AN ANALYSIS OF GENOTYPE AND ENVIRONMENT INTERACTION IN THE CHARACTER OF SUNFLOWER SEED OIL CONTENTS

WU TIAN-PING
Jilin Province Research Institue of Sunflower, Baicheng City, Jilin Province, P. R. China.

SUMMARY

The trial was carried out at eight regions were included six provinces and autonomous region of China. In order that the genotypic stability and genotype-environment interaction in the character of sunflower seed oil contents were studied in this trial, so as to improve the selective responce of the character and use specific genotype to suit for the special envieonment. Eberhart's modle (1966) was adopted in this trial. The effect of genotype- environment and genotypic stability were analysed by measuring two important parameters which are regression coefficent of genotype and different environment respondence (b_i) and regressive (S^2_{di}). The results shown that seed oil contents of the most of varieties with high genotypic stability were lower; but this kind of variety had a widespead adaptablity and high hardiness in wide - ranging environments. There were more difference among varieties on parameters of genotypic stability, and the effect value of genotype and environment interaction were significantly different (1%), too. The ecovalences which all of kinds genotypes were influenced by environment were very different. There are genuinely linear relation between phenotype of character in sunflower seed oil contents and environment conditions. In the early stage of breeding program, the information of genotype-environment interaction will be utilized to estimate accurately the branch part of accidental error in genotypic variance, thus more effectively improving the selection index in the character of sunflower seed oil contents.

INTRODUCTION

Sunflower as a rising oil-crop has become the second edible vegetable oil in the world. To improving sunflower seed oil contents, at present, has been turned to major object in sunflower breeding. The character of sunflower seed oil contents has been studied by many sunflower genitists and breeders. The results shown that the character was a quantitative character to be conditioned by the polygene. In sunflower breeding program, to correctly explain the hereditary variation of the character and forecast phenotype of the character depend to estimate the genotype value accurately. Made these estimation, however, must base on the data that reported the genetic and non-genetic influence in development of plant. Freeman & Perkins reported that there were genuinely linear relation between phenotype of specially designated genotype and environment conditions. The correlation between genotype and phenotype was reduced greatly by the effect of genotype-environment interaction, thus the confidence level of data were relatively brough down, which data were obtained through the experiments of heredity and improvment on sunflower seed oil contents. It is very importent to correctly analyse the genotype-environment interaction effects in the character of seed oil contents, and the use of genetic variance to infer genetic constitution correctly. It is necessary to improve the selective advance of the character, the use of the specific genotype to suit for specially ecotope in the sunflower

production, too. In this paper, depending on the data of regional test of sunflower, the genotypic stability in the character of sunflower seed oil contents and genotype - environment interaction effect were studied.

MATERIALS AND METHODS

1. Materials

Four hybridized combinations and one variety were involved in this trial. As follows: "74102-4A × I113", "7611A × Liao68", "76055A × 181", "485A × 77-13" and "Peredovik".

2. Methods

The combined regional test was carried out at eight test places where were involved in six provinces and autonomous regions, and as follows: Jilin province Institute of Sunflower, Liaoning province Acodemy of Agriculture, Shonghuajang prefecture Institute of Agriculture, Aohan prefecture Institute of Agriculture, Shandong province Farm, Xinjiang autonomous region Institute of Agriclture Inner Mongolia autonomous region Acodemy of Agriculture and Fuxin Institute of Agriculture. The randomized block design with three times repetition was adopted in this trial, and planting distance 40 cm × 60 cm, 10 M × 3 M per plot. Sunflower seed oil contents were determined by sampling ripen sunflower seed from every plot. Eberhart's modle (1966) was adopted in this trial. The effect of genotype-environment interaction and genotypic stability were analysed by measuring two important parameters which were regression coefficent of differently environmental respondance (b_i) and regressive variance ($S\bar{d}_i$).

