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Investigating the Reaction of Quantitative Characteristics Related to the Yield of Maize Genotypes using Correlation and Regression Relationships

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ABSTRACT

In order to study the growth characteristics and identify the morphological basics of yield difference and also to study the relationships between different characteristics with each other, especially with kernel yield, and for determining the most important characteristics effective on kernel yield in maize genotypes and classifying them based on a number of selected morphological characteristics, this experiment was conducted in Malakandi Village, Pars Abad Moghan County, in 2012. In this experiment, 12 maize genotypes were evaluated using a randomized complete block design with 3 replications. Totally, 15 characteristics (including yield and yield components) were measured and analyzed. Significant differences were observed in terms of all studied characteristics between genotypes. The linear correlation between characteristics showed that the kernel yield has a positive and significant correlation with the amount of kernels per ear row, leaf length, number of days before crossing, and ear length. The number of kernels per ear row, weight of 1000 kernels, and ear diameter were included in the model as the effective variables while analyzing the Variance Inflation Factor (VIF) of kernel yields using the studied characteristics. The path analysis showed that the number of kernels per ear row had the highest and the ear diameter had the lowest direct impact on the kernel yield. The indirect impact of ear diameter through the number of kernels per ear row was higher than its direct impact.

KEYWORDS: Path Analysis; Maize; Multiple Regression; Kernel Yield; Correlation.

1. INTRODUCTION

Maize (*Zea mays L.*) is one of the important plants from the cereal family. Due to the fundamental strategic importance of cereals among other produce in providing food sector demands, it seems that planning is inevitable in the course of increasing their production. Among cereals, maize is the third important product after wheat and rice; therefore, it receives an especial focus Crossa et al.[2].

2. LITERATURE REVIEW AND RESEARCH HYPOTHESIS

2.1 Conceptual Background

A growing body of research is conducted concerning the evaluation of characteristics and identifying the nature and importance of the relationship with the kernel yield using factor analysis in cereals Denis and Adams [3]. Gardner et al. [6] associated the better performance of new maize hybrids to characteristics including leaf area, seed filling rate and duration, amount and weight of kernel and rate. Moreover, attempts are made to identify relationships between characteristics and the share of most important effective characteristics on yield in other cereals Belkma[1] Simple linear regression is an instrument for evaluating the linear relationship between an independent variable (X) with a dependent variable or a function (Y) Montogray et al.[8]. Multiple regression is the extended form of simple regression in which two or more dependent variables (X) are used to estimate a dependent variable (Y) Montogray et al. [8]. In this method, the contribution of each independent variable is determined by holding other independent variables as constants in explaining dependent variations. More independent variables would lead to higher accuracy of the regression relationship; however, this makes their estimation harder, and therefore either a few main variables should be selected as representatives or fewer independent variables (P) should be selected out of more independent variables (p+q) and those variables with no significant effect on yield should be excluded. When including a large number of characteristics into a correlation study, the indirect relationships between them become more complex and, in such cases, correlation coefficients affected by indirect effects become complicated Sing et al.[11]. Here, it would be hard to draw out a solid relationship between different characteristics. Information from correlation coefficients could be increased by dividing correlations to direct and indirect effects. Accordingly, path analysis is recommended for this very purpose Fraser and Eaton.[5] . Using path analysis in eugenic programs was first investigated by DeVelv in 1959. Today, this method is excessively exercised by specialists in livestock improvement, genetics, and eugenics Farshadfar[4]. Using path analysis while studying the relationship of maize characteristics, Malhutra and Kehra [7] found that plant height and ear height are effective on yield, while the emergence time of female organs in plant had low importance.

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3. METHODOLOGY

This experiment was carried out in May/June 2012 in Malakandi Village located at 10 km from Pars Moghan Abad County. Seeds were dry planted on 23 June, 2012, and then the whole farm was irrigated. In order to study 12 medium-maturity corn hybrids (Namely TOUNO, ELDORA, TRIUMFO, MACARI, CHILAN, AS 55, AS 54, AS 63, AS 51, Maxima, SC500, and SC400) with regard to cultivation characteristics, an experiment was carried out using Randomized Complete Block Design [RCBD] in tree replications. Each experimental plot included 4 lines with 75 cm spacing and 6.48 in length. Each genotype was manually planted in 36 hills with 18 cm spacing. Given the planting lines spacing and only one shrub in each hill, the selected density was 75000 shrubs per hectare. SPSS and PATH-2 were used for the statistical analysis of data.

