PERFORMANCE STABILITY OF SUNFLOWER CULTIVARS, IN BRAZIL

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SUMMARY

When varieties are compared over a series of environments, the significant superiority of any variety is difficult to demonstrate due to genotype - environment interactions. If stability of performance is a genetic characteristic, the selection of genotypes that interact less with the environment is a manner to reduce the effects of this interaction.
With the objective of evaluate the stability of performance of some varieties cultivated in Brazil, a series of Yield Comparative Trials were done.
The experimental material consisted of 9 commercial sunflower cultivars, which were tested in 8 different environments in a randomized complete block design, with 4 replication. The locations differed mostly in soil type and climatic conditions. The cultural practices used were the same for all locations.
The genotype - environment interactions were studied by the model of Eberhart & Russell.
The statistical analysis showed a great difference between the environments and the genotypes. The genotype - environment interaction was statistically significant, indicating the possibility of selection for genotypes adapted to a specific environment.
The hydrid DK-180 showed the best performance in low-yielding environments and had, also, a good performance in high-yielding environments.

INTRODUCTION

When genotypes are compared over a series of environments, the relative rankings usually differ, causing difficulties in demonstrating the superiority of any one.
The genotype - environment (G x E) interactions are of major importance to avaliate unknown genotypes and, also, for choosing standard varieties and better genotypes for crossings in breeding programs.
If the ability to show a minimum interaction with the environment is a genetic characteristic, a preliminary evaluation could identify the stable genotypes. This identification will aid the breeder in the selection of superior genotypes. Those genotypes could be selected to be well adapted to a known region or to have a good performance in all kinds of environments.

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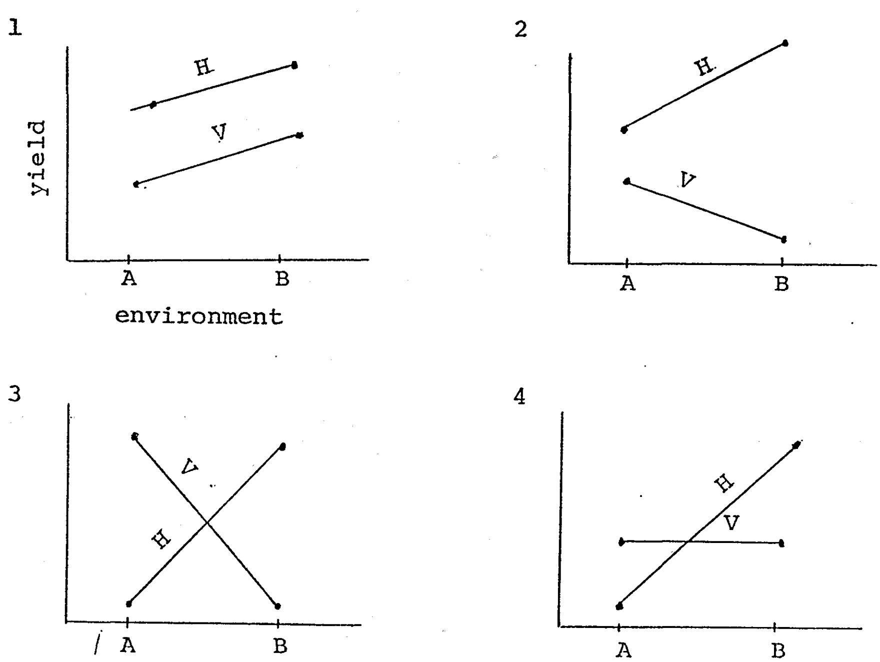
The commercial cultivation of sunflower in Brazil is quietly recent. Almost all the cultivated genotypes were introduced into cultivation directly, without any selection for our conditions. In the current status of sunflower cultivation in Brazil, it is important to have a material with good adaptation to different environments. As is known, the yield stability is particularly important in undeveloped countries where the dificient use of chemicals and machineries limits the control of weeds, pests and diseases by the farmers. Wide variation in soil types and climatic conditions mean that no two growing environments are similar, so that cultivars must show general adaptation in order to avoid crop failure that subsistence farmers can hardly afford. The selection or recomendation of specific genotypes in plant breeding programmes is often proceded by multi-environmental testing in which the relative performance of the genotypes varies from one environment to another, i.e., there is a genotype-environment interaction.
Eberhart and Russell (1966) developed a method of measuring crop yield stability based on a regression technique. The regression method of stability analysis has been used in a number of studies related to the yield stability of different crops (Faris et alii, 1981; Scott, 1967; Riede & Barreto, 1985). The regression approach has been used in comparing and measuring genotype performance of sunflower at different environments (Bruniard & Ludueña, 1984).
Allard & Bradshaw (1964) summarized what is known about G x E interactions in order to help plant breeders in developing varieties which minimize unfavourable interaction. The authors especified G x E interactions types in 2 environments, with 2 genotypes. The figures 1, 2, 3 and 4 show some types of genotypes behaviors.



