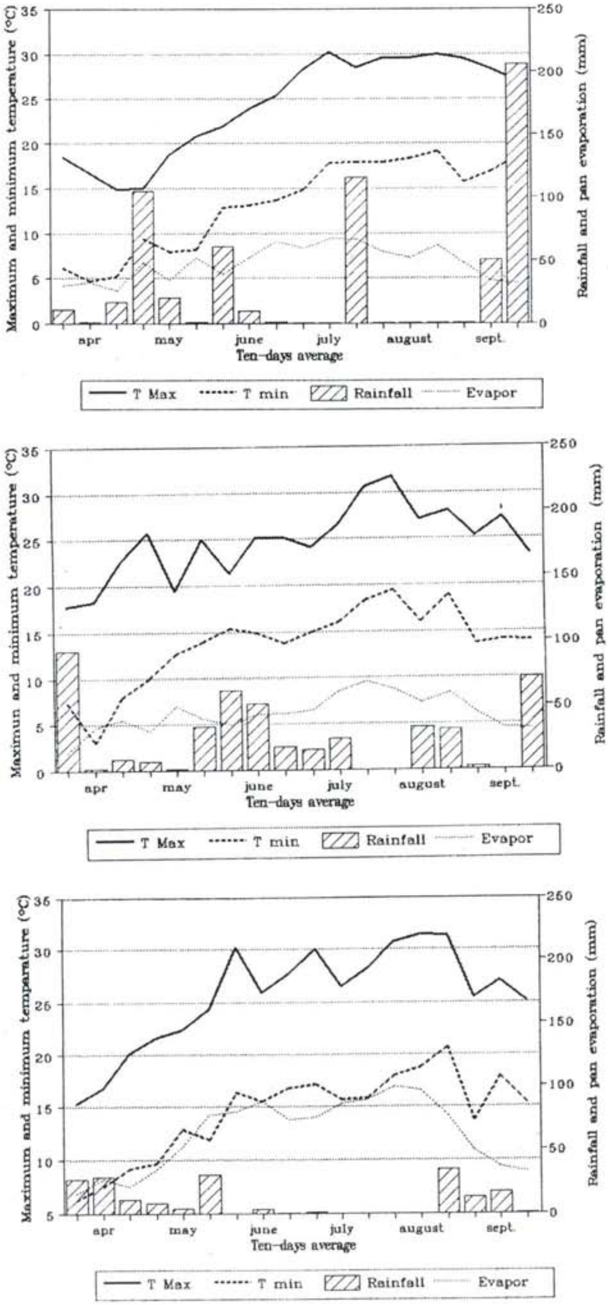

Figure 1. Maximum and minimum temperature, rainfall and evaporation at ten-day intervals during the experiments of 1991 (a), 1992 (b) and 1993 (c).

Table 1: Pedo-climatic conditions and amount of available water and nitrogen for plants during three years of experimentation.

	1991	1992	1993
ETE sunflower (mm)	550	496	701
Rainfall during crop cycle (mm)	238	285	89
Water available in the soil (mm)[a]	100	90	130
Irrigation (mm)	200	100	400
Total water available (mm):			
-E0 treatment (without irrigation)	348	375	219
-E1 treatment (with irrigation)	538	475	619
N fertilization (kg/ha)	180	180	180
N mineral in the soil (kg/ha)[a]: N0 treatment	62	60	68
N fertilization + N mineral soil: N1 treatment	242	240	248

[a] in the first 1 m of soil at deep sowing

at preplanting time 150 kg/ha P_2O_5 was applied, while K was not applied, because the level was adequate. The main pedo-climatic conditions and the level of the crop management practices adopted are reported in Table 1. The same land was used for each year of experimentation and the previous crop to the first trial was winter wheat. Weeds were controlled weekly by hand until full canopy cover was attained, after which minimal control was required. At harvest, ten plants were manually taken at random from the central two rows of each plot. Seed yield (Y) was estimated per hectare and the folowing measurements were performed on the seeds:

