T1992BRE09

ELEMENTS OF EXPLICATION OF THE VARIABILITY OF THE HULLING ABILITY IN SUNFLOWER

A. BEAUGUILLAUME* and F. CADEAC
Laboratoire botanique et forestier de l'université PAUL SABATIER
39, allées Jules Guesdes. 31062 TOULOUSE.
* C.E.T.I.O.M.
147, av. Victor Hugo. 75116 PARIS.

SUMMARY.
Complex relationships link hulling ability of sunflower achenes to genetical and pedoclimatic factors which control the plant growth.
Our purpose, among a wider aim, is to enlight the nature and the direction of these relationships by two ways of investigations : morphology and anatomy.
We have in view to establish the hierarchy of the factors considered according to their influence.

INTRODUCTION.

The hulling of the usks of sunflower achenes in oil-works has become an indespensable stage for the valorization of the oil-cake. It is an economic stake which is important for both France and the E.E.C.. But the grinders are faced with the problem of the variability of the hulling ability of batches of achenes that they receive.
It is two years since the C.E.T.I.O.M. has started some experimentations in order to supress the variability of the sunflower production and this within the European framework "ECLAIR" .
Before having the possibility to create a vegetable material fit for industrial hulling, is necessary to study thoroughly the sources of variations of hulling ability of the present production.
In a communication that is to be presented in this same conference we notice the existence of two types of sclerenchimatic bulks in the pericarp of sunflower achenes. We also notice the extent of the observable variability within the transversal architecture of the husks. This variability which derive from the existence of two bulks expresses itself according to the cultivar. Finally, we emphasize the very importance of the transversal architecture of the husks in the resistance to the distortion and to the break.
We offer to study various origins of fruits whose hulling ability is known. The study is based upon two main lines investigation : a macroscopic and microscopic one. Then we will determine the share that genetic and pedoclimatic influences have in the expression of the features of the achene.

MATERIAL AND METHODS

You will find in picture 1, the main characteristic of the origins studied.
For each origin we have studied 4 capitules.
The availability of the material under the aspect of capitules has always enabled us to study achenes of compable position on the capitule.

We have studied some of the macroscopic characteristics of the achenes :
-the average density measured in water thanks to 20 or 30 achenes by each plant.
-the length, the width and the thickness measured by means of a calliper rule thanks to 12 achenes by each plant.

The microscopic characteristics are studied on 3 achenes by plant on the basis of pieces of half-husks taken at half the height of the achenes.
These pieces are mass coloured with "Carmin aluné vert d'iode" and observed through a binocular lense.

One the one hand we measure variables of the "radial structure" of the husks (ref. picture 2 = abbreviations employed) :
- -thickness
- -total number of the cells layer of the sclerenchyma
- -number of the lignified cells layer of the sclerenchyma

One the other hand, we measure variables of "transversal architecture" of the husks :
- -frequency of the observable line of unlignified cells for each semi-husks studied
- -relative dimension of the bulks of "type 2"

RESULTS

I. study of the correlations.

In this study, plus the measured variables we have included :

- -the percentage of oil (G).
- -the 1000 seeds weight (P).
- -the percentage of fines (I).
- *-the percentage of mechanical hulling (C)*

(C.E.T.I.O.M.'s datas)

(ref. picture 3)

We notice that within the limits of this study, the feature best correlated to the hulling ability is the percentage of oil. But this feature nearly followed by the variables of transversal architecture of the husks. Then come 2 macroscopic characteristics of the achenes, the density and the length . On the contrary, the thickness of the husks appears to be a bad criterion of discrimination of the batches of achenes in relation to the hulling ability considering its small level of correlation with C.

II. Analysis of variances.

Ref. picture 4.

*The length of the achenes, is a feature which seems essentially genetically fixed : Albena presents the longest achenes and Euroflor the shortest ones.

*The density of achenes (ref. Graphic 1), is a feature which expresses both under the genetic and pedoclimatic influence. Genetic, because Frankasol characterizes itself by the small density of its achenes. Pedoclimatic, in the extent that, when the conditions of cultivation are bad in the Charentes, we can notice the apparition of small density. Here, as far as the cultivars Albena and Frankasol are concerned, the small density is associated with record rate of hulling.