Type 1 - Genotype H is better than V in both environments. There is no interaction G x E.

Type 2 - The change in environment affects the genotypes in opposite directions.

Type 3 - There is interaction G x E. Genotype H is better in environment B and genotype V is better in environment A.

Type 4 - Genotype H is a specialized variety, and V is less specialized than H.

With the objective of determine the behavior of some sunflower commercial cultivars planted in Brazil, a multi-environmental test was done and the results were analysed in order to verify if there were genotype - environmental interactions.

MATERIAL AND METHODS

The experimental material, consisting of 9 sunflower commercial cultivars, represented 3 different groups: variety, single-cross hybrid and double-cross hybrid. They were tested at 8 experimental sites selected to provide different climatic and soil conditions. In Campinas (SP) and Dourados (MS) the experiments were carried out both under dry (1984) and wet (1983) condition. The cultural practices were the same for all locations. Plots consisted of 5 rows, 6m in lenght, in a spacing of 70cm between rows and 20cm between plants in the line. The 3 center rows were harvested for yield. The experimental design was randomized blocks, with 4 replications. The statistical procedure used was a regression model developed by Eberhart and Russell (1966).
The analysis of variance was carried out for each location and for all locations together.
According to the model of Eberhart and Russell, stability parameters may be used to describe the performance of the genotypes over a series of environments.
These parameters are defined with the following model:

$Y_{ij} = \mu_i + B_i I_j + \delta_{ij}$, where

Y_{ij} is the variety mean of i^{th} variety at the j^{th} environment ($i = 1,2 \ldots, v$; $j = 1,2 \ldots, n$);

μ_i is the mean of the i^{th} variety over all environments;

B_i is the regression coefficient that measures the response of the i^{th} variety to varyng environments;

I_j is the environmental index obtained as the mean of all varieties at the j^{th} environments minus the grand mean;

δ_{ij} is the deviation from regression of the i^{th} variety at the j^{th} environment.

RESULTS AND DISCUSSION

The results of grain yield (kg/ha) of 9 sunflower cultivars in the 8 different sites are given in Table 1, together with the mean yield and environmental indices (I).
The mean yield, the correlation coefficient (r) and the stability parameters (b and s^2d) obtained by the model of Eberhart & Russell are given in Table II.

The analysis of variance showed significative differences between genotypes, environments and the genotype - environment interactions (Table III), indicating the possibility of selection for a genotype adapted to a specific environment.
The regression analysis by the model of Eberhart & Russell revealed that the value of the regression coefficient b was always near 1.0 which is the ideal to avaliate the behavior of a genotype in varying environments.
Although the number of environments tested were not so high, it was sufficiently wide to represent a good and a poor sunflower grain yield.
The two varieties tested produced 10% less than the hybrids.
C - 33 and Issanka, appeared to have minor potential for grain yield because they produced, almost everytime, less than the average in all environments, with Issanka being the worst genotype tested.

Table I - Average yield in kg/ha of 9 sunflower genotypes tested at 8 different sites and the environmental indices (I). Mean of 4 replications.

Cultivar	Florestal	Ilha Solteira.	Janaúba	Campinas 83	Dourados 83	Campinas 84	Uberaba	Dourados 84
Contisol	513	476	517	1181	1232	1405	1854	2035
Conti 112	355	515	1295	969	904	1526	1897	1947
Conti 233	446	443	790	1234	1498	1052	1932	2072
Conti 422	510	492	1316	862	1001	1521	1938	1997
Conti 812	524	483	867	1085	1305	1482	1599	1959
DK - 180	565	540	1497	1272	1062	1658	1801	1926
C - 33	364	543	915	869	958	1665	1407	1849
IAC-Anhandy	372	454	1222	959	775	1547	1737	1759
Issanka	378	473	812	1136	1049	1227	1235	1894
mean	471	502	1026	1063	1087	1454	1711	1937
I	-685.10	-654.43	-130.22	-93.55	-69.44	297.12	554.66	781.01

Table II - Mean yield (kg/ha), regression coefficient (b), determination coefficient (r) and deviation from regression (s^2d) in the Yield Comparative Trials.