4. RESULTS AND DISCUSSION

Independent variables may directly or indirectly influence the dependent variable in correlation. In fact, the coefficients of correlation, *r*, which measures the relationship between two different variables, could assume a value between -1 to +1. If $r = +1$ then the correlation between the two variables is 100% positive. If $-1 < r < +1$ then there is relatively positive and/or negative correlation between them. However, if $r = -1$ then the correlation between the two variables is 100% negative. In case $r = 0$, there is no relationship between the two variables. Linear correlation coefficients between the studied characteristics showed that the kernel performance is positively and significantly correlated with number of kernels per ear row, leaf length, number of days to crossing, and ear length, at levels of 1% and 5%. The highest coefficient of correlation concerning kernel yield belonged to the correlation of yield with number of kernels per row [0.834**]. That is, the effect of this characteristic on kernel yield is greater and more important than the number of rows per ear and weight of 1000 kernels. Moreover, it was found that the number of kernel rows per ear has a negative and significant correlation with the length of male inflorescence [tassel] and weight of 1000 kernels, at level of 1%. Moreover, it has a positive correlation at level of 5% with number of days to silking and number of days to crossing. The linear correlation between characteristics in this study indicated that number of kernels per row is positively and significantly correlated with ear length [$P < 0.01$] and is negatively and significantly correlated with male inflorescence [$P < 0.05$]. Furthermore, the weight of 1000 kernels had a positive and significant correlation with the number of days before physiological maturity and the length of male inflorescence. Moreover, it was indicated that ear height had a positive and significant correlation with shrub height [$P < 0.01$]; i.e. increasing the plant's height would increase the height of ears. The correlation between the male inflorescence with the number of kernel rows per ear, the number of kernels per ear row, and ear length was negative and significant [Table 1]. Stuber et al. [12] determined strong genetic relationships between yield and number of ears, number of ears and number of tillers, and also shrub height and ear height while studying a hybrid population of maize. Younes et al. [15] believed that ear diameter, number of kernel rows per ear, number of kernels per ear, and ear length are positively and significantly correlated with kernel yield.

Multiple linear regression analysis was performed through stepwise regression. Number of kernels per ear row, weight of 1000 kernels, and ear diameter were included as effective factors in the VIF regression analysis on kernel yield. Table [2] presents standardized regression coefficients and incomplete regression coefficients. The highest standardized regression coefficient belongs to ear diameter. The regression coefficients of number kernels per ear row and weight of 1000 kernels were positive and significant. In the regression analysis of characteristics, Sadat Rasool [10] indicated that the number of kernels per row has more implication on yield variations.

Table1: Linear correlation coefficient between traits in maize genotypes

Row	Traits	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Grain yield	1														
2	No. kernel rows	0.414	1													
3	No. kernel /row	0.834**	0.568	1												
4	1000 kernel weight	0.071	-0.751**	-0.347	1											
5	Plant length	0.162	0.434	0.176	-0.372	1										
6	Ear length	0.316	0.179	0.390	-0.167	0.807**	1									
7	ear leaf Width	0.715**	0.226	0.514	0.095	0.674*	0.745**	1								
8	ear leaf length	0.390	0.288	0.248	0.004	0.456	0.461	0.641*	1							
9	No. of days to 50% pollen shedding	0.684*	0.649*	0.559	-0.106	0.354	0.335	0.486	0.453	1						
10	No. of days to 50% silking shedding	0.264	0.586*	0.141	-0.124	0.171	0.011	0.014	0.198	0.825**	1					
11	No. of days to for maturity physiological	0.206	-0.503	-0.155	0.788**	-0.251	-0.035	0.135	0.128	0.107	0.095	1				
12	ear length	0.665*	0.557*	0.922**	-0.463	0.016	0.277	0.289	0.235	0.465	0.136	-0.176	1			
13	ear diameter	0.452	0.542	0.155	-0.117	0.627*	0.294	0.610*	0.462	0.574	0.461	0.121	0.032	1		
14	tassel length	-0.362	-0.728**	-0.641*	0.639*	0.101	0.140	0.087	-0.007	-0.438	-0.335	0.616*	-0.691*	0.056	1	
15	No. of tassel branches	0.493	0.472	0.660*	-0.437	0.764**	0.866**	0.692*	0.299	0.389	0.049	-0.161	0.545	0.394	-0.132	1

* and ** significant at $p \leq 0.05$ and $p \leq 0.01$, respectively

Path Analysis

In order to separate the correlation of different characteristics with kernel yield into direct and indirect impacts, path analysis was used. Considering the results from VIF regression, path analysis was exercised on characteristics with significant coefficient of regression. The direct and indirect impacts of characteristics on kernel yield are presented in Table [3] and Figure [1].

