RELATIONSHIPS BETWEEN YIELD AND YIELD COMPONENTS IN FORTY POPULATIONS OF SUNFLOWER

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INTRODUCTION

A knowledge of the relationships between characters is very important from evolutionary point of view and for selection purposes. In breeding work, one of the major objectives is the improvement of yield or other quality traits. Many agronomic and quality traits are quantitative in nature and are complex in inheritance and often involve several related characters. For this reason a knowledge of the degree of associations and relationships between desirable characters is very useful. The associations between different characters may indicate a cause and effect relationship, pleiotropy or linkage and can therefore assist in the identification of promising materials. Different pairs of characters are correlated with each other because of a mutual association positive or negative. When many variables are considered, the indirect causes of the associations appear more complicated and less obvious. At this point, an analysis to partition the direct and indirect causes of the associations would be useful. Path coefficient analysis as a standardized partial regression coefficient would be used to indicate the linear relationships that exist between related characters.

The nature of the associations between yield and other characters in sunflower revealed that yield was positively significantly correlated with head diameter, seed weight, number of leaves and plant height while path coefficient analysis revealed that head diameter, head weight, seed weight and plant height had great direct effects on seed yield (Burns, 1970; Alba and Greco, 1979; Giriraj et al., 1979; Pathak and Dixit, 1984).

Although the associations and relationships obtained in different sunflower populations have been reported, the results may not be applicable to all populations under different environmental conditions, for this reason it becomes necessary to measure such associations and partition the cause and effect relationships in populations of interest to the breeder. This paper therefore reports the associations and relationships between yield and five other characters in forty sunflower populations introduced from different parts of the world.

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MATERIALS AND METHODS

Forty populations of sunflower introduced from different parts of the world were used as the experimental materials in this investigation. The trial was conducted in the field, for two years in 1986 and 1987 at the Institute for Agricultural Reseach, Farm Samaru (11°11'N; 07°38'E). Plots of 9.2 m^2 consisting of four ridges 0.75 m apart and 3.0 m long were used. The experiment was laid out in blocks replicated four times. In each lock the experimental materials were randomized. About five seeds were sown per hole 30 cm apart on the ridges. The seedlings were later thinned to two plants per stand two weeks after sowing. Fertilizers were applied at sowing in trenches 5 to 10 cm away from the seeds. One hundred kg N in form of calcium ammonium nitrate (26 % N), 50 kg P_2O_5 as single super phosphate (18 % P_2O_5) and 30 kg K_2O as muriate of potash (62 % K_2O) were applied per hectare. Weeding was done manually twice.

Data were recorded at harvest from five competitive plants per plot on (a) Number of leaves as the total number of leaves produced per plant, (b) Head diameter in centimeters as the diameter across the head measured with vernier calliper, (c) stem diameter in centimeters as the diameter of the stem at one meter height, (d) 100-seed weight in grams as the weight of 100 air-dried seeds obtained from bulked seeds per plot, (e) Days to maturity as the number of days from sowing to the date when the back of the heads in a plot had turned yellow and the outer bracts had turned brown, and (f) Yield per plot in kg as the weight of air-dried seeds after threshing.

Table 1

Mean with standard error (±), range and coefficient of variation (C.V.) of six characters in forty sunflower populations

Character	Mean S. E.	Range	C.V. %
No. of leaves	27.28±0.63	18.00—39.00	14.63
Head diameter (cm)	19.24±0.49	12.75—28.00	16.22
Stem diameter (cm)	1.79±0.04	1.10— 2.33	15.54
Days to maturity	90.84±0.55	87.25—98.75	3.82
100-seed weight (g)	4.10±0.15	2.00— 6.00	22.80
Yield per plot (kg)	1.58±0.06	0.99— 2.53	23.08

Because the variations between experimental units receiving the same material need not enter into the evaluation of the associations between the characters, the means of the populations across years and replications were used in the analysis. Correlation coefficients were computed and multiple regression analysis was used to partition the direct and indirect causes of the associations as reported by Dewey and Lu (1959), Turner and Stevens (1959), and Wright (1960).

RESULTS

The mean values, range and coefficient of variation for six characters in forty populations of sunflower used in this study are given in *Table 1*. Significant variations were observed for 100-seed weight and yield. *Table 2* shows the degree and nature of linear associations of six characters in all combinations. The results indicate highly significant positive correlations between head diameter with stem diameter (r=0.74) and days to maturity (r=0.38), while days to maturity was highly significantly positively correlated with stem diameter (r=0.46). Yield was non-significantly negatively correlated with all the characters except number of leaves per plant while the correlation between head diameter and 100-seed weight was positive and significant (r=0.30).

The nature and magnitude of the direct and indirect contributions of the different characters (the causes) on the dependent variable (the effect) is presented in *Table 3*. The results indicate that head diameter had the largest positive direct contribution towards yield followed by number of leaves per plant. The largest indirect positive contribution towards yield was shown by stem diameter through head diameter. Stem diameter, days to maturity and 100-seed weight each registered a negative direct contribution towards yield.

Table 2

Correlation coefficient between different pairs of characters in forty sunflower populations

	No. of leaves	Head diameter	Stem diameter	Days to maturity	100-seed weight
Yield	0.04	—0.06	—0.13	—0.12	—0.03
No. of leaves		0.14	0.07	0.03	0.05
Head diameter			0.74***	0.38**	0.30*
Stem diameter				0.46**	0.11
Days to maturity					—0.14

* = Significant at 0.05 level of significance.
** = Significant at 0.01 level of significance.
*** = Significant at 0.001 level of significance.

