CORRELATION AMONG THE MOST IMPORTANT CHARACTERS OF SUNFLOWER IN F_1 GENERATION

DRAGAN ŠKORIĆ
(Yugoslavia)

Correlative dependence represents an average relationship among various characters of living creatures. The mutual relationship between two or more characters originates genetically from the influence of common genes and their linkage and therefore these common linked genes (aditives and others) cause also a correlative common exposition and variation of characters.

Practical importance of correlation is particularly expressed by creating new varieties of cultural plants, because very often after the intensity of one character which is involved in correlation, it can be learned what are the other characters of a certain individual.

Putt (1943) found out that there is a correlation between seed yield and several other characters, as well as between the oil content and other sunflower characters. Schuster (1964) investigated the correlative dependence among a great number of characters in different self-pollinated generations of sunflower. The correlation between seed yield and a great number of other characters in different wheat genotypes was found by Borojević and Ćupina (1969). The correlative dependence between seed yield and some important characters of maize hybrids was established by Jovanović (1969).

MATERIAL AND METHOD OF WORK

For these investigations six groups of hybrids of F_1 generation based on genetic male sterility linked with the anthocyanic gene were used. At the calculation by computer the average two-year values of the investigated characters were used. Calculation was made of the simple, partial and multiple coefficients of correlation and coefficients of regression and equation of regression between oil yield per hectare and length of growing season, seed yield, oil content in seed, percent of husk, 1000 kernel weight, height of plant, head

Table 1

Simple (r_a) and partial (r_b) coefficients of correlation between oil yield (kg/ha) and several characters for the hybrid group (F_1) between NS-GMS-A9345 x inbred lines of Peredovik and Smena

Character	Coefficient	Oil yield kg/ha	Length of vegetation, days	Seed yield, mtc/ha	Oil content in the seeds, %	Husk, %	Weight of 1000 seeds, g	Height of plant, cm	Diameter of head, cm	Diameter of stalk, mm	Number of leaves per plant
		1	2	3	4	5	6	7	8	9	10
Lenght of vegetation, days	2 r_a	0.371									
	$(X_1)r_b$	—0.615*									
Seed yield mtc/ha	3 r_a	0.936**	0.418								
	r_b	0.997**	0.628*								
Oil content in the seeds, %	4 r_a	0.547**	0.089	0.234							
	r_b	0.956**	0.570*	—0.946**							
Husk, %	5 r_a	—0.389	—0.120	—0.082	—0.886**						
	r_b	—0.831**	—0.564*	0.846**	0.646*						
Weight of 1000 seeds, g	6 r_a	0.338	—0.100	0.205	0.456	—0.489					
	r_b	0.502*	0.201	—0.484	—0.412	0.475					
Height of plant, cm	7 r_a	0.834**	0.436	0.846**	0.204	—0.086	0.022				
	r_b	0.871**	0.611*	—0.843**	—0.889**	0.601*	—0.426				
Diameter of head, cm	8 r_a	0.443	0.058	0.497	—0.064	0.325	—0.298	0.619*			
	r_b	0.817**	0.416	—0.822**	—0.694*	0.868**	—0.604*	—0.567*			
Diameter of stalk, mm	9 r_a	0.493	—0.094	0.416	0.309	—0.311	0,622*	0,308	0.162		
	r_b	0.476	0.164	—0.481	—0.469	0.369	0.114	—0.353	—0.291		
Number of leaves per plant	10 r_a	0.630*	0.307	0.639*	0.221	—0.036	—0.197	0.702*	0.558*	0.068	
	r_b	0.157	0.035	—0.166	—0.035	0.310	—0.267	0.061	—0.188	—0.420	
Leaf surface per plant	11 r_a	0.738*	0.205	0.729*	0.308	—0.223	0.218	0.628*	0.439	0.608*	0.690*
	$(X_2)r_b$	—0.510*	—0.294	0.537*	0.411	—0.587*	0.222	0.298	0.502*	0.683*	0.650*

diameter, stalk diameter, number of leaves and leaf surface. Because of the abundant data, on this occasion we will present the results of only two characteristic groups of hybrids. It is worth mentioning that in all hybrids (34) of these two groups the female parent is the same male sterile line.