- seed moisture (SM) at physiological maturity of each plot;
- 1000 seed weight, (SW), estimated from the weight of 250 seeds per sample:
- seed density, (SD);
- hull content (HC), determined after manual hulling of 20 seeds per sample;

$$HC = \frac{\text{weight of hull}}{\text{weight of seed}} \times 100$$

- mechanical hull extraction (MH) was calculated by the use of a laboratory huller, composed of a disc spinning at 3800 rpm, with centrifugal force projecting the seed against the vertical valls of the huller. A laboratory separator divided the hulled products into three fractions: fines, comprising kernel fragments smaller than 2.5 mm; industrial kernels, a mixture of kernels and partially

Table 2: Analysis of variance for sunflower characters analyzed during 1991-1993 period.

Source	d.f.	EF	FM	SW	D	SM	OIL	P	Y	GDD	HC	MH	H
							Mean squares						
years	2	465.1**	114.2**	174.0**	9.0**	78.7**	25.4*	11.4**	1064.5**	28933.6**	0.37	99.8**	1414.5**
treatments	2	62.2**	98.5**	725.5**	17.1**	16.1**	55.4**	82.3**	1925.9**	4007.5**	14.6**	6.5*	233.2**
cultivars	2	480.5**	111.2**	575.6**	96.9**	124.0**	274.3**	5.7**	22.8*	69259.5**	277.2**	632.7**	4146.6**
tr x years	4	3.8**	1.8	240.2**	1.5	2.0	1.3	3.9**	36.1*	1642.8**	2.4**	2.1	20.6
cv x years	4	22.8**	9.8**	61.9**	2.0*	15.2**	1.0	0.7**	58.3**	12283.2**	2.0*	5.9**	179.3**
cv x tr	4	1.7*	0.2	37.2**	2.2*	2.2	2.2	1.1**	41.1**	1346.3**	2.2*	22.8**	448.2**
cv x tr x years	8	1.4*	0.6	11.4	1.2	0.6	3.0	0.5**	5.6	321.5	0.6	2.8	48.6**
error	54	0.6	0.4	7.1	0.7	1.2	1.7	0.1	6.8	185.1	0.7	1.0	15.1

*, ** Significant at $P \leq 0.05$ and $P \leq 0.01$ levels, respectively

EF=emergence-flowering period in days; FM=flowering-maturity period in days; SW=seed weight in g; SD=seed density in g/l; SM=seed moisture at harvest in %; OIL=seed oil content in %; P=seed protein content in %; Y= seed yield in q/ha; GDD=growing degree-days in °C; HC=seed hull content %; MH=hull extracted%; H=hullability %.

Table 3: Mean values for the sunflower characters analyzed during 1991-1993 period.

Source	EF	FM	SW	SD	SM	OIL	P	Y	GDD	HC	MH	H
years 1991	51.3b	45.1c	51.0b	36.7b	12.1c	46.6	20.7a	26.1b	937.0a	25.6	17.4a	67.5a
1992	57.9a	48.6a	53.2ab	37.7a	15.0a	46.3	20.7a	32.4a	816.4b	25.4	14.1c	55.0c
1993	57.2a	47.2b	55.3a	37.5a	13.7b	47.9	18.7b	34.9a	806.9c	25.6	16.0b	62.0b
treatments E1N1	56.2a	48.0a	56.1a	37.9a	14.1a	45.6c	23.6a	37.9a	873.1a	24.9c	15.7	62.9a
E1N0	56.2a	47.9a	55.4a	37.1b	13.9a	47.1b	20.8b	32.2b	872.3a	25.6b	16.3	63.0a
E0N0	53.9b	45.1b	48.0b	36.5c	12.9b	48.0a	15.8c	23.4c	814.9b	26.1a	15.5	58.5b
cultivars Viki	55.4b	47.4b	51.3b	38.3a	13.6b	49.1a	19.4b	30.4	825.9c	23.9b	11.8c	49.7c
Euroflor	59.1a	48.4a	50.5b	37.9a	15.5a	47.8b	19.6b	32.0	882.2a	24.0b	15.4b	64.2b
Oscar	51.8c	45.0c	57.8a	35.3b	11.8c	43.8c	21.2a	31.1	852.1b	28.7a	20.2a	76.a

Mean values in column followed by different letters differ significantly for $P \leq 0.01$.