3. Statistics

A. Eberhart's modle: $Yij = \mu_i + \beta iIj + \sigma ij$;

B. Formulas on b_i, $S\bar{d}_i$ and Ij: $b_i = \sum_j y_{ij}\, Ij \,/\, \sum_j Ij^2$; in this formula, $\sum_j y_{ij}\, Ij = XI$; in it, X—— Matrix of mean; I —— vector of environmental index. $S\bar{d}_i = \sum_j \sigma^2 ij/(n-2) - S\bar{e}^2/r$; in it: n —— test place numbers, σij —— regression deviation, r —— replications, Se —— common error.

The characteristic of replication under a series of environments were adopted to determine genotypic action under different environments:

Variative source	DF	MS	EMS
Environment	e - 1		
Genotype	g - 1	MS1	$\sigma^2 + r\sigma^2 ge + re\sigma^2 g$
Genotype × environment	(g-1) (e-1)	MS2	$\sigma^2 + \sigma^2 ge$
Error	ge (r-1)	MS3	

Analysis of variance modle on stability parameters:

Variative source	DF	Sum of squares common difference	No.	MS
Total (in mean)	nv - 1	$\sum_i \sum_j y^2_{ij} - C$	I	
Genotype	v - 1	$\frac{1}{n}\sum_i y_i^2 - C$	II	MS1
Environment + (g × e)	v(n-1)	$\sum_i \sum_j y^2_{ij} - (\sum_i y_i^2/n)$	III	
Environment (linear.)	1	$\frac{1}{v}\sum_j (y_j I_j)^2 / \sum_j I^2$	IV	

Genotype x environment	v - 1	$\sum_i (b_i \sum_j y_{ij} I_j) - IV$	V	MS2
Total dispersion	v(n-2)	$\sum_i \sum_j \sigma^2_{ij}$	VI	MS3

*C = Correction index.

Signfication test of $S\hat{d}^2_i$: $F = (\sum_j \sigma^2 ij / (n - 2)) / S\hat{e}^2 / r$.

At first, the data of seed oil contents, from every test place, were analysed respectively, then the data were combined to analyse so that the genotype-environment interaction information was obtained by different materials.

RESULTS AND DISCUSIONS

Combinative analysis of variance and mean analysis of variance shown that genotype-environment interaction and genotypes in character of sunflower seed oil contents were high signficant difference(Table1,2)

Table 1. Combining analysis of variance:

Variative source	DF	SS	MS	F
Total	119	3580.5200	30.0884	
Genotype	4	1657.2639	414.3160	
Environment	7	918.9445	131.2778	
Genotype x environment	28	484.7597	17.3128	2.6658**
Common error	80	519.5519	6.4944	

*Significance level 0.01.

Table 2. Mean analysis of variance whole of test places:

Variative source	DF	MS	F
Genotype	4	138.11	28.24**
Environment	7	43.76	8.95**
Genotype x environment	28	4.89	

*Signifiance level 0.01.

The high significant difference among genotypes in the character indicated that the difference among materials were conditioned by their genotype. That genotype-environment interaction effect were also high significant difference shown that represent of genotype would be changed with environmental change, and there were a genuinely linear relation between the represent of special resigned genotype and environment conditions. The result, on the genotypic stability parameter analysis of variance, could see that F - test reached high significant difference (Table 3). The results testified that the genotypic stability among materials were different so that genotypic stability for environment was different, too. The ecovalences of which different genotypes were influenced by environmental index (Ij) were significantly different.

According to measuring results on b_i testified that the b_i, the response of genotypes for environment, were situated between 0.6254 and 1.4491, and among them were indifferent. b_i value of three materials were lower than 1, and two materials higher than 1; and $S\hat{d}_i$ value of two materials were high significant difference(table4).

Table 3. Stability parameters analysis of variance:

Variative source	DF	SS	MS	F
Genotype	4	552.4200	138.1350	35.2993**
Environment + (g x e)	35	446.7280		
Environment (linear)	1	306.3159		
Genotype x environment	4	23.0368	5.7592	1.4720
Total dispersion	30	117.3709	3.9124	
Sum of variances	39	999.1500		

*Significant level 0.01.

