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ARAŞTIRMA MAKALESİ/**RESEARCH ARTICLE**

STUDY ON RELATIONSHIP BETWEEN EAR WEIGHT AND SOME OTHER EAR CHARACTERS IN COLD TOLERANT MAIZE POPULATIONS BY PATH ANALYSIS METHOD

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ABSTRACT

This research was carried out to study; a) phenotypic and genotypic correlations between ear weight, with number of grain per ear, kernel weight per ear and 1000 kernel weight which are important yield components of maize, b) the effects of different components on ear weight by path coefficient analysis and c) to estimate broad sense heritability for ear traits.

Significant variations were found between genotypes related to the traits under study. Genotypic coefficient of variation was high for all characteristics in both years. Broad sense heritability was high for ear weight, while it was moderate for number of kernel per ear, grain weight per ear and 1000 kernel weight. Phenotypic and genotypic correlations were found high and positive between ear weight and other traits. Negative correlation between number of grain per ear and 1000 kernel weight implied that simultaneous improvement of these two traits is highly difficult. Phenotypic path coefficient value indicated that the grain weight per ear has significant effect on ear weight. There for selection for ear weight can be use to increase kernel weight per ear and consequently yield per se.

Key Word: Maize, Ear characteristics, Genotypic correlation, Phenotypic correlation, Path analysis, Variance components, Yield components.

SOĞUĞA TOLERANSLI MISIR POPULASYONLARINDA KOÇAN AĞIRLIĞI İLE ÖTEKİ BAZI KOÇAN ÖZELLİKLERİ ARASINDAKİ İLİŞKİLERİN PATH ANALİZİ YÖNTEMİYLE ARAŞTIRILMASI

ÖZ

Bu çalışma; a) mısırda önemli verim komponentleri olan koçan ağırlığı ile koçanda tane sayısı, koçanda tane ağırlığı ve 1000 tane ağırlığı arasındaki fenotipik ve genotipik korelasyonları incelemek, b) Path analizi yöntemiyle değişik ögelerin koçan ağırlığını nasıl etkilediğini ortaya koymak, c) koçan özellikleri için geniş anlamdaki kalıtımı saptamak amacıyla yürütülmüştür.

Üzerinde çalışılan karekterler yönünden, genotipler arasında önemli varyasyonlar saptanmıştır. Genotipik varyasyon katsayısı her iki yılda da yüksek çıkmıştır. Geniş anlamda kalıtım derecesi koçan ağırlığı için yüksek; koçanda tane sayısı, koçanda tane ağırlğı ve bin tane ağırlığı için orta değerler vermiştir. Koçan ağırlğı ile öteki özellikler arasında geniş ve olumlu fenotipik ve genetik korelasyon bulunmuştur. Koçanda dane sayısı ile 1000 dane ağırlığı arasında bulunan olumsuz korelasyon, bu iki özelliğin birlikte geliştirilmesinin zor olduğunu göstermektedir. Fenotipik path katsayısı; koçanda dane ağırlığının koçan ağırlığı üzerine önemli oranda doğrudan etki yaptığını göstermektedir. Bu nedenle oldukça kolay olan koçan ağırlığı alınarak yapılacak seleksiyonla, koçanda tane ağırlığı ve bu yolla birim alandan alınacak ürün (verim) artırılabilecektir.

Anahtar Kelimeler: Mısır, Koçan özellikleri, Genotipik korelasyon, Fenotipik korelasyon, Path analizi, Varyans komponentleri, Verim komponentleri.