EF=emergence-flowering period in days; FM=flowering-maturity period in days; SW=seed weight in g; SD=seed density in g/l; SM=seed moisture at harvest in %; OIL=seed oil content in %; P=seed protein content in %; Y= seed yield in q/ha; GDD=growing degree-days in °C; HC=seed hull content %; MH=hull extracted by a mecnanical huller in %; H=hullability %.

hulled achenes; free hulls, containing only hulls. This variable was analysed and calculated from:

$$MH = \frac{\text{weight of free hulls}}{\text{weight of sample before hulling}} \times 100$$

- hullability (H), defined as the portion of hull removed mechanichally, compared with total sample hull content as previously described by Baldini et al., (1994):

$$H = \frac{MH}{HC} \times 100$$

- oil (OIL) seed content, measured by nuclear magnetic resonance (N. M. R.);
- nitrogen (NT) seed content, measured with the Kjeldahl method.

Flowering (DAE) and physiological maturity (DAF) for each plot were recorded and growing degree-days (GDD) were calculated by the following equation:

$$GDD = \frac{(T_{max} + T_{min})}{2} - T_{base}$$

where T max and T min are the daily maximum and minimum air temperature in Celsius immediately above the canopy and T base (6°C from Merrien et al., 1986) is the temperature below which no thermal time is accumulated.

All the data acquired were submitted to an analysis of variance which tested the effects of year, treatment, genotype and their interactions. Simple correlations (and regression in some cases) were calculated for some variable means.

RESULTS AND DISCUSSION

The statistical analysis of the treatments and the interactions during three years of experimentation on sunflower characteristics is reported in Table 2. All characteristics were significanlty infulenced by the treatments adopted and particularly the 'cultivar x year' and 'cultivar x treatment' interactions appearal to criticaly influence hullability, confirming the importance of the 'genotype x environmental conditions' interaction on the expression of the above characteristics (Beaguillaume and Cadeac, 1992b; Denis et al., 1994; Baldini et al., 1994).

The mean values reported in Table 3 demonstrate a strong difference in hullability between the genotypes. Of these, cv Oscar with 70.6% hullability (mean over years and treatments) definitely had achenes with intrinsic characteristics better suited for mechanical dehulling (Beguillaume and Cadeac, 1992b) than Euroflor and Viki (64.2 and 49.7%, respectively). In fact, this cv had the best % of hull in the achene (Table 3). This characteristic favours its hullability (Merrien et al., 1992; Baldini et al., 1994; Denis et al., 1994), but at the same time it produces a decrease in the achene oil content, actually to a value lower than the other two genotypes (Table 3). Significant differences in hullability were also observed in the treatments adopted (over years and genotypes). That one did not provide any productive factor use (E0N0) causes, in terms of the general mean, a moderate, but statistically significant, decrease of hullability. At first sight, these results could appear to be in contrast to those reported by Merrien et al., (1992) and Laprince-Bernard (1990), but it is necessary to consider that the above results relate to the genotypes examined and the particular environment of each trial, as reported by Denis et al., (1994). Significant differences in hullability were observed between the three years of trial (as a mean value over treatments and genotypes) with hullability in the first year (67.5%) significantly higher than the other two years (62 and 55% in 1993 and 1992, respectively). Figure 2 reports the 'cv x treatment' interaction, with Oscar always having higher hullability than cv Viki in each treatment and both xv decreased their hullability with treatments E1N1 and E0N0.

