T1980BRE41

STUDIES ON THE GENOTYPIC AND PHENOTYPIC VARIABILITY AND SOME CORRELATIONS IN SUNFLOWER (HELIANTHUS ANNUUS L.)

P. IVANON, Y. STOYANOVA*

In the last years sunflower breeding has gained considerable success. A large number of high-yielding varieties have been developed, as well as certain hybrids, falling in line with, or even superior to the best varieties.

At the Institute for Wheat and Sunflower there have been developed hybrids of genetic potential coming to 35 - 38 q/ha seed yield. Besides, they are combining some other valuable biological and economical characters, i.e. resistance to diseases, different vegetation periods etc. These materials present a promising object for studying the relation between yield and some other characters and their interdependence. The present study is aimed at following both the genotypic and phenotypic variability of eight characters associated with yield and their direct and indirect effect on productivity.

The object of the study is a competitive trial testing the 6 most promising moderately late varieties and 10 hybrids. The trial was sown in 1979 in 4 replications. The characters that have been measured and recorded are: yield/20 m^2 plot, 1000 seed weight, kernel, seed oil and protein, plant height, head diameter, vegetation period from germination to flowering (VP I) and from flowering to maturity (VP II).

Phenotypic and genotypic variances, variation and correlation coefficients as well as heritability coefficients have been determined by a variance and covariance analysis. Path coefficients have been calculated by the method of Dewey and Lu (1959).

* Institute for Wheat and Sunflower, Tolbuhin, BULGARIA.

TABLE 1

Range, mean with S.E., and components of variance of some quantitative characters

Character	Range	Mean	S.E. ±	Variances	
				Phenotypic	Genotypic
Seed yield kg/20 m^2	5,07 - 6,61	5,87	0,09	0,56	0,09
1000 seed weight, g	43 - 77	60	0,83	78,9	60,8
Kernel, %	74,8 - 80,2	77,4	0,05	3,46	1,82
Oil in the seed, %	44,5 - 49,6	48,0	0,25	4,26	0,64
Protein in the seed, %	13,7 - 17,8	15,4	0,05	3,09	1,07
Plant height, cm	152 - 239	203	2,65	452	371
Head diameter, cm	21 - 28	24,3	0,32	6,72	2,76
VP I, days	53 - 68	62	0,53	18,90	16,79
VP II, days	47 - 62	56	0,55	19,67	16,85

Meteorological conditions in 1979 have been characterized as favourable for sunflower growing. The results obtained and the corresponding conclusions apply mainly to the materials of the tested group, i.e. they explain the interdependence of the charaters in high-yieling varieties and hybrids.

Data in Table 1 give an idea about the variation limits and the standard error for each of the characters tested, together with their phenotypic and genotypic variances. It is evident that narrowest variation limits occur with seed yield, kernel, oil and protein content of the seed and widest ones with plant height and 1000 seed weight. The better manifested variation is expressed by variation coefficients determined on a phenotypic (PVC) and genotypic (GVC) level (Table 2). Highest are the GVC with 1000 seed weight and plant height. The difference between the values obtained for GVC and PVC is greatest in seed yield and protein. The relation between the phenotypic and genotypic variation is expressed by the heritability coefficient. According to the values obtained for H^2 the characters fall into three groups. VP I, VP II, plant height and 1000 seed weight are the least variable under the conditions of growing. Therefore a selection by a phenotypic expression would be most effective with them. The second group includes kernel percentage, seed protein and head diameter where the genetic potencial causes about 34,6 - 52,6% of the phenotypic manifestation of the character. Thus, a selection there would be of lower effectivensess. In order to obtain a satisfactory result, the selection should be of much higher intensity. The third group includes yield and oil content, where the genetic control is respectively 16,1 and 15%. Those two characters were by now the chief object of

TABLE 2

Genotypic and phenotypic variation coefficients and heritability of some characters

Character	GVC	PVC	Heritability
Seed yield kg/20 m^2	5,11	12,57	16,1
1000 seed weight, g	13,00	14,80	77,1
Kernel, %	1,74	2,40	52,6
Oil in the seed, %	1,67	4,30	15,0
Protein in the seed, %	6,72	11,41	34,6
Plant height, cm	9,48	10,47	82,0
Head diameter, cm	6,84	10,67	41,1
VP I, days	6,61	7,01	88,8
VP II, days	7,32	7,91	85,7

all selection work. That resulted in an equalization of the genetic potentials both of the varieties and hybrids in the tested group.

