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Correlation and path coefficient analyses of forage yield in corn hybrids as second crop

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Abstract

In order to study correlation between traits and forage yield components of corn hybrids and to determine the most effective factors on forage yield, an experiment was carried out at the agricultural research farm of Khosroshahr jahad Keshavarzi Center (Tabriz, Iran) in 2012. The experiment was conducted as a Randomized Completely Block Design with four replications. The correlation coefficient of forage yield with stem diameter, ear weight, kernel number per row, ear length, days to silk emergence and days to physiological maturity was positive and significant. In the regression analysis, stem diameter, ear weight, and plant height remained in the final model of regression analysis and were considered as the effective components on the forage yield. Path analysis revealed that ear weight could be used as a selection criterion because of its highly positive direct effects on forage yield. Stem diameter and plant height could also be considered for selection in forage corn breeding.

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Introduction

Maize crop plays an important role in the world economy and is valuable ingredient in manufactured items that affect a large proportion of the world population (Alvi *et al*., 2003). Within Europe 50% of the crop is grown for grain, the remainder, in the more temperate climatic areas, is grown for forage. Maize is attractive as a preserved forage because of its inherent quality, capable of increasing the forage intake of cattle and sheep and producing higher live weight gains and higher yields of high protein milk than other conserved forages (Crowley, 1998). Many environmental factors, management systems, and genetic factors influence yield and quality of maize forage (Struik, 1983; Cox *et al*., 1994; Cusicanqui and Lauer, 1999). The final feeding quality of corn silage or grain is a function of plant genetics, growing environment, harvest timing/management, extent of processing/grinding, and length of time ensiled for fermented feeds (Below, 2009). Digestibility could be affected by plant genetic and all fodder of forage corn could be affected by variety (Frey, 2004).

A number of researchers focused on forage maize tried to explain the relations of yield-related components by using correlation and path coefficient analysis (Gallais *et al*., 1976; Schmid *et al*., 1976; Hunter, 1986; Mo *et al*. 1986; Xu 1986; Jatimliansky *et al*. 1988; Kara *et al*., 1999; Kumar Srivas and Singh, 2004; Iptas and Yavuz, 2008; Ergul and Soylu, 2009; Icoz and Kara, 2009; Carpici and Celik, 2010). Kara *et al*. (1999) reported that green forage yield in maize was positively correlated with stem diameter, ear diameter and ear weight. Ergul and Soylu (2009) did not determine any significant correlation between forage yield and plant height, first ear height, ear diameter, stem ratio, leaf number, leaf ratio, ear ratio. Schmid *et al*. (1976), Hunter (1986) and Iptas and Yavuz (2008) reported that plant height and stem diameter were not related to dry matter yield. However, Gallais *et al*. (1976) proved that plant height and stem diameter are related to dry matter yield. Kumar Srivas and Singh (2004) notified that dry forage yield plant^{-1} was found to be significantly and positively associated with green fodder yield and yield components like plant height, number of leaves plant^{-1} and stem diameter. Thus, the improvements in characters like plant height, number of leaves plant^{-1} and stem diameter will help in improving the fodder yield in maize both directly and indirectly. Iptas and Yavuz (2008) reported that dry matter yield was negatively correlated with stem ratio and leaf ratio. Icoz and Kara (2009) suggested that to optimize the silage corn yield the greater priority must be given to ear weight, leaf number and stem diameter. Carpici and Celik (2010) proved that plant height, first ear height, ear number plant^{-1}, leaf ratio, ear ratio, ear diameter, leaf area index and light interception had significant and direct effects on dry forage yield of maize. The direct and indirect effects of different quantitative traits on grain yield were studied in 90 hybrids by Geetha and Jayaraman (2000) too, and they reported that number of grains per row exerted a maximum direct effect on grain yield.

Plant breeders work with some yield components related to yield in the selection programs and it is very important to determine relative importance of such characters contributing to yield directly or indirectly. Correlation and path coefficient analyses can assist to determine certain characters to be used in the improvement of the complex character such as yield (Joshi, 2005).