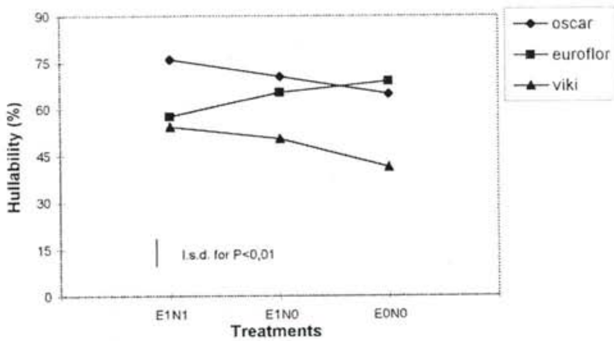

Figure 2. Effects of "treatment x cultivar" interaction on hullability character (over years). E1N1 = High water and nitrogen availability; E1N0 = High water and low level of nitrogen; E0N0 = Low water and nitrogen availability.

The cv Euroflor clearly reacted to different crop managemenet practices; in fact, while with treatment E1N1 its hullability values were the same as cv Viki, in treatment E1N0 and particulary E0N0, its values were the same as cv Oscar. In Figure 3, where the 'cv x year' interaction is reported, it could be argued that the three cultivars always had their hullability differences in the first two years of trials; cv Oscar showed significantly higher values than Viki and Euroflor and this latter cv had intermediate values. In 1993, cv Euroflor had a significant increase in its hullability, reaching the same values as cv Oscar.

The correlation between achene oil content and hullability was negative for the pooled data (Table 4), in agreement with results from many other studies (Roath et al., 1987; Dedio, 1989; Baldini et al., 1994; Denis et al., 1994a; Denis et al., 1994b).

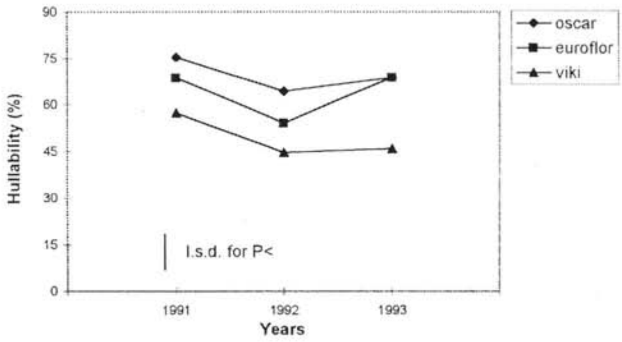

Figure 3. Effect of "year x cultivar" interaction on hullability character (over treatments).

Even if the data are considered for each of the 3 years of trials, the correlation between these two characteristics was always highly significant and negative (data not shown), underlining the fact that different climatic conditions are not sufficient to invert such a trend. However, when the same data were evaluated for each of the three cultivars (Figure 4), while the relationship remained almost unvaried for cv Oscar and Viki, for cv Euroflor the achene oil content and hullability significantly and positively co-varied, confirming that the negative correlation between oil content and hullability, although present in sunflower, is not absolute, as previously reported by Denis et al., (1994a) and Baldini et al., (1994). In addition, of the seed characteristics analysed, seed density also affected hullability, with a negative relationship in this environment (Table 4) as reported by Dedio and Dorrell (1989) in other studies.

Of the environmental parameters considered, thermal time, expressed as growing degree-days (GDD), required to complete the seed maturity phase, negatively influenced hullability (Table 4), appeared to be negatively correlated with the achenes' hull content (Figure 5), and was positiviely correlated with the achenes specific weight (Figure 6). All this confirms that the environment and the crop management practices, during the grain filling period and maturation when the lignification of the ovary wall occurs, strongly influence hullability (Denis et al., 1994b).