But, we must also notice that in Agen, with an important hydric deficit but accompanied with an irrigation we obtain densities which are not significatively different from those observed in Indre. For the cultivar Euroflor and Viki, it is in Agen that we have observed the best rate of hulling. Here, the good hulling ability cannot then be explained by the small density.

This has led us to think that the density (and through it the notion of filling of the achenes, or the presence of a space between the husk and the ovule) can only be explanatory elements of the hulling ability when the conditions are very bad.

*The variables of "transversal structure" of the husks (only represented by F),(ref. graphic 2), is a feature which expresses both under the genetic and pedoclimatic influence. However we can assert that the variables mainly expresses themselves under genetic influence. Thus, we always tell cultivars with pericarpic sclerenchyma which are very much splitted up from those cultivar which are little splitted (ref. the other article presented during the same congress). It is only secondarily that these variables express themselves under the pedoclimatic influence. Here, in a general way it is the bad conditions which by splitted up the pericarpic sclerenchymas. Thus it is in Agen that the most splitted sclerenchymas can be observed. This splitting is accompanied with interesting rate of hulling above all as far as Euroflor and Viki are concerned. On the contrary in the Indre, on the level of the splitting up of the sclerenchymas, we cannot observe a significant difference between the 2 situations. Thus, the improvement of the hulling of the second situation thus cannot be explained by a more important hulling of the husks.

*The variables of the radial structures of the husks (only represented by T and L), (ref. picture 3 and 4),these variables also express themselves both under genetic and pedoclimatic influence. Genetic, because we tell the cultivars having thick and strongly lignified husks (Frankasol and Albena) from those having thin and little lignified husks (Viki and above all Euroflor). But the expression of these variables is much more sensitive to the environmental influence than the expression of variables of tranversal architecture is. Thus, when we move, in Indre, from the first to the second situation, by improving the hydric and nitrogenous feeding, we can observe an improvement of the componants of the radial structure of the husks (husks thicker and better lignified) for all the cultivars. Within the limits of our study it seems to be the only element which accounts for the improvement of the hulling observed for the second situation in the Indre.

DISCUSSION

Our results about the influence of the thickness of the husks as regards the hulling ability, are in contradiction with MORISSON and al. (1981) in LEPRINCE (1987): it is difficult to hull cultivars having thin husks. This may be due to the presence in our study of achenes of the Euroflor cultivar which can offer a good hulling ability despite the fact that they have a very thin husk and an elevated density.

Our results, about the important influence of the radial architecture component of husks and the reduced influence of achene density in hulling ability, add themselves to LEPRINCE's results (1990), according to which :

- the hulling ability depends on the two things : the orientated structure of pericarp in the same direction as the great axis of the achenes and the presence of an internal parenchyma without which there wouldn't have any interstitiel space between husk and ovule.
- when breaking the husk this latter is fractured at the level of the non lignified cells which separate the sclerenchimatic bulks.

For the study of variables of tranversal architecture we must notice the particular behairour of the Euroflor cultivar. Actually, as we have noticed it in an another article presented in this same congress, this cultivar has a lack of differenciation of the pericarpic sclerenchymas which feeds the observer to under rate the splitting level of the husks. This is what happened here to the achenes coming from the Charentes.

In order to situate Euroflor from the point of view of all the variables studied by suppressing the influence of the lack of differenciation, we have made a study limited to the achenes coming from the second situation in the Indre. (ref. graphics 5 to 9).

This study makes appear that in optimum conditions of cultivation, the Euroflor cultivar characterizes itself by :

- small achenes (the shortest achenes among the 4 cultivars studied).
- characteristics which are quite similar to Viki as far as the components of the radial structure of the husks are concerned (thin husks and little lignified).
- characteristics which are quite similar to Frankasol or Albena as far as the variables of the transversal architecture of the husks are concerned.

In this situation, Euroflor which turns out to be a cultivar containing much oil, presents a hulling ability far better than that of Viki. These results shed a new light on results, asserting that the varieties having much oil are not easy to hull because the thin husks are more plastics than thick husks.

Our results, about the variables of the radial structure of the husks, complement the results of PERCIE and DURRIEU (1988), who have demonstrated that the lignification process of the fruit walls (and thus a part of the variability of the thickness of the husks) depends upon the climatic conditions of the end of the cultivation cycle; and also complete those of LEPRINCE, who has demonstrated that the husks are so much thick since the time of maturation of the achenes is short.