DISCUSSION

The wide range observed for number of leaves per plant, head diameter and days to maturity in the populations indicate the variability of the populations for these characters and the possibility of changing the characters through selection. The highly significant positive correlation between head diameter and days to maturity indicate that small heads matured earlier and that selection

Table 3

Direct (underlined) and indirect contributions of five characters towards yield in forty sunflower populations

Yield attributes	Effects through					
	No.of leaves	Head diameter	Stem diameter	Days to maturity	100-seed weight	Correlation with yield
No. of leaves	0.04	0.02	—0.01	—0.003	—0.003	0.04
Head diameter	0.01	0.11	—0.12	—0.06	—0.02	—0.56
Stem diameter	0.003	0.08	—0.16	—0.04	—0.006	—0.13
Days to maturity	0.001	0.04	—0.07	—0.09	0.008	—0.12
100-seed weight	0.002	0.03	—0.02	0.01	—0.06	—0.03

for earliness might result in plants with smaller heads. However, head diameter depends on other environmental factors especially sowing date, soil fertility, plant population and competition with weeds among others.

The correlations between yield and all the other characters were not significant in this study. The non-significant correlations should, however, not be taken to imply the absence of any functional relationship between yield and the other characters. This is because any two variables may have a strong non-linear relationships even if their linear correlation coefficient value is low and non-significant. A negative non-significant correlation between yield and head diameter was observed (r=—0.056). Similarly, Ross (1939) observed a non-significant correlation between yield and head diameter and reported that contrary to general belief, there was no significant correlation between the yield of seed and the diameter of the main heads. This is because the weight of seeds produced in a head depends not only on the diameter of the head but also on the number of flower zones which are fertile and on the length of the kernels.

Even though head diameter was negatively correlated with yield, it registered the highest direct positive contribution towards yield. The negative correlation was therefore caused indirectly because of the associations between head diameter with the other characters particularly stem diameter, days to maturity and 100-seed weight each of which was negatively correlated with yield as well as registered a negative direct contribution towards yield. Thus the indirect contributions of head diameter through stem diameter, days to maturity and 100-seed weight play a very important role in masking the direct influence giving a net negative correlation with yield. Despite the negative correlation between yield and head diameter, the direct influence of head diameter indicates that with other variables held constant, increasing head diameter will directly increase yield. This shows that the positive direct contribution contradicts the observed correlation. This apparent contradiction arises from the fact that the two methods measure are different things. Whereas the correlation coefficient simply measures mutual associations between pairs of characters without regard to causation, the path coefficient analysis specifies the causes and measure their relative importance (Dewey and Lu, 1959).

A relatively sizeable positive contribution by stem diameter towards yield was observed through head diameter. This result is not unexpected because stem diameter is highly significantly correlated with head diameter (r=0.74). The number of leaves per plant, though non-significantly correlated with yield registered a positive direct contribution towards yield. Also all the indirect contributions via number of leaves were positive. The weak correlation between number of leaves per plant and yield (r=0.04) was therefore caused by the negative indirect contribution of number of leaves per plant via stem diameter, days to maturity and 100-seed weight.

In partitioning the correlation coefficients, it was assumed that all the relations are linear and that unknown residual factors uncorrelated with any other factors and independent of other variables exist (Wright, 1960). Since most of the direct contributions towards yield in this study are negative, the residual variables might have appreciably large direct contributions indicating their importance on seed yield.

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RELATIONS ENTRE LE RENDEMENT ET LES COMPOSANTS DU RENDEMENT CHEZ QUARANTE POPULATIONS DE TOURNESOL

Résumé

L'étude des relations linéaires entre le rendement et cinq autres caractères pour quarante populations de tournesol provenant de plusieurs pays, ont montré qu'il y a une association négative entre le rendement et le diamètre du capitule (r = —0,056), le diamètre de la tige (r = —0,13), le nombre de jours jusqu'à la maturité (r = —0,12) et le poids de 100 graines (r = —0,03). Le diamètre du capitule est associé de manière hautement significantive avec le diamètre de la tige (r = 0,74) et le nombre de jours jusqu'à la maturité (r = 0,38). L'analyse de la régression multiple a montré que la plus importante contribution directe positive à la formation du rendement revient au diamètre du capitule ; le diamètre de la tige a la plus importante contribution indirecte négative à la formation du rendement, par l'intermède du diamètre du capitule. Les résultats prouvent la possibilité d'améliorer le rendement par la sélection pour le diamètre du capitule et le nombre de feuilles.

RELACIONES ENTRE EL RENDIMIENTO Y SUS COMPONENTES EN CUARENTA POBLACIONES DE GIRASOL

Resúmen

Los resultados de las asociaciones lineales entre el rendimiento y otros cinco caracteres en cuarenta poblaciones de girasol, procedentes de diferentes paises, muestran que aquel estaba correlacionado negativamente con el diámetro del capitulo ($r = -0.56$), diámetro del tallo ($r = -0.13$), dias a maduración ($r = -0.12$) y peso de 100 semillas ($r = 0.03$).

El diametro del capitulo estaba significativamente asociado con el diámetro del tallo ($r = -0.74$) y dos a maduración ($r = 0.38$). Se han realizado análisis de regresión multiple que indicaban que la contribución directa y positiva más importante al rendimiento era via diámetro de capítulo, mientras que la contribución indirecta y positiva de más importancia se hacia por el diámetro del tallo via diámetro de capitulo. Los resultados indican la posibilidad de mejorar el rendimiento mediante selección para diámetro de capítulo y número de hojas por planta.