RESULTS OF INVESTIGATIONS

On the basis of the results presented in table 1 it can be pointed out that in the hybrid groups whose male parent lines originate from Peredovik and Smena, the simple coefficients of correlation show a firm positive correlation between oil yield per hectare and seed yield per hectare, oil content in seed and height of plant. Medium firm positive correlation is between oil yield per hectare and number of leaves and leaf surface per plant. Analyzing further the components of oil yield per hectare it can be proved, on the basis of the partial coefficients of correlation by which the pure (net) correlation among the investigated characters was established, under condition that the effect of other characters was excluded, that there is a firm positive correlation between oil yield and seed yield per hectare, oil content in seed and height of plant. Besides, in this group of hybrids the partial coefficients of correlation show a firm positive relationship between oil yield per hectare and head diameter of plant and a negative one in relation to the percent of husk. The partial coefficients show also a medium firm positive correlation between oil yield and 1000 kernel weight, as well as a negative one between the length of growing season and leaf surface.

The results obtained for the group of hybrids whose male parent lines originate from VNIIMK 8931 and VNIIMK 1640 are presented in table 2 and they show a similar correlation among the investigated characters. In this group of hybrids too, the simple and partial coefficients show a firm positive correlation between oil yield per hectare and seed yield (kg/ha) and oil content in seed. It could be expected because oil yield per hectare is the product of seed yield and oil content in seed. In this group of hybrids the simple coefficients of correlation show higher dependence of oil yield upon the length of growing season of hybrid, a similar one upon the leaf surface and less upon height of plant. The partial coefficients show that the positive correlation of oil yield per hectare in this group of hybrids is higher than the number of leaves per plant and stalk diameter in the previous group of hybrids. Likewise, in this group of hybrids the partial coefficient shows that there is a negative medium firm correlation between oil yield per hectare and height of plant, which was not the case with the first group of hybrids. Also, it is characteristic that the partial coefficient of correlation in hybrids based on lines from VNIIMK 8931 and VNIIMK 1640 shows a positive correlation between oil yield per hectare and leaf surface per plant, while in the first group of hybrids this correlation was negative. This indicates that the correlation of the individual characters in different genotypes of sunflower is different.

Table 2

Simple (r_a) and partial (r_b) coefficients of correlation between oil yield (kg/ha) and several characters for the hybrid group (F_1) between NS-GMS-A9345 x inbred lines of VNIIMK 8931 and VNIIMK 1640

Character	Coefficient	Oil yield kg/ha	Length of vegetation, days	Seed yield, mtc/ha	Oil content in the seeds, %	Husk, %	Weight of 1000 seeds, g	Height of plant, cm	Diameter of head, cm	Diameter of stalk, mm	Number of leaves per plant
		1	2	3	4	5	6	7	8	9	10
Length of vegetation, days	2 r_a	0.572*									
	r_b	0.241									
Seed yield mtc/ha	3 r_a	0.866**	0.532*								
	r_b	0.992**	—0.259								
Oil content in the seeds, %	4 r_a	0.863**	—0.033	—0.501*							
	r_b	0.962**	—0.114	—0.953**							
Husk, %	5 r_a	0.'59	0.265	0.588*	—0.893**						
	r_b	—0.705*	0.631*	0.730*	0.541*						
Weight of 1000 seeds, g	6 r_a	0.313	0.353	0.489	—0.414	0.334					
	r_b	—0.170	0.316	0.210	0.060	—0.285					
Height of plant, cm	7 r_a	0.573*	0.592*	0.668*	—0.325	0.295	0.460				
	r_b	—0.601*	0.674*	0.647*	0.521*	—0.768**	—0.198				
Diameter of head, cm	8 r_a	0.274	0.120	0.585*	—0.724*	0.763**	0.071	0.334			
	r_b	0.162	—0.195	—0.179	—0.195	0.284	—0.303	0.258			
Diameter of stalk, mm	9 r_a	—0.292	—0.307	0.065	—0.633*	0.432	0.300	0.195	0.300		
	r_b	0.623*	—0.462	—0.688*	—0.634*	0.632*	0.266	0.726*	—0.287		
Number of leaves per plant	10 r_a	0.348	0.291	0.486	—0.446	0.560*	0.045	0.271	0.633*	—0.168	
	r_b	0.829**	—0.307	—0.854**	—0.815**	0.700*	0.171	0.661*	—0.116	—0.823**	
Leaf surface per plant	11 r_a	0.534*	0.221	0.821**	—0.736*	0.730*	0.385	0.540*	0.776**	0.469	0.512*
	r_b	0.411*	0.195	0.501*	0.399	—0.432	—0.194	—0.471	0.419	0.766**	0.587*