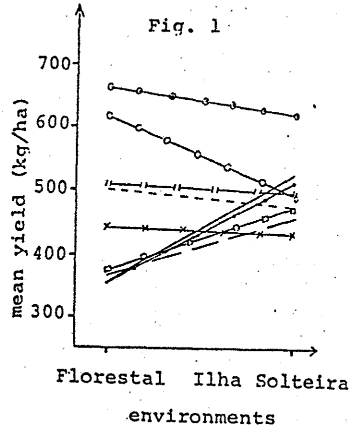
Genotypes	mean yield	b	r	s^2d
Contisol	1151	1.09	0.94	307566.94
Conti 112	1176	1.09	0.97	226557.16
Conti 233	1183	1.07	0.91	468884.77
Conti 422	1175	0.93	0.97	99800.50
Conti 812	1205	1.08	0.97	161214.78
DK 180	1316	0.89	0.95	13[illegible]082.00
C 33	1072	0.95	0.95	162898.42
IAC-Anhandy	1105	1.00	0.96	176529.76
Issanka	1026	0.86	0.94	169236.64

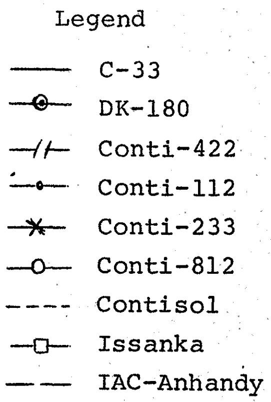
Table III - Grouped Analysis of the 9 genotypes at 8 Environments.

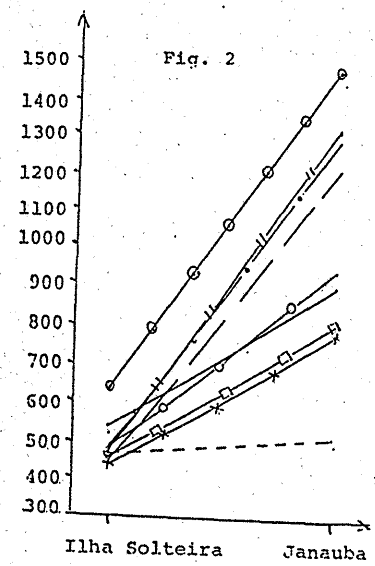
	DF	SS	F
Environments	7	9976334.23	108.98**
Blocks	24	3930596.80	-
Genotypes	8	2165959.03	2.95*
G x E	56	8191671.82	1.59*
Error	192	17575567.14	

CV = 26.37%

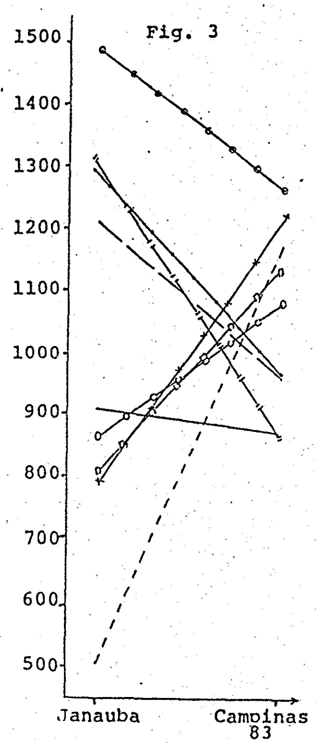
The production obtained in Florestal and Ilha Solteira Were extremely low and of the same magnitude in both environments. This happened probably because both have the same soil condition (pH < 4.7) and high average temperature. Although Janauba also had high average temperature, the soil condition was better (pH > 5.4). Campinas 83 and Dourados 83 had soils with average fertility and pH > 5.0. But both sites showed an excess of rain, mostly in the flowering period, which caused a great foliar diseases incidence and poor seed set.
The figures 1 to 7 show, the behavior of the genotypes in the different sites.







Many types of behavior occurred in the experiment, which can be seen in the Figures 1 to 7. For example, type 1- between DK-180 and Conti-233 in Uberaba and Dourados 84; type 2- between Issanka and IAC-Anhandy in Campinas 83 and Dourados 83; type 3- between Conti-812 and Conti-422 in Janauba and Campinas 83; type 4- between C-33 and Conti-112 in Campinas 84 and Uberaba. Although C-33 yielded less than the mean in almost all the environments, in Campinas 84 it gave the highest yield, indicating that possibly it is specialized for that environmental condition.