Table 4. Average of seed oil contents of genotype, b_i, $\hat{Sd}_i$, MS value combining eight test places:

Material	Average of seed oil contents (%)	b_i	$\hat{Sd}_i$	MS
74102-4A x I113	32.8556	0.6254	1.1593	2.0200
7611A x Liao68	35.8889	0.8953	2.1396	3.0259
76055A x 181	41.4956	0.9280	1.7848	2.6852
485A x 77 - 13	38.2222	1.4491	4.5278**	4.5705
Peredovik	42.2778	1.1056	4.9744**	3.8085

*Average of seed oil contents of population: 38.1480. *0.01.

According to Eberhart's modle, when $b_i < 1$, $b_i = 1$ and $b_i > 1$ stand for genotypic stability are better, middle, worse separately. At $b_i > 1$, the effect value of genotype-environment interaction was high and sensable with environmental change. The absolute value of $\hat{Sd}_i$ for a stabilitive genotype should be lower and no difference in F - test; conversely, it might be influenced by environement and not stability. From table 4 could see that "74102-4A X I113" and "7611A X Liao68" were well-buffered materials, the ability that genotype regulated its phenotype was higher and possessed stronger adaptability with harmful environments. "76055A x 181" 's b_i value approached to 1, and was higher than above-mentioned two hybrids's b_i value, and $\hat{Sd}_i$ was 1.7848 and indifference in F - test , too. The results shown that its genotypic stability was middle, since the hybrid had a higher seed oil contents , so it is a high- yield and stabilitive type in seed oil contents character. The b_i value of "485A x 77-13" and "Peredovik" all were higher than 1, and $\hat{Sd}_i$ value were high significant difference in F - test. Although $\hat{Sd}_i$ of "Peredovik" was higher than "485A x 77-13" 's, "Peredovik"'s b_i value was lower than "485A x 77-13" 's, and mean variance of "Peredovik" was lower than "485A x 77-13" 's too, so "Peredovik" was more stabilitive than "485A x 77-13. Because " 485A x 77 -13"and "Peredovik" 's effect of genotype-environment interaction all were higher, so they were non-stability materials on genotypic effect. "485A 77-13" 's b_i value (1.4491) was the highest than other show that it was the most sensable with environmental change , genotypic representation was influenced greatly by environment. Between genotypic representation and environmental condition in character of sunflower seed oil contents existed a genuinely linear relation, and when Ij absolutate value was changed genotypic phenotype would be changed with the change of Ij absolutate value.

CONCLUSIONS

In sunflower production, requiring a variety should be having the highest potentiality of seed oil contents and the greatest stability with the best environment. However, this kind of material was difficultly obtained. The results (table 4) testified :

1. The varieties which had greatly genotypic stability, most of them, had a lower seed oil contents. The results have testified the fact in "74102-4A x I113" and "7611A x Liao68".

2. It's greatly significant for working out and achieving the breeding program to analyse genotype-environment interaction in character of sunflower seed oil contents. The parameter of genotypic stability was of great variation, and effect values of genotype-environment interaction were high significant difference among varieties. In sunflower production, the effective value of genotype-environment interaction could be utilized on the basis of ecotopic characteristics. If breeders want to obtain good materials which suit for wide-range environments, the materials which must be lower effect value of genotype-environment interaction and higher genotypic stability may be selected in breeding process , thus improved varietes had a wide adaptablity and high hardiness. The "74102-4A x I113" belongs to this kind of hybrid in this trial. If breeders demand selecting the varieties which adapt to a resigned ecotope, specially high productive ecotope, the material which have high effect value of genotype-environment interaction may be selected like "Peredovik". Therefore, only by measuring correctly the effect of genotype-environment interaction can materials and varieties at hant be defined for adaptive sunflower production area.

3. The character of sunflower seed oil contents has a relatively high heritability (99.47%). therefore, in the early stage of sunflower breeding program, e. g. using "Peredovik" to make systematic selection to improve seed oil contents, the information of genotype-environment interaction will be utilized to correctly assess the branch part of random error in genotypic analysis of variance, thus the selective index was more effectively improved in the character of sunflower seed oil contents.

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