

# MORPHOLOGICAL DIFFERENCES BETWEEN HIGH AND LOW YIELDING HYBRIDS OF SUNFLOWER.

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## ABSTRACT

Two experiments were done in Belgium, 1978. The experimental layout was a randomized complete block design with three replications, one experiment with 24 treatments (12 pairs of hybrids) and the other with 16 treatments (8 pairs of hybrids). Each pair should satisfy the following requirements: 1) the hybrids of one pair ought to have the same maturity, 2) of each pair, one hybrid had to be high yielding, whereas the other had to be low yielding. In total, 43 and 36 morphological characters were studied. From these, the following characters: dry head weight (without seeds), number of seeds, ratio: seed yield/total dry weight, showed significant differences between the means of high and low yielding hybrids. Only the two last mentioned characters had significant correlation coefficients with seed yield in the three groups of hybrids formed (all the hybrids, high and low yielding) and in the two experiments done.

## INTRODUCTION

If the idiotype of high yielding plants could be known, this would allow the selection for higher yield, on the basis of other plant characteristics. In other words, it would allow an indirect selection for high yielding plants.

An easy way to find the idiotype of sunflower, for a determinate environment, is to compare a high yielding population with another, low yielding, and measure any differences.

The objectives of this work were: 1) to find which morphological characters could be used in an indirect selection for high yielding plants, and 2) are the morphological characters that are of interest to be used in an indirect selection for high yielding plants, the same in different environments?

## MATERIALS AND METHODS

One investigation was done in the Rijksstation voor Plantenveredeling in Merelbeke during the season of 1978 and the other was conducted in the greenhouse of the Faculty of Agricultural Science of Gent, Belgium.

The experimental layout was a randomized complete block design with three replications of 24 treatments (12 pairs of hybrids) for the Merelbeke experiment and 16 treatments (8 pairs of hybrids) for the greenhouse experiment.

Each experimental plot used in the Merelbeke experiment consisted of 3 lines, 6 m long and 80 cm apart, with 20 cm between plants. Ten plants were marked in the central line, but some of the 43 measurements were done on only 5 plants.

Three plastic pots, 24 cm in diameter, formed the experimental unit of the greenhouse experiment. Distance between pots was approximately 30—35 cm. Thirty-six measurements were done on each plant. Each pair of hybrids should satisfy the following requirements: 1) the hybrids of one pair ought to have the same maturity, 2) one hybrid had to be high yielding ("good" hybrid) whereas the other had to be low yielding ("bad" hybrid).

The seeds and the information about the productivity and maturity type were obtained from INRA of Mon Decir, France.

The t-test for paired samples was used to test for differences between the means of the characters of both groups of hybrids ("good" and "bad" hybrids).

The correlation coefficients between the morphological characters and yield were calculated with the values obtained for each plant, except for the character, percentage of grain humidity.

## RESULTS AND DISCUSSION

The original classification of the hybrids into "good" and "bad" hybrids, was done on the basis of the information received from France and denominated "France, original order". At harvest it was found that the seed yield of some "good" hybrids under "France, original order" was, in the Merelbeke or in the greenhouse, lower than that of the "bad" hybrids under the "France, original order". For this reason, two new classifications, under the names "Belgium Merelbeke order" and "Belgium greenhouse order" were created. From the 8 pairs of hybrids used in the greenhouse experiment, 3/4 changed in the classification in relation to the "Belgium, Merelbeke order" and 5 pairs changed in relation to the "France, original order". Only 2 hybrids, the pair formed by the hybrids 1 and 2, retained the same order in 3 classifications.

No significant differences were found for the maturity type under the "Belgium, Merelbeke order" (date of flowering and percentage of grain humidity) and "Belgium, greenhouse order" (date of flowering), but highly significant differences were found for yield. This proves that the pairing of the "good" and "bad" hybrids in both experiments was well done.

### 1. Results and discussion of the Merelbeke experiment

In the climatic conditions of Merelbeke 1978, the group of high yielding hybrids showed (Table 1) significant differences with the low yielding hybrids, for the means of the following characters: 1) number of seeds, 2) harvest index (ratio: seed yield/total dry weight), 3) seed yield ( $P < 0.01$ ), 4) fresh leaves weight, 5) dry head weight, 6) number of green leaves at harvest, 7) ratio: green leaves at harvest/number of leaves ( $P < 0.05$ ).