Bearing in mind the existance of correlation between oil yield per hectare and several characters, the multiple coefficient of correlation shows a firm positive correlation between oil yield per hectare and 10 investigated characters in both groups of hybrids : $Ry_1...10 = 0.99$.

The coefficient of determination in the first group of hybrids is $R_1^2 = 0.995$, and in the second group $R_2^2 = 0.996$, sthows that in both groups of hybrids with 10 investigated characters more than 99% of variability of oil yield per hectare can be explained. The dependence of oil yeld per hectare (y) upon the individual characters in the investigated two groups of hybrids of F_1 generation are shown also by regression equation ($\hat{y}$), ranging to :

a) for the group of hybrids based upon self-pollinated lines from Peredovik and Smena

$$\hat{Y}\,I\,yl\ldots\ldots 10 = 1064.4 - 1.9\,X_1 + 35.1^{***}\,X_2 + 31.4^{***}\,X_3 - 9.3^{*}\,X_4 +$$

$$+ 0.7\,X_5 + 2.1^{**}\,X_6 + 7.6\,X_7 + 3.9\,X_8 + 0.3\,X_9 - 96.2\,X_{10}$$

b) for the group of hybrids based upon self-pollinated lines from VNIIMK 8931 and VNIIMK 1640

$$\hat{Y}\,II\,yl\ldots\ldots 10 = -1446.9 + 0.8\,X_1 + 35.6^{***}\,X_2 + 33.8^{***}\,X_3 -$$

$$- 4.9^{*}\,X_4 - 1.3\,X_6 + 2.1\,X_7 + 12.0\,X_8 + 4.4^{**}\,X_9 - 1.7\,X_{10}$$

The regression equations show also that the highest effect on oil yield per hectare in both groups of hybrids have seed yield per unit area (X_2) and oil content in seed (X_3). Among other properties an equal effect in both groups of hybrids on oil yield has the percent of husk (X_4). It is characteristic that in the group of hybrids based upon self-pollinated lines from Peredovik and Smena, beside the above mentioned characters a significantly positive effect on formation of oil yield has the height of plant (X_6) while in the group of hybrids based upon self-pollinated lines from VNIIMK 8931 and VNIIMK 1640 — the number of leaves per plant. This indicates that on the formation of oil yield per hectare the contribution of the individual characters can be various in different genotypes.

The results presented in tables 1 and 2 show that other investigated characters have different effect on the seed yield per hectare and oil content in seed, the main components of oil yield per unit area. In the group of hybrids whose male parent lines originate from Peredovik and Smena, the simple coefficient shows a positive firm correlation between seed yield and height of plant. Medium firm positive correlation exists between number of leaves and leaf surface per plant. The partial coefficient shows higher correlation between seed yield per hectare and investigated characters. There is a firm positive correlation between seed yield and percent of husk, and medium firm positive

correlation between length of growing season and leaf surface. A firm negative correlation is expressed between seed yield and oil content in seed, height of plant and stalk diameter.