CONCLUSION

Finally it seems that the splitting up of the pericarpic sclerenchyma favors achene hulling.

Quite often, pericarpic sclerenchyma of this type may be encountered for cultivars which are not champions for oil production. But for the selectors, it would be interesting to dissociate "oil richsness for ovules" and "favoring husks architecture"

We think that it is possible, a proof being given by the Euroflor cultivar. In fact, this cultivar shows a favoring "tranversal architecture of husks" (Albena or Frankasol type). In spite of its oil richesness, of the smallness and the small thickness of the husks, their weak lignification and the differenciation defect, one can observe a better hulling for this cultivar than for Viki or Mirasol.

The selectors should also take in account the achene lengthening, radial husks development and husks lignification, which are also factors that favor hulling.

PICTURE 1 : Characteristics of the origins of the achenes.

ARIEA	AGEN		CHARENTES		INDRE			
H.D. T.N.	-425 279		-580 78		-115 DRYLAND 126		-20 IRIGAGATION 208	
ALB.	45	36, 5	33	33, 8	54, 3	40, 8	50, 3	57, 4
	23, 2	8, 9	27, 6	21, 4	11, 1	9, 8	21, 7	13
EUR.	45, 3	37	46, 3	38, 2	56, 4	37, 4	55	39, 9
	14, 1	9, 9	11, 4	9, 1	8, 6	3, 1	10, 4	12, 7
FKS.	51, 2	41	26	32, 7	46, 2	39, 9	46, 5	43, 9
	23, 3	3, 3	26, 8	22	14, 1	11, 7	19, 3	24, 3
VIK.	46, 8	41, 1	50, 3	31, 8	55, 8	28, 2	54, 2	43, 4
	13, 6	17, 2	8, 2	6, 5	4, 3	5	5, 8	3, 2

OIL		1000 SEEDS WEIGHT
	HARVEST MOISTURE	
MECANICAL HULL %		MECANICAL FINES %

H.D. = HYDRIC DEFICIT
T.N. = TOTAL NITROGEN

PICTURE 2 : Abbreviations employed.

MACROSCOPIC CHARACTERISTICS OF THE ACHENES	DENSITY	D
	LENGTH	L1
	WIDTH	M
	THICKNESS	L3
VARIABLES OF THE RADIAL STRUCTURE OF THE HUSKS	THICKNESS	E
	TOTAL NUMBER OF THE CELLS LAYER OF THE SCLERENCHYMA	T
	NUMBER OF THE LIGNIFIED CELLS LAYER OF THE SCLERENCHYMA	L
VARIABLES OF TRANSVERSAL ARCHITECTURE OF THE HUSKS	FREQUENCY OF THE OBSERVABL LINES OF UNLIGNIFIED CELLS FOR EACH SEMI-HUSK	F
	RELATIVE DIMENSION OF THE BULKS OF TYPE 2	R

PICTURE 3 : Matrix of the total correlations.

	D	M	L1	L3	E	T	L	F	R	G	P	I	C
D	1												
M	-0.022	1											
L1	-0.232	0.647	1										
L3	-0.051	0.572	0.323	1									
E	0.134	0.805	0.471	0.475	1								
T	-0.018	0.669	0.661	0.345	0.675	1							
L	-0.017	0.533	0.577	0.27	0.564	0.809	1						
F	-0.39	-0.36	0.183	-0.158	-0.172	0.152	0.162	1					
R	0.347	-0.171	-0.392	0.003	-0.055	-0.38	-0.306	-0.848	1				
G	0.586	0.139	-0.258	0.231	0.215	-0.005	-0.03	-0.506	0.477	1			
P	0.344	0.4	0.204	0.297	0.412	0.467	0.349	-0.157	-0.04	0.246	1		
I	-0.301	0.16	0.28	-0.049	0.152	0.294	0.232	0.33	-0.445	-0.713	0.091	1	
C	-0.429	0.242	0.61	-0.014	0.124	0.415	0.323	0.629	-0.738	-0.751	0.17	0.604	1

PICTURE 4 : Variances analysis.