The last four characters have negative "t" values, so the "bad" hybrids had higher fresh leaves weight, dry head weight, ratio: green leaves at harvest/number of leaves and more number of green leaves at harvest than the high yielding hybrids.

None of the characters studied in the young sunflower plant help to construct the picture of the idiotype of the high seed yield plant under these environmental conditions. There are only 4 characters that have correlation coefficients with "seed yield" in the 3 groups of hybrids (1—all the hybrids, 2—high yielding hybrids, 3—low yielding hybrids) with values close to or higher than 0.5. These characters are: 1) diameter of head, 2) fresh stem and head weight, 3) number of seeds, 4) harvest index.

The correlation coefficients, changed from significant to non significant in 13 (over 42) characters in at least one of the 3 possible groups of hybrids. If the "high seed yield plant" can be defined on the basis of the 12 pairs of hybrids studied in Merelbeke 1978, it will be a plant with a lot of seeds and a high harvest index, and a low fresh leaf weight, dry, head weight, with few a number of green leaves at harvest and a low ratio: green leaves at harvest/number of leaves.

### 2. Results of the Greenhouse experiment

Using the t-test for paired samples, and in the environmental conditions of the greenhouse, the group of high yielding hybrids showed (Table 2):

(a) significant differences at the 1% level with the low yielding hybrids, for the means of the following characters: 1) distance from ground level to cotyledon, 2) height of plant (one month), 3) number of leaves, 4) dry head weight, 5) number of seeds, 6) harvest index, 7) seed yield.

The calculated t-value was negative for the characters "number of leaves" and "dry head weight". So, under greenhouse conditions, the sunflower plants produce more

16—Length of petiole of highest leaf	0.03	-0.02	0.06	1.14	8.31	8.01
17—Stem diameter below cotyledon	0.30++	0.38++	0.32++	-1.06	26.6	27.3
18—Number of leaves	0.20++	0.25++	0.10	0.04	25.3	24.2
19—Number of ligula flowers	0.20++	0.10	0.20++	0.24	49.0	46.1
20—Date of flowering	0.21++	0.19++	0.33++	-0.63	21.7	22.1
21—Number of bracts of external circle	0.04	0.05	-0.10	0.28	12.8	12.6
22—Final height of plant	0.22++	0.26++	0.11	0.51	156	153
23—Angle of petiole of largest leaf	0.07	0.13	0.12	-1.41	48.5	52.1
24—Angle of petiole of highest leaf	0.005	-0.09	0.15	-0.55	42.7	43.0
25—Diameter of head	0.59++	0.66++	0.51++	0.19	16.2	16.0
26—Diameter of sterile centre	0.04	0.003	0.16+	-1.65	5.47	5.96
27—Fresh leaves weight	0.22++	0.34++	0.26++	-2.44+	93.5	121.7
28—Fresh stem weight	0.42++	0.53++	0.41++	-1.37	292	319
29—Fresh head weight	0.47++	0.57++	0.38++	-0.03	260	261
30—Fresh stem and head weight	0.50++	0.60++	0.45++	-0.80	552	579
31—Total fresh weight	0.45++	0.57++	0.41++	-1.27	646	701
32—Dry leaves weight	0.35++	0.48++	0.29++	-0.93	32.5	33.9
33—Dry stem weight	0.42++	0.56++	0.33++	-1.12	62.2	65.2
34—Dry head weight (without seeds)	-0.08	-0.01	-0.19+	-2.15+	29.9	31.5
35—Dry stem and head weight	0.08	0.28++	0.11	-1.48	92.1	96.6
36—Total dry weight	0.26++	0.31++	0.29++	-1.22	125	131
37—Number of green leaves at harvest	0.18++	0.33++	0.17+	-2.30+	6.87	9.08
38—Percentage of grain humidity (x)	0.11	0.11	0.26	-1.38	23.9	25.5
39—Number of seeds	0.59++	0.56++	0.80++	4.17++	1141	891
40—Weight of 100 seeds	0.16++	0.36++	-0.03	-1.52	5.18	5.52
41—Ratio: green leaves at harvest/number of leaves	0.02	0.25++	0.16+	-2.44+	0.27	0.37
42—Harvest index	0.53++	0.39++	0.56++	5.17++	0.24	0.21
43—Seed yield	—	—	—	4.93++	56.4	47.9