The highest positive, direct effect on kernel yield belonged to the number of kernels per ear row and the lowest belonged to ear diameter. The highest positive, indirect effect was for the effect of ear diameter through the number of kernels per ear row. These two had a positive and insignificant correlation with each other. The highest negative, indirect effect was for the effect of weight of 1000 kernels trough the number of kernels per ear row. The ear diameter had a negative, indirect effect through the weight of 1000 kernels on kernel yield. Yupadiayula et al. [13] suggested that, due to the low heritability of yield, indirect selection for yield through characteristics related to ear (such as number of kernels per row and number of rows per ear) could be effective. Yazdandoost [14] and Rame'e et al. [9] stated that the direct effect of number of kernels per row on kernel yield is greater than other characteristics.

Considering the high direct effect of number of kernels per ear row and the high indirect effect of ear diameter through the number of kernel per ear row, it could be discussed that to achieve increased yield, increasing these two characteristics is highly important in case of second planting. On the other hand, yield is a complex feature and, in addition to recognizing important factors such as inheritance and environment, other effective characteristics and their governing relationships should not be overlooked in order to obtain higher yields.

Table 2 - Multiple linear regression results of yield among genotypes

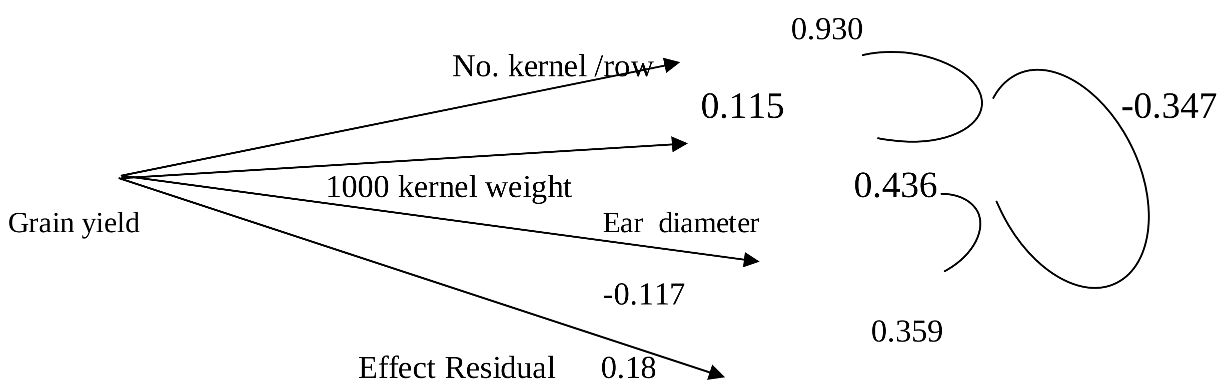
Traits	Indirect Effect of Way			Direct Effect	Correlations Coefficient by Grain yield
	No. kernel /row	1000 kernel weight	ear diameter		
No. kernel /row	-	-0.1513	0.0556	0.9297	0.834
1000 kernel weight	-0.3227	-	-0.0420	0.4357	0.071
ear diameter	0.1442	-0.0510	-	0.3588	0.452
Effect Residual	0.18				

* and ** significant at $p \leq 0.05$ and $p \leq 0.01$, respectively

Table 3 : path analysis of grain yield among genotypes of corn maturity using the effective yield resulting from stepwise regression

Traits Residual on Model	Regression Coefficients
No. kernel /row	0.241**
1000 kernel weight	0.008*
ear diameter	1.196**
R Square	0.969
Adjusted R square	0.957

Figure 1 - Diagram of path analysis for yield and its related traits among genotypes



4.1 Conclusion

In this experiment, the simple correlation coefficients of characteristics showed that the number of kernels per ear row had the highest correlation with kernel yield.

The multiple regression analysis results indicated that three characteristics (number of kernels per ear row, weight of 1000 kernels, and ear diameter) were among the important and effective factors for determining kernel yield.

In path analysis, using the most important characteristics effective on yield in medium-maturity genotypes, the highest positive, direct effect on kernel yield belonged to the number of kernels per ear row and the highest indirect effect of ear diameter was exerted through the number of kernels per ear row.

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