It seems that former experiments for increasing forage yield of corn aren't enough so the aim of this study was to determine the relations between forage yield and other studied traits and also to determine the most effective traits and their direct and indirect effects on forage yield of corn hybrids.

Material and methods

Plant materials and experimental conditions

18 hybrids of different groups of maturing corn were evaluated in a randomized completely block design with four replications in 2012 growing seasons at the research farms of jahad Keshavarzi Center of Khosroshahr, near Tabriz, Iran (38° 02′ N, 46° 02′ E). The results obtained of experimental farm soil analysis showed that soil pH=8.47, EC=1.79 dsm^{-1}

approximately, soil texture is loamy clam and the amounts of silt, clay and sand were 32, 30, 38 respectively. Mean precipitation during the experiment was 12.6 mm and temperature mean was 19.88°. Planting done on 6th July in 2012 simultaneously second planting date on area. Each plot had 6 row 6m length with spacing 75 cm between rows and 15 cm between plants. One third of nitrogen fertilizer was used after seedling emergence, and one third at 6 to 9 leaf stage and remained one third was used when male tassel emerged. Plots were irrigated with attention to the soil moisture and environmental conditions and through the growing season weed control was done by hand weeding.

Sampling

At the harvest time to prevent border effect, two row from both sides of each hybrid eliminated and eight plants from middle rows of each hybrid were harvested and fresh-weighed insitu to determine forage yield when kernel was dough and following traits were measured: plant height, first ear height, leaf number plant^{-1}, leaf number up to first ear plant^{-1}, stem diameter, ear weight, cover leaf number ear^{-1}, row per ear, kernel per row, ear length, ear diameter, days to silk emergence and days to physiological maturity.

Software used

Analysis of correlations between different traits and regression was computed by SPSS17 package. After determining correlation coefficients and their direct and indirect effects, sequential path analysis diagram was drawn.

Results and discussion

Simple correlation between all measured treatments has been calculated and given in Table 2. Base on this matter, forage yield was positively and significantly correlated with stem diameter, ear ratio, kernel number per row, ear length, ear emergence date and days to physiological maturing. The relation of plant height with first ear height is significantly positive and its relation with ear diameter is significantly negative. Stem diameter was positively and significantly correlated with kernel number per row, ear length and days to silk emergence. Ear weight correlation with cover leaf number, kernel number per row and ear length is significantly positive. The relations between yield and yield-related components vary with the ecological conditions. Therefore, there are discrepancies among the findings of researchers who conducted their studies under different ecologies. Kara *et al.* (1999), Gallais *et al.* (1976) and Icoz and kara (2009) found positive relation between forage yield and stem diameter. Kara *et al.* (1999), Icoz and kara (2009) and Carpici and Celik (2010) proved that dry forage yield in maize was positively correlated with ear weight. The results of Ergul and Soylu (2009) indicated that there were no relations between forage yield and plant height, first ear height, ear diameter, leaf number. All these result are in agreement with our study. The relation of dry forage yield with stem diameter was found insignificant (Schmid *et al.*, 1976; Hunter, 1986; Iptas and Yavuz, 2008; Carpici and Celik, 2010); The relation of dry forage yield with plant height was positive (Gallais *et al.*, 1976; Kumar Srivas and Singh, 2004; Icoz and Kara, 2009), which all these results are opposite of our result.

Table 1. Correlation coefficient of studied traits in corn hybrids.

	plant height	first ear height	leaf number plant^{-1}	leaf number up to first ear plant^{-1}	stem diameter	Forage yield	ear weight	cover leaf number ear^{-1}	row per ear	kernel per row	ear length	ear diameter	days to silk emergence
first ear height	0.781^{**}												
leaf number plant^{-1}	0.330	0.282											
leaf number up to first ear plant^{-1}	0.452	0.499^{*}	0.733^{**}										