The simple and partial coefficients show similar positive correlation between seed yield and leaf surface in the group of hybrids based upon self-pollinated lines from VNIIMK 8931 and VNIIMK 1640 (table 2). Likewise, the simple and partial coefficients show medium firm positive correlation between seed yield and percent of husk and height of plant. In this group of hybrids there is a negative correlation between seed yield and oil content in seed. There is a positive correlation between seed yield and head diameter only when the simple coefficient of correlation is considered. If only the partial coefficient of correlation is considered, in this group of hybrids, the seed yield is in a negative correlation to the stalk diameter and number of leaves per plant.

In the group of hybrids whose male parent lines are from Peredovik and Smena, the multiple coefficient of correlation between seed yield per hectare and 9 investigated characters is positive and it is $R_{Iyl-9} = 0.83$, while the coefficient of determination shows that 79.6% of variability in seed yield, in this group of hybrids, can be prescribed to the investigated characters (9). The regression equation for the level of significancy of 0.1% is

$$\hat{Y} = -3.26 + 0.27\ X_6$$

and shows that seed yield in this group of hybrids depends mostly upon the height of plants.

The hybrids whose male parent lines originate from VNIIMK 8931 and VNIIMK 1640 have multiple coefficient for seed yield per hectare, as a dependent changeable character and other 9 characters, in table 2 (except oil yield), as undependent changeable character and positive $R_{IIyl-9} = 0.88$. The coefficient of determination (R^2) indicates that with 9 investigated characters it is possible to explain 80,5% of variability in seed yield per hectare, in this group of hybrids.

The regression equation in this group of hybrids is :

$$\hat{Y} = 25.76 - 1.59^{**}X_8 + 0.07^{***}X_{10}$$

Accordingly the seed yield per hectare in this group of hybrids has the highest positive dependence upon the leaf surface per plant (X_{10}) and negative dependence upon stalk diameter (X_8) respectively.

The results presented in tables 1 and 2 show that the oil content in seed in both groups of hybrids depend differently upon the investigated characters. Likewise, the interaction of other investigated characters is different.

CONCLUSIONS

On the basis of the results obtained it can be concluded that the decesive role in formation of seed yield and oil yield per hectare in the investigated groups of hybrids of F_1 generation, have a great number of characters. The contribution of each individual character can be different in different genotypes.

The simple, partial and multiple coefficients of correlation and coefficients of regression, as well as the regression equation showed that in both group of hybrids, the seed yield and oil content in seed have the greatest effect on oil yield per hectare, which is quite reasonably since the oil yield is the product of these two characters. Among other investigated characters the percent of husk has an equal negative effect on oil yield in both groups of hybrids.

It is characteristic that in the group of hybrids based on self-pollinated lines from Peredovik and Smena, beside the abovementioned characters, the height of plants has a significantly positive effect on formation of oil yield while in the group of hybrids based on self-pollinated lines from VNIIMK 8931 and VNIIMK 1640 the number of leaves per plant.

The other investigated characters have different effect on the seed yield per hectare and oil content in seed, as the main components of oil yield per unit area.

In the group of hybrids based on self-pollinated lines from Peredovik and Smena, the seed yield per hectare is in a positive correlation to the height of plants (as well as the oil yield). In the hybrids based upon self-pollinated lines from VNIIMK 8931 and VNIIMK 1640 there is a positive correlation between seed yield and leaf surface per plant.

The correlative dependence among other investigated characters is different.

REFERENCES

1. Borojević, S., Ćupina, T., 1969, *Istraživanje komponenti prinosa zrna kod različitih genotipova pšenice,* Savremena poljoprivreda, No. *1,* (3—27), Novi Sad.
2. Jovanović, B., 1969, *Proučavanje heterozisa rodnosti i drugih osobina medjulinijskih hibrida kukuruza zubana i tvrdunca F_1 generacije,* Beograd, Doktorska disertacija.
3. Putt, E. D., 1943, *Association of seed yield and oil content with other characters in the sunflower;* Scientific Agriculture, *23,* (377—383).
4. Schuster, W., 1964, *Inzucht und Heterosis bei der Sonnenblume (H. annuus L.),* Habilitationsschrift, Giessen.