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1. INTRODUCTION

In term of consumption and production, maize is one of the most important cereals for Turkey and it currently ranks third after wheat and barley. However, total production is not sufficient and Turkey often imports maize grain to meet demand. There are two different ways to increase production. First way is the enlargement of the maize acreage. Turkey has this possibility in Southeastern Anatolian Project (GAP) areas and the vast areas of Central Anatolian Region. Short growing season for maize is main limiting factor in Central Anatolian Region (CAR). However, with suitable varieties and growing techniques this limit may overcome in many locations. To take full advantage of growing period in CAR, early planting is recommendable but if the variety to be planted doesn't have some tolerance to cold in early growing stages, early planting becomes risky. Second way to increase production is selecting high yielding varieties from adapted populations in breeding programs. Althought, several institutions were studied on yield and adaptation, a continious research program especially on breeding has not been placed for CAR. As it is reported by various researchers, breeding for yield components may offer possibilities to develop efficient ways leading to improve grain yield. Thus, knowledge on inheritance and interrelationship of ear traits may very helpfull to be use in breeding for selections.

Path Coefficient analysis has been used succesfully to clarify the interrelationships between yield and several other characteristics for many crops such as field bean (Duarte and Adams, 1972), soybeans (Pandey and Torrie, 1973), wheat (Bhatt, 1973; Sidwel et al., 1976; Gebeyou et al., 1982), barley (Tewari, 1976; Hamid and Grafius, 1978; Pury et al, 1982; Garcia del Moral et al, 1991; Wright, 1921). This methods is originally developed by Wright (1921) and later used and elaborated by Dewey and Lu (1959) and some others. It can be used to partition the correlation coefficients into direct and indirect effects. A path coefficient is a standart partial regression coefficient, obtained from equations where all variables have been expressed as deviations from the mean in units of standart deviation (Steel and Torrie, 1982 ; Burton and De Vane, 1953). Thus, it provides a measure of the relative importance of each independent variable to the prediction of changes in the dependent one. The proper use of the method requires that, cause and effect exist between the variables and that the researcher assign direction in the causal system, either a priori or based on experimental evidence (Li, 1956; Steel and Torrie, 1982).

This study was carried on cold tolerant maize populations.Main objectives were to determine phenotypic and genotypic correlation coefficients between several important ear traits and to explain compresive path coefficient analysis showing how ear weight, affect by different components and to estimate broad sense heritability for ear traits. And also provide suggestions for succesful selection criteria to obtain high yielding genotypes.

2. MATERIALS and METHODS

Twelve open pollinated yellow dent maize populations were used in this investigation. Those were among the selections obtained by Kınacı (1991) for cold tolerance at early growing stages and adaptation to Central Anatolia. Experiments were conducted at Bahri Dağdaş International Winter Cereals Research Center's farm in Konya, during 1993 and 1994 growing seasons in randomize complete block design with two replications. Each population were grown in 8 rows with 10 meters row lenght. Row-to-row spacing was 70 cm and hil-to-hill spacing within rows was 20 cm .

Data were recorded for ear weight: each dry ear weight of 20 random ears; number of kernel per ear: average number of kernel per ear of 20 random ears; kernel weight: ear weight-cob weight and thousand kernel weight as weight of 1000 kernels.

Mean values were estimated and used for statistical analysis. The coefficient of variation and heritability were worked out by using the formulae of Burton and De Vane (1953), Hanson et al. (1956). Genotypic and phenotypic correlation coefficients among all traits were calculated from the variance and covariance components showed by Sing and Chaudary, (1979).

Direct and indirect path coefficient were calculated as proposed by Wright (1934), Li (1956), Dewey and Lu (1959) and by Singh and Chaudary (1979). Ear weight was considered as a resultant variable, while number of kernel per ear, kernel weight and thousand kernel weight were taken as main causal variables.

3.RESULTS and DISCUSSION

Significant differences were observed between genotypes for ear weight in both years (Table 1). Mean values, genotypic and phenotypic variation and heritability in broad sense for all characters under study are set out in Table 2.

Highest genotypic coefficient of variation was found for kernel weight per ear and 1000 kernel weight in 1994. They were followed by ear weight in both years (Table 2). Lowest genotypic coefficient of variation was exhibited by number of kernel per ear in both years.