stem diameter	0.142	-0.123	-0.170	-0.178									
Forage yield	0.416	0.040	-0.178	-0.010	0.751**								
ear weight	-0.053	-0.324	-0.433	-0.162	0.392	0.681**							
cover leaf number ear-1	-0.157	-0.298	-0.198	-0.066	0.398	0.366	0.615**						
row per ear	-0.372	-0.301	-0.691**	-0.673**	-0.132	-0.126	0.225	0.022					
kernel per row	0.346	0.025	-0.186	0.111	0.591**	0.881**	0.684**	0.472*	-0.174				
ear length	0.168	-0.099	-0.324	-0.016	0.707**	0.867**	0.824**	0.610**	-0.089	0.878**			
ear diameter	-0.536*	-0.484*	-0.219	-0.370	-0.125	-0.117	0.443	0.435	0.484*	-0.110	0.032		
days to silk emergence	0.287	0.053	-0.124	-0.111	0.537*	0.625**	0.164	-0.102	0.018	0.523*	0.380	-0.425	
days to physiological maturity	0.230	-0.064	-0.118	-0.086	0.451	0.642**	0.266	0.121	-0.146	0.694**	0.545*	-0.418	0.794**

*, ** significant at 5% and 1%, respectively.

Table 2. Anova of multiple regression.

	DF	SS	MS
Regression	3	294.8	32.32**
Residual	14	9.12	

**Significant at 0.01 probability level.

Table 3. Stepwise regression for forage yield in corn hybrids.

Entered traits to model	Regression coefficient	T
stem diameter	33.32**	0.537
ear weight	15.61**	0.74
plant height	17.933*	0.29

*, ** significant at 5% and 1%, respectively.

Table 4. Path analysis of forage yield with related traits in corn hybrids.

		Indirect effect via			
Entered traits to model	Direct effects	stem diameter	ear weight	plant height	Correlation coefficient with grain yield
stem diameter	0.5	-------	0.198	0.053	0.751
ear weight	0.505	0.196	-------	-0.0197	0.681
plant height	0.371	0.071	-0.027	-------	0.416

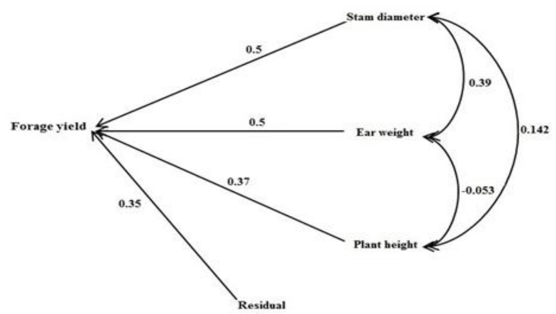

Fig. 1. Path diagram of forage yield and its effective components.

Stepwise multiple regression was used to selection of traits that have important role in the explanation of forage yield. In the regression analysis, stem diameter, ear weight, and plant height remained in the final model of regression analysis and were considered as the effective components on the forage yield (tables 3 and 4). R^2 value of the model was indicated that more than 85% of the total variations of forage yield were explained by these traits. Because of the positive and significant regression coefficients of these traits can say that increase in their values will lead to increase in the forage yield. These traits have to be analyzed for their action namely their direct effect on the forage yield and also by the indirect effects over other yield components on the forage yield (Kumar *et al.*, 2011). Path analysis was performed using results of stepwise regression model for forage yield. In this analysis, forage yield was considered as the dependent variable and stem diameter, ear weight, and plant height were the independent variable. The results of path analysis was shown that ear weight had most direct effect and stem diameter via ear weight had most indirect effect on the forage yield. The indirect effect of ear weight via plant height (and inverse) on forage yield was negative. Earlier studies indicated that ear diameter had direct effect on forage dry matter (Xu 1986; Mo *et al.* 1986; Jatimliansky *et al.* 1988). Kara *et al.* (1999) and Carpici and Celik (2010) reported that plant height and ear weight were the characters having the highest direct effects on fresh forage in corn. Ilker (2011) indicated that plant height had low and negative direct on grain yield. Icoz and Kara (2009) reported that ear weight, leaf number and stem diameter had direct effects on plant weight. Their results of stem diameter, ear weight and plant height are in agreement with our result.

Conclusion

Ear weight could be used as a selection criterion due to its highly positive direct effect on forage yield also indirect effects on all other characters. Also ear diameter and plant height could be considered as yield component as selection criteria in silage corn breeding.

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