VARIABLES	FACTEURS	TEST F	PROBA
D	F1	17.62	0
	F2	11.96	0
	F3	3.86	0.02
	INTER F1 F2	6.96	0
	INTER F1 F3	0.9	0.54
	INTER F2 F3	1.77	0.12
L1	F1	0.75	0.53
	F2	91.85	0
	F3	1.08	0.38
	INTER F1 F2	6.25	0
	INTER F1 F3	1.27	0.3
	INTER F2 F3	1.73	0.13
M	F1	31.88	0
	F2	40.99	0
	F3	1.4	0.26
	INTER F1 F2	7.26	0
	INTER F1 F3	1.79	0.11
	INTER F2 F3	1.41	0.23
E	F1	21.04	0
	F2	13.24	0
	F3	0.61	0.62
	INTER F1 F2	4.21	0.002
	INTER F1 F3	1	0.46
	INTER F2 F3	1.28	0.29
T	F1	19.86	0
	F2	63.28	0
	F3	0.86	0.48
	INTER F1 F2	3.68	0.004
	INTER F1 F3	2.14	0.06
	INTER F2 F3	0.86	0.57
L	F1	14.55	0
	F2	37.93	0
	F3	3.45	0.03
	INTER F1 F2	4.46	0.001
	INTER F1 F3	0.48	0.88
	INTER F2 F3	1.43	0.22
F	F1	43.15	0
	F2	53.57	0
	F3	0.3	0.83
	INTER F1 F2	20.76	0
	INTER F1 F3	0.63	0.7652
	INTER F2 F3	3.13	0.0104
R	F1	23.87	0
	F2	65.84	0
	F3	0.58	0.64
	INTER F1 F2	15.15	0
	INTER F1 F3	0.34	0.95
	INTER F2 F3	1.66	0.15

F1 = ARIEA.

F2 = CULTIVAR.

F3 = PLANT.

PICTURE 5 : Variances analysis.

VARIABLES	FACTEURS	TEST F	PROBA
D	F1	3.25	0.07
	F2	0.14	0.71
	F3	2.79	0.1
	INTER F1 F2	1.24	0.35
	INTER F1 F3	3.01	0.06
	INTER F2 F3	1.41	0.3
M	F1	524.8	0
	F2	48.71	0
	F3	19.95	0
	INTER F1 F2	3.88	0.05
	INTER F1 F3	21.02	0
	INTER F2 F3	3.31	0.07
L1	F1	150	0
	F2	15.8	0
	F3	3.2	0.08
	INTER F1 F2	0.42	0.75
	INTER F1 F3	1.9	0.18
	INTER F2 F3	0.2	0.89
E	F1	54.9	0
	F2	28.8	0
	F3	3.3	0.07
	INTER F1 F2	0	0.48
	INTER F1 F3	3.6	0.03
	INTER F2 F3	0.9	0.48
T	F1	49.7	0
	F2	0.38	0.57
	F3	2.64	0.11
	INTER F1 F2	1.08	0.41
	INTER F1 F3	0.64	0.74
	INTER F2 F3	0.6	0.63
L	F1	50.1	0
	F2	1.1	0.3
	F3	0.4	0.7
	INTER F1 F2	1.4	0.3
	INTER F1 F3	0.3	0.9
	INTER F2 F3	1.1	0.4
F	F1	8.64	0
	F2	0.8	0.4
	F3	0.4	0.78
	INTER F1 F2	0.6	0.64
	INTER F1 F3	1.17	0.41
	INTER F2 F3	1.28	0.34
R	F1	104.8	0
	F2	1.64	0.23
	F3	1.22	0.36
	INTER F1 F2	8.47	0.008
	INTER F1 F3	0.37	0.92
	INTER F2 F3	0.25	0.88

F1 = CULTIVAR.

F3 = PLANT.

PICTURE 6 at 9 : Results of NEWMAN-KEULS tests.

PICTURE 6, accoding to L1.

CULTIVAR	MOYENNES	GROUPES HOMOGENES
FKS	10.76	A
ALB	10.42	B
VIK	9.33	C
EUR	9.1	D

PICTURE 7, according to F.