Broad sense heritability estimates for ear weight were also high in both years, while the number of kernel per ear and kernel weight per ear were moderately low. Thousand kernel weight exhibited the lowest broad sense heritability estimates (0.15) in 1994. Heritabilities of ear traits found in this study were slightly higher than those presented by Halluer and Miranda (1988), but they were similar to results obtained by Sentz (1971) and Sing et al. (1984).

3.1. Correlation Among Characters

Phenotypic and genotypic correlation coefficient between all possible pairs of traits are presented in Table 3. In 1994 , the phenotypic correlation coefficient is matched to genotypic correlation coefficient which means, environment effects on these relationships was minimum. In those cases, where the magnitude of the phenotypic and genetic correlation coefficient was nearly same, the environmental variance and covariance had been reduced to zero or to a negligible level as declarated by Kang et al. (1983). In both years, high or moderately high values obtained for genotypic correlation coefficient between ear weight and kernel weight per ear, and ear weight with thousand kernel weight. This indicates that, they are either not genetically independent or physiologically related as suggested by Adams (1967). The phenotypic and genotypic correlation between ear weight and number of kernel per ear were of the same magnitude, positive and significant in 1994, while none significant in 1995. Phenotypic and genotypic correlations between ear weight and kernel weight per ear were positive and significant.

Table 1. Mean Square for Ear Weight and Some Other Traits in Maize Population in the Years 1994 and 1995.

Source of variation	Ear weight		Number of kernel per ear		Kernel weight		Thousand kernel Weight	
	1994	1995	1994	1995	1994	1995	1994	1995
Genotypes	442.64*	225.3	2486.36	1521.95	463.14	200.17	2356.24	1011.96
Error	116.64	44.24	1370.25	655.48	217.41	79.44	1749.82	417.18

P=0.05 * P= 0.01**

Table 2. Estimates of Genetic Parameters for Ear Weight and Some Quantative Traits in Maize.

	Range		Mean		Coefficient of variation: Genotypic		Coefficient of variation: Phenotypic		Heritability	
	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995
Ear weight	112.4-203.3	184.7-232.6	148.42	210.79	8.6	4.51	11.27	5.51	0.58	0.67
Number of kernel per ear	328.7- 540.3	509.5-644.6	424.73	556.1	5.56	3.74	10.34	5.93	0.29	0.4
Kernel weight	89.2 –188.2	157 -214.7	121.48	175.26	9.12	4.43	15.18	6.75	0.36	0.43
Thousand kernel weight	239.3-491.4	250.1-375.7	287	310.61	6.07	5.55	15.79	8.61	0.15	0.42

Table 3. Phenotypic and Genetic Correlations Between All Possible Pairs of Characters 1994 (above the diagonal), 1995 (below the diagonal).

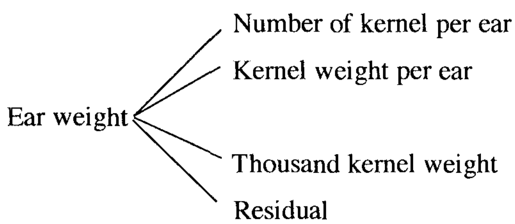
	Ear weight	Number of kernel per ear	Kernel weight	Thousand kernel weight
Ear weight		0.67* (0.87)**	0.81** (0.98)**	0.35 (0.68)*
Number of kernel per ear	0.32 (0.20)		0.39 (0.77)**	-0.30 (0.21)
Kernel Weight	0.63* (0.95)**	0.35 (0.25)		0.76** (0.79)**
Thousand kernel weight	0.67* (0.78)**	-0.23 (0.09)	0.02 (0.06)	

Genetic values shown in parenthesis. P=0.05 **P=0.01

3.2. Path Coefficient Analysis

Furter information on the relationships among the characters was obtained by path coefficient analysis of the phenotypic and genotypic correlation coefficient. This was accomplished by assigning direct and indirect effects to ear components as their contribution to ear weight. Ear weight was considered as the resultant variable while number of kernel per ear, kernel weight per ear and thousand kernel weight were considered as causal variables.