Data concerning correlation coefficients on both the levels are given in Table 3. Notable is the relatively higher positive value of the phenotypic correlation yield/oil content and the negative value of yield/protein. On the contrary, on a genotypic level there is established a highly negative correlation between yield and oil content, kernel and protein and positive one with VP I. A positive, though weakly manifested is the correlation with plants height. There is a positive relation between yield and head diameter on a phenotypic level, but it is again poorly expressed. The 1000 seed weight has shown on a genotypic level a good positive correlation with seed protein and the VP II, but a negative one with oil content in the seed. From the rest of the correlations an attention deservers the high genotypic relation kernel/oil content, kernel/protein, kernel/VP I and the negative relation of kernel/ head diameter.

The analysis of the direct and indirect effect of the characters on the yield is carried out on a phenotypic and genotypic level. A similar study, but on a phenotypic level only, is done by Alba and Greco (1979) with a group of early biological cycle. Thus the comparison of their results to ours has to be made an object of special attention. Besides, conclusions drawn out by the two methods are in favour of those, calculated on a genotypic level. Dewey and Lu (1959) recommend mostly genetic correlations in order to avoid unnecessary repetitions. Martinov (1978), as regards the same, lays stress on the genotypic correlations as being the basic moment of the analysis, for calculations of path coefficients on a phenotypic level cannot throw light on the genetic effects of the separate characters.

Results given in Tables 4 and 5 concern the direct and in direct

Plant height has a high direct positive effect, but through the oil, protein, head diameter and VP I –a negative one, though the total correlation remains positive.

The direct effect of oil content in the seeds is highly negative, though a little weakened by its indirect effect via the kernel, protein, plant height and head diameter. Nevertheless the total correlation is markedly negative (–0,696).

Highest negative direct effect on yield is exhibited by the protein in the seed (–56,570) though it is lowered by the positive indirect effect of the rest of the characters.

The negative direct relation between head diameter and seed yield is reinforced by the negative indirect effect via the value of the kernel (-23,972). Though the total correlation remains negative (-0,317), it is considerably balanced by the positive indirect relation between the rest of the characters, of greatest importance being protein and plant height.

The duration of VP I shows a markedly negative direct effect that is further strengthened by the negative indirect effect via oil content and the kernel. But here this result is entirely compensated by the positive indirect effect of all the other characters, in the first place plant height and protein. That results in a positive total correlation coefficient (+0,403).

VP II has shown a low negative direct effect. Its duration has a positive indirect effect via the kernel, the 1000 seed weight and oil content, and a negative one via its interaction with protein, plant height and head diameter.

Therefore, high yield can be expected of plants, giving seeds of high kernel percentage, 1000 seed weight and developing higher stems. At the same time one have to use positive indirect effects too. They are realized through oil content and protein, i.e. the sum total of oil-protein has to be on a maximum level. Breeding work must be directed towards correcting the negative direct effect of head diameter combined with a simultaneous increase of the kernel percentage, i.e. a combination of big-size diameter and a high kernel percentage. With respect to time of flowering, breeding work has to be aimed at early flowering forms with an intensive initial stem growth, permitting the development of an optimun vegetative mass. The negative direct effect of oil content and protein can be galanced by increasing the kernel percentage.

The comparison of the correlation coefficients with the results of path analyses, together with the conclusions drawn, shows a considerable variation. That comes to prove that correlations simplifying the complex interactions between the characters studied, canoften lead to wrong conclusions. Path analysis on the other hand has proved to be of higher practical value and must therefore be widely applied in breeding.

REFERENCES

1) Alba, E., I. Greco (1979) - An analysis of the association factors influencing seed yield in sunflower (Helianthus annuus L.). The sunflower newsletter, no. 2, vol. 3, 13-15.

2) Dewey, D., K. Lu (1959) - A correlation and path-coefficient analysis of components of crested wheatgrass seed production Agronomy journal, n.º 9, vol. 51, 515-518.

3) Martinov (1978) - Primenenii putevogo i discriminantnogo analysa dlia ocenki seleccionoi znatshimosti komponentov urogaia. In: Genetica kolitshestvenih priznakov selskohozaistvenih rastenii 52-58.