The negative correlation between hullability and achene moisture at harvest (Table 4) could have been caused by the particular environmental conditions during the seed filling up to maturity found in cv Euroflor. In fact, treatments E1N1 and E1N0, with optimal water and nitrogen supply, contribute to the determination of an excessive prolongation of the final period of the cycle for cv Euroflor, already considered late in our environment (Table 3). This fact probably led to the achene maturity period progressing under non-optimal conditions of temperature, which, linked to excessive soil water and nitrogen availability,

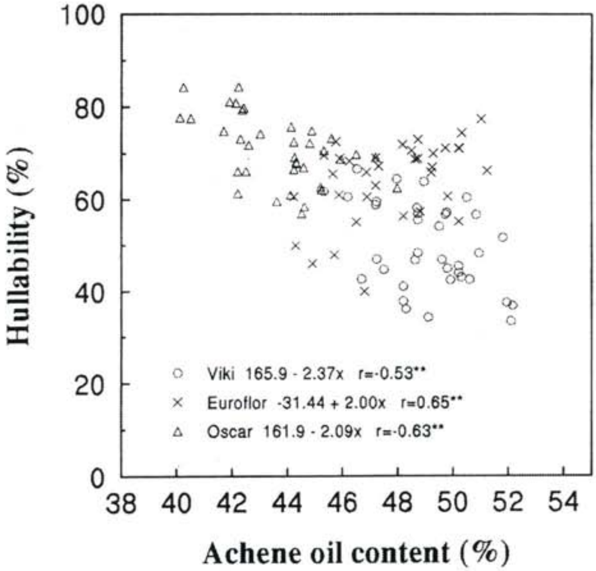

Figure 4. Relationship between hullability and achene oil content in each cultivar. Values are means across years and treatments.

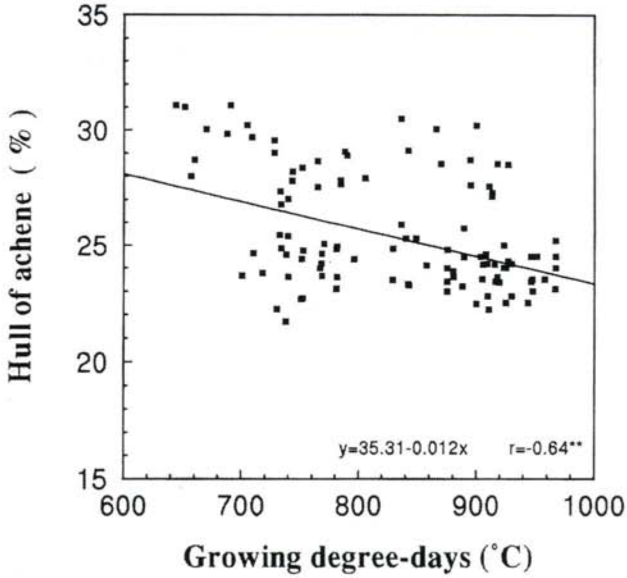

Figure 5. Relationship between growing degree-days during the grain-filling period and hull of achene. Values are means across treatments, years and cultivars.

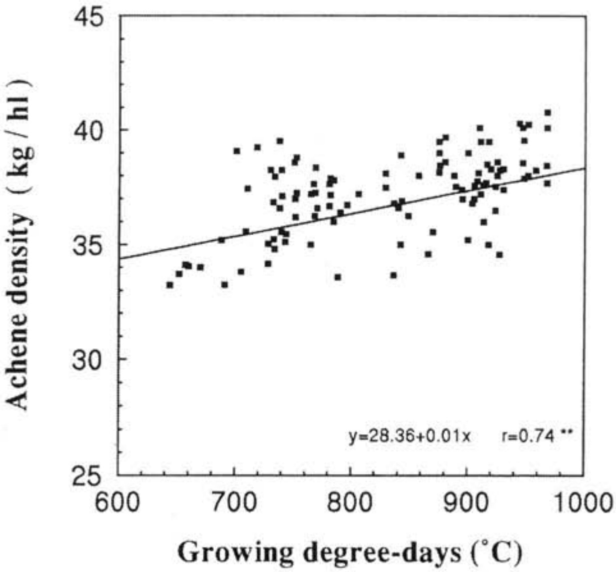

Figure 6. Relationship between growing degree-days during the grain-filling period and achene density. Values are means across treatments, years and cultivars.

caused not only high seed humidity but also low lignification of the sclerenchima cells and a reduction of hull content, with an increase in specific weight and a better filling up of empty spaces between almond layer and pericarp, which negatively influenced hullability (Laprince et al., 1988; Dedio and Dorrel, 1989; Beauguillaume and Cadeac, 1992).