A path diagram based on phenotypic correlation coefficient is present as follows:



The residual was assumed to be independent of the other variablies and in effect measures the failure of the three components to account for ear weight. Each component had a direct influence acting alone and indirect influence acting in combination with the other variables with which it was correlated. The amount of variation in the dependent variable (ear weight) which is accounted for by path coefficient analysis can be determined as $(1 - R^2)$ where R is the path coefficient of residual. The phenotypic measurement of the three components in the analysis was accounted as 91 % of the total variation for ear weight in 1995. Had the product of these components exactly equaled total ear weight, all of the variation would have been accounted for in phenotypic path diagram.

A genetic path analysis also has application but its interpretation is some what different. Besides the obvious difference between genetic and phenotypic effects, the residual has a different interpretation. In genetic system, the residual is measure of the failure of estimated genetic correlations among the variables to account for the total genetic variation in ear weight. The correlations calculated for this system were accounted as 99 % of genetic variation in the dependent variable ear weight in 1994, while it was 56 % in 1995.

A summary of the direct and indirect phenotypic and genetic effects of each variable is presented in Table 4.

Phenotypic and genetic direct effect of kernel weight per ear on ear weight was found as positive and quite large in both years. This was apparently indications of less environmental effect.

If environmental effect is less, modification of any character due to environment is little. Thus, selection of the character based on phenotype may be more dependable. Similar suggestions were also made by Sidwell et al. (1976). As it is known, succes of selection for any desirable character is very much depend upon the variation exist in the population for that character. In this investigation fairly high genotypic coefficient of variation was determined for ear weight. This is likely an evidence for good response to selection. Debnaht (1987), was also made similar statements in his research.

Table 4. Direct and Indirect Influences of Three Different Main Characters on Ear Weight in Maize. (genetic values shown in parenthesis)

Pathway	1993		1994	
Ear weight vs. number kernel weight.				
Direct effect	**0.82****	**(-0.05)**	**0.31**	**(-0.10)**
Indirect effect via kernel weight	0.02	(0.99)**	0.18	(0.23)
Indirect effect via thousand kernel weight	-0.17	(-0.07)	-0.17	(0.07)
Total correlation	**0.67***	**(0.87)****	**0.32**	**(0.20)**
Ear weight vs. kernel weight				
Direct effect	**0.04**	**(1.29)****	**0.51**	**(0.93)****
Indirect effect via number of kernel per ear	0.32	(-0.04)	0.11	(0.003)
Indirect effect via thousand kernel weight	0.45	(-0.26)	0.02	(0.04)
Total correlation	**0.81****	**(0.98)****	**0.63***	**(0.95)****
Ear weight vs. thousand kernel weight				
Direct effect	**0.57***	**(-0.33)**	**0.73****	**(0.73)****
Indirect effect via number of kernel per ear	-0.25	(-0.01)	-0.07	(-0.09)
Indirect effect via kernel weight.	0.03	(1.02)**	-0.01	(0.06)
Total correlation	**0.35**	**(0.68)***	**0.67****	**(0.78)****
Residual	**0.44**	**0.10**	**0.30**	**-0.66**

Correlations among characters are usually desirable or non desirable depend on their directions and level. In this investigation, significant and positive correlations were obtained between ear weight and'kernel weight per ear in two years. Thus, improvement in any of this two features may also result in improvement of other.

Any breeding program which deals with large populations in attemting to develop improved varieties is mostly bases on observations and selections on measurements of the phenotype. The task of the selection from large numbers of progenies is formidable. If it is to be effective a well organized and fast procedure of selection is needed.

According to the results of this study , selection for better ear weight can be use reliably to obtain better kernel weight and consequently improved grain yield per se. Selection for ear weight is quite easy and it can be done in a short period of time.

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