(x) with n = 36

**Table 2. In this table it is possible to find :— the coefficients of correlation with the yield of the three possible groups of hybrids, — the analysis of the difference between high and low yielding hybrids, — the means of high and low yielding hybrids, of the experiment carried out in the greenhouse.**

Characters	Coefficient correlation			t-test	means of hybrids	
	all the hybrids	high yield	low yield	"high" "low"	high yield	low yield
1—Length of cotyledon	0.08	0.12	0.13	-1.54	2.93	3.02
2—Width of cotyledon	0.16	0.02	0.21	1.33	1.86	1.79
3—Distance from ground level to cotyledon	0.01	-0.05	0.18	3.28++	4.90	3.86
4—Distance between leaf tips of first leaves	0.25++	0.14	0.39++	-0.35	22.9	23.1
5—Length of first leaf	0.22+	0.07	0.39++	-0.36	8.66	8.77
6—Width of first leaf	0.11	0.11	0.18	-0.59	4.39	4.45
7—Stem diameter below cotyledon (one month)	0.10	-0.06	0.33+	0.27	11.1	10.9
8—Height of plant (one month)	0.25++	0.003	0.26	2.91++	62.5	57.1
9—Length of largest leaf	0.33++	0.22	0.35++	2.65+	20.8	19.9
10—Width of largest leaf	0.31++	0.14	0.41++	1.30	22.1	21.6
11—Length by width of largest leaf	0.33++	0.19	0.39++	2.49+	462	433
12—Length of petiole of largest leaf	0.16	0.21	0.10	0.51	122	119
13—Stem diameter below cotyledon	0.04	0.15	0.04	-1.59	157	163
14—Number of leaves	-0.12	0.17	-0.17	-3.17++	31.3	33.5
15—Number of ligula flowers	-0.13	-0.02	-0.13	-0.72	42.5	45.7
16—Date of flowering	-0.23+	-0.04	-0.25	-1.62	19.9	21.8
17—Number of bracts of external circle	0.07	0.08	0.11	-1.39	16.0	16.8
18—Final height of plant	-0.15	0.09	-0.19	-1.77	196	206
19—Diameter of head	0.44++	0.48++	0.43++	0.91	8.61	8.58
20—Diameter of sterile centre	-0.24+	-0.15	-0.20	-1.44	2.68	3.14
21—Fresh leaves weight	0.006	0.36++	-0.08	1.59	21.6	24.1
22—Fresh stem weight	0.05	0.31+	-0.24	-1.04	43.1	44.8
23—Fresh head weight	0.75++	0.88++	0.64++	0.83	27.0	26.3
24—Fresh stem and head weight	0.25++	0.52++	-0.05	-0.82	70.2	71.1
25—Total fresh weight	0.21+	0.51++	-0.06	-1.08	91.7	95.1
26—Dry leaves weight	0.16	0.45++	0.05	-2.16+	17.7	19.0
27—Dry stem weight	-0.11	0.15	-0.26	-1.43	25.7	27.2
28—Dry head weight (without seeds)	-0.16	0.39++	-0.36++	-2.79++	5.63	7.61
29—Dry stem and head weight	-0.15	0.26+	-0.33+	-1.92	31.2	35.3
30—Total dry weight	-0.08	0.34++	-0.20	-2.09+	48.8	53.8
31—Number of green leaves at harvest	-0.10	-0.04	-0.09	-1.14	0.56	1.42
32—Number of seeds	0.65++	0.43++	0.75++	3.94++	609	467
33—Weight of 100 seeds	0.24+	0.59++	0.02	-1.52	3.22	3.55
34—Ratio: green leaves at harvest/number of leaves	-0.10	0.05	-0.09	-1.09	0.015	0.026
35—Harvest index	0.87++	0.84++	0.89++	3.39++	0.39	0.30
36—Seed yield	—	—	—	4.05++	19.2	15.5