CULTIVAR	MOYENNES	GROUPES HOMOGENES
EUR	0.2	A
FKS	0.19	A
ALB	0.17	A
VIK	0.14	B

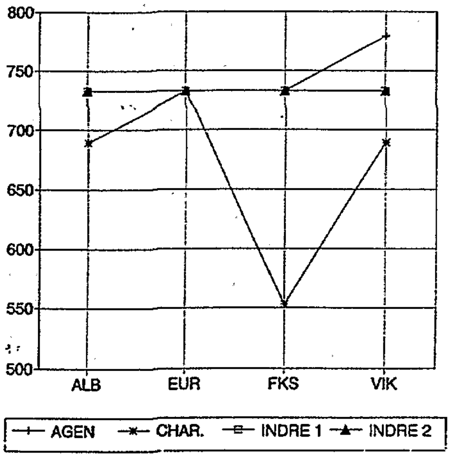
PICTURE 8, according to T.

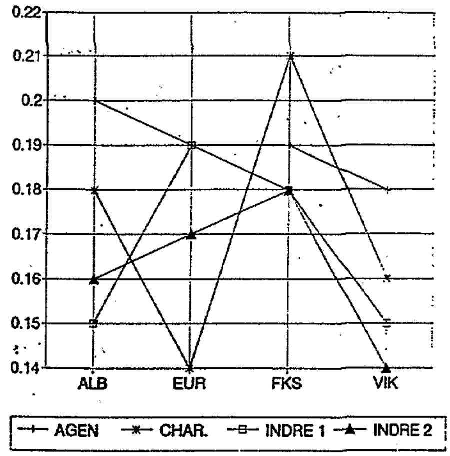
CULTIVAR	MOYENNES	GROUPES HOMOGENES
FKS	9.6	A
ALB	8.5	B
EUR	7	C
VIK	6.4	C

PICTURE 9, according to L.

CULTIVAR	MOYENNES	GROUPES HOMOGENES
FKS	5.1	A
ALB	4.1	B
VIK	2.6	C
EUR	2.5	C

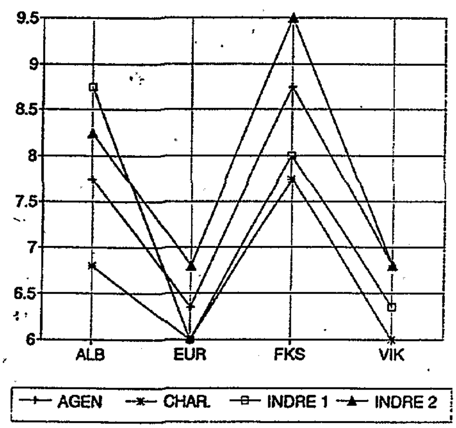
GRAPHIC 1 :
Representation of NEWMAN-KEULS tests. According to D.

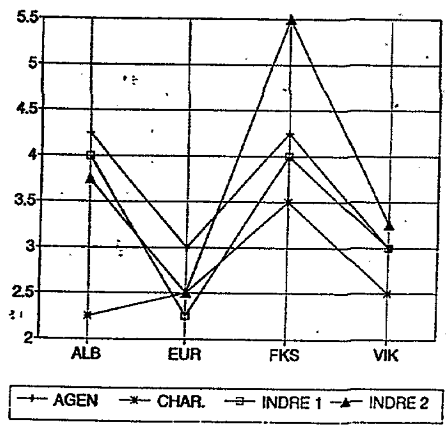




GRAPHIC 2 :
Representation of NEWMAN-KEULS tests. According to F.

GRAPHIC 3 :
Representation of NEWMAN-KEULS tests. According to T.





GRAPHIC 4 :
Representation of NEWMAN-KEULS tests. According to L.

Growing conditions can also have an positive effect on hulling ability :

- an important hydric stress (for an important climatic demand)with which the achene density is reduced and with which a vacuum between the husk and the ovule appears.
- moderated hydric stress, with which the husk fractionment is increased .
- without any hydric stress (some areas with irrigation), with which the husk thickness and its lignification are ameliorated. But, in this case, we only have a moderated results.

REFERENCES

LEPRINCE M.N., 1987. Evaluation de l'aptitude au décorticage de la graine de tournesol : approche structurale. D.E.A., I.N.R.A. Nantes.

LEPRINCE-BERNARD M.N., 1990. Aptitude au décorticage de la graine de tournesol. Thèse de Doctorat, I.N.R.A. Nantes.

PERCIE DU SERT C. and DURRIEU G. Edification de l'akène et de la graine de tournesol (*Helianthus annuus*). Bul. inf. tech. du C.E.T.I.O.M., 103 : 13-20.