Table 4: Correlation coefficients of hullability and other yield characters and components across hybrids and years of the experimentation.

Characteristic	Correlation
Emergence-flowering period (EF)	-0.33**
Flowering-maturity period (FM)	-0.36**
Seed weight (SW)	0.27**
Seed density (SD)	-0.49**
Hull content (HC)	0.43**
Seed yield (Y)	0.07 n.s.
Oil seed content (OIL)	-0.56**
Seed protein content (P)	0.24*
Seed moisture at harvest (SM)	-0.43**
Flowering-maturity - Growing Degree Days (GDD)	-0.44**
Nitrogen availability (N)	0.07 n.s.
Water availability (W)	0.05 n.s.
Mechanical hull extraction (MH)	0.93**

*, ** significant for P≤ 0.05 and P≤0.01 respectively (n=106), n.s., not significative.

In fact, from Table 5 it is evident that in Euroflor the values between hullability and nitrogen availability and water use during the flowering-maturity period were negative, above all in water use, while for Oscar and Viki, genotypes with a middle cycle and earlier than Euroflor in our environment (Table 3), the correlation was not significant or quite positive, confirming the hypothesis of Merrien et al., (1992) and Denis et al., (1994a).

Some authors (Baldini et al., 1994; Denis et al., 1994b), when discussing the very strong and close positive correlation between hullability and mechanically extractable hulls (Table 4), suggested that it would be possible to eliminate measurements of total hull content, thus avoiding manual hulling, which requires much time, especially when large number of samples have to be measured such as during a breeding programme, and hullability could be estimated directly from the quantities of hulls extracted mechanically. However this method would have the disadvantage of not retaining rare genotypes with low hull and consequently small amounts of mechanical hull removed, but with good hullability due to favourable anatomical characteristics of the pericarp. These genotypes have been found probably because of their good oil content associated with good hullaiblity.

Table 5: Correlation of hullability (over treatments and years) and water use and soil N availability during the flowering - maturity period in each of the three cultivars.

Cultivar	Water use	Soil N availability
Viki	0.39*	0.32 n.s.
Euroflor	-0.53**	-0.45**
Oscar	0.34*	0.46**

*, ** significant for $P \leq 0.05$ and $P \leq 0.01$ respectively (n=34).

CONCLUSIONS

In this experiment, the results obtained with the hybrid Euroflor (Figure 4) allow, for the first time, the description of hullability as a character not exclusively linked to low achene oil content or high hull content of the achene, thus allowing breeders to overcome the barrier of simultaneously improving seed oil content and hullability.

This result was derived from the fact that hull anatomical characteristics, with pericarp sclerenchima extremely split by many parenchyma rays, favouring hullability (Beauguillaume and Cadeac, 1992b) and linked to moderate hull content, were influencal significantly by particular environmental conditions and cultural practices.

Thus, the strategy for improving this characteristic could be, on the one hand, to try to introduce by an adequate breeding programme, the same or better anatomical characteristics than Euroflor in a hypothetical new genotype, but on the other hand specify the pedo-climatic and cultural practice conditions for the selected genotype and environment in order to favour hullability.

In fact, it is necessary to consider that the environment influences both cell sclerenchimatic lignification, a process generally completed abour 30 days after the end of flowering (Perestova, 1976) and the hull thickness. Both characterisics affect hullability (Laprince et al., 1988) and at the same time show a lack of relationship with the hull content (Denis et al., 1994a; Laprince-Bernard, 1990), because the increase of the latter would favour hullability, but would result in a decrease of achene oil content (Denis et al., 1994a, Laprince-Bernard, 1990; Dedio, 1982).