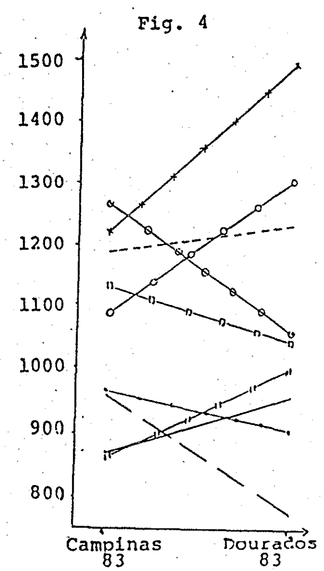


Fig. 5

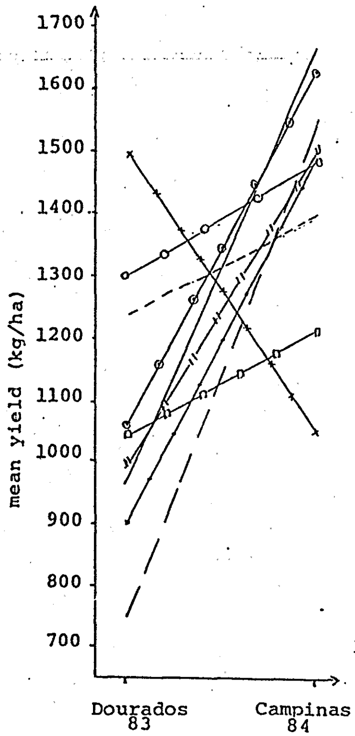


Fig. 6

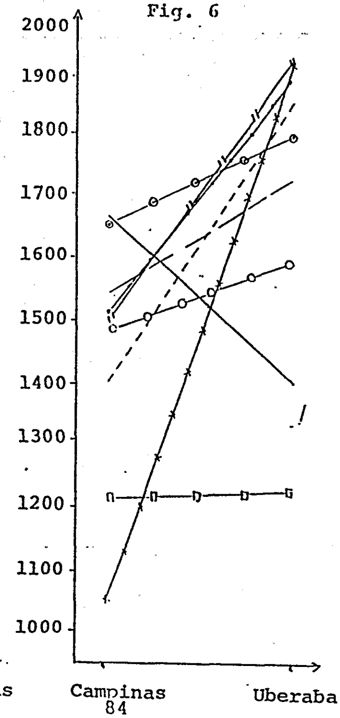


Fig. 7

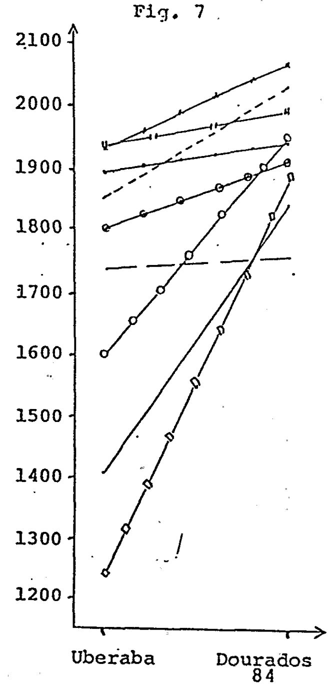
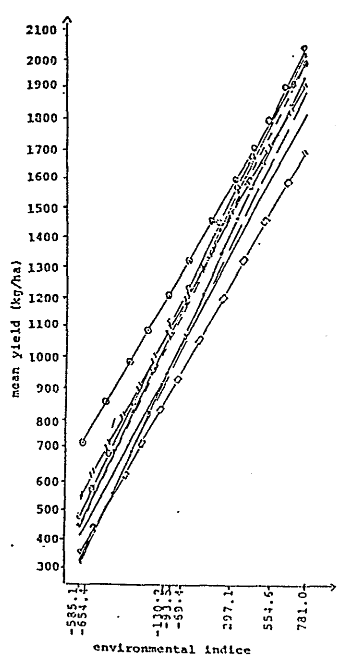


Figure 8 show the superiority of DK-180 and Conti-812. Although Conti-233 (b = 1.09) had a good response to the increase of the environmental indice, it gaved the highest deviation from regression and a lower mean yield.
DK-180 showed the highest final mean yield and yielded above the mean in all environments, except in two, where it yielded as much as the mean (Table 1). Otherwise, it had b < 1.0 (b = 0.89) which, by definition, should led to less adaptability to good environments.
According to Allard and Bradshaw (1964) genotypes that minimize unfavorable genotype - environmental interactions are those which are able to control their developmental processes in such a way as to give high and consistent performance.
Between the genotypes tested in our work, DK-180 was the one that fits better the definition of Allard and Bradshaw.
Contisol (b = 1.09) also showed a genotype-environment interaction, with a good response to the increase of the environmental indice, but it yielded less and had a greater s^2d than DK-180.

Figure 8 - The regression lines for the 9 genotypes.



The total mean yield of the three-way hybrid (Conti-422) was 13% higher than the mean yield of the two varieties and 4% higher than the mean yield of the one-way hybrids. This advantage of the three-way hybrid over the average of the one-way hybrid could be expected. Sprague & Federer (1951) found that variety x location interaction was smaller for double crosses than for single crosses, which suggests greater stability of double crosses. This stability allows double crosses to make high mean yields over many years, even though the highest yield in any place is obtained for some single cross (Eberhart et alii, 1964) because the mean interaction of a mixture of genotypes, as three-way hybrids, could be smaller than the interaction for only one genotype.

CONCLUSIONS

- The model of Eberhart & Russell was not so good to discriminate the more stable sunflower genotype.
- The hybrids DK - 180 (b = 0.86) and Conti - 812 (b = 1.09) were the best genotypes to brazilian conditions.

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