Thus, when such anatomical characteristics of the hull are improved or incorporated *ex novo* in a genotype, the crop management practices will favour a small water and nitrogen deficit, especially during the grain-filling period, if its crop cycle is late for the environment of cultivation, otherwise this fact could produce a lignification defect of the pericarpic cells, too high a humidity content at physiological maturity and a decrease of oil content in the achene in favour of a larger protein accumulation. In contrast, with early or middle-early genotypes having different anatomical characteristics of the hull, it seems that hullability is favoured by good water and nitrogen supply during the second phase of the crop cycle.

This suggests that breeders must aim to produce cultivars adapted to specific regions and the level of hullability will depend on the 'genotype x crop management practice' interaction and considerable attention must be given to the stability of the characteristics observed.

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EFECTO DE LAS PRÁCTICAS DE CULTIVO Y AMBIENTALES SOBRE APTITUD AL DESCASCARILLADO DE HIBRIDOS DE GIRASOL

RESUMEN

El objetivo de este trabajo fue la evaluación de los efectos de diferentes prácticas de manejo de los cultivos durante tres años de experimentación de cultivares de girasol carcterizados por diferente anatomia de la cáscara, a fin de investigar la interacción genotipo x ambiente en el descascarillado. Los experimentos fueron conducidos de 1991 a 1993 en la finca Experimental de la Universidad de Pisa (latitud 43° y 41' Norte y longitud 10° y 23' Este) adoptándose tres diferentes combinaciones de niveles de suministro de agua y nitrógeno y tres cultivares diferentes de girasol, *Helianthus annuus* L., Oscar, Viki y Euroflor. El cultivar Euroflor caracterizado por aquenios delgados y con alto contenido en aceite, mostraron una relación positiva entre contenido de aceite y apitud al descascarillado, hasta ahora inusual en girasol, ofreciendo por tanto a los mejoradores la posibilidad de sobrepasar la barrera de mejorar simultáneamente estos dos caracteres. Sin embargo, al mismo tiempo, debe ser dada una atención considerable a las condiciones pedoclimáticas. De hecho este cultivar mejoró pequeñas deficiencias de agua y nitrógeno durante el periodo de llenado, mientras que en contraste los otros dos cultivares más tempranos tuvieron mejores caracteristicas de descascarillado con buenos suministros de agua y nitrógeno.

CONDUITES CULTURALES ET EFFETS ENVIRONNEMENTAUX SUR L'APTITUDE AU DÉCORTICAGE D'HYBRIDES DE TOURNESOL

RÉSUMÉ

L'objet de ce travail est d'évaluer l'incidence de différentes conduites culturales durant trois années d'expérimentation sur des cultivars de tournesol caractérisés par différentes structures de coque, pour analyser les interaction "environnement x génotype" sur l'aptitude au décorticage. Les essais ont été conduits de 1991 à 1993 à la ferme expérimentale de l'Université de Pise (latitude 43° et 41' Nord, longitude 10° et 23' Est), avec trois différentes combinaisons d'alimentation hydrique et de fertilisation azotée et trois différents cultivars *d'Helianthus annuus* L: Oscar, Viki et Euroflor. Le cv Euroflor caractérisé par des akènes minces et une teneur en huile élevée, a montré une relation positive inhabituelle jusqu'à présent chez le tournesol entre la teneur en huile de la graine et l'aptitude au décorticage, donnant ainsi au sélectionneur la possibilité de contourner l'amélioration conjointe de ces deux caractéristiques. Pourtant, en parallèle, une attention particulière doit être accordée aux conditions environnementales pedo-climatiques. En fait, ce cultivar a vu augmenter significativement son aptitude au décorticage avec les conduites culturales qui favorisent de légers déficits hydriques et de fertilisation azotée durant la phase de remplissage du grain, tandis qu'à l'opposé les deux autres cultivars plus précoces présentaient une meilleure aptitude au décorticage en conditions de bonne alimentation hydrique et azotée.