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Correlation and Path Analysis of Morphological Traits in Different Wheat Genotypes under End Drought Stress Condition

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Abstract: In order to study cause and effect relations among some morphological traits of nine advanced wheat genotypes under end drought stress, a research had been performed in the Research Farm of Islamic Azad University, Ardabil branch. Experiment were carried by factorial split plot experiment on the basis of completely randomized blocks design with 3 replications in 2008-2009 agricultural year. Path analysis results showed that the grain yield has a direct and positive effect (0.527) over harvest index, while the straw yield has a direct and negative effect over it(-0.366). Of effective traits to grain yield, four traits including number of grain per spike (0.212), grain weight (0.408), 1000 grain weight (0.093) and biological yield (0.853) had the most direct and positive effect on grain yield. Three traits including spike length, spike weight and biological yield had the most direct effect to straw yield (respectively with 0.029,-0.191 and 0.891). With respect to the achieved results, we can use biological yield trait as a selected suitable criteria in the wheat breeding programs and production of productive varieties.

Key words: Path analysis · Correlation · Wheat · Drought

INTRODUCTION

Triticum aestivum is the most important crop in the world. Extensive extent and high adaptation of this plant as well as its diverse consumptions in the human nutrition lead to presented as the most important cereal in the world, especially in developing countries and it can provided 20 percent food resources of the world people [1]. According to evaluation which performed in the international bureau of food regulation, wheat demand rate in the world will increase significantly by 2010, while available resources to producing wheat has the limitations. So, it is predicted that there is lack of wheat supply about 100 million tone in the global market at 2020 [2]. Under cultivation about country's wheat had been estimated about 6.61 million hectare which 38.57 percent is in the irrigated way and 61.43 percent is cultivated in the dry lands. Drought stress after anthesis is a common stress in Mediterranean areas. Time of this stress is compatible with pollination and ripening of wheat grains. Extensive part of land under wheat cultivation in Iran is also part of these areas [3]. Wheat cultivation in semidry areas encountered drought stress more during last stages of growth. Drought stress may have an influence on growth and yield during difference stages of wheat growth, but it seems the most critical stage is from flowering period to complete formation of spikelets [4].

The meaning of path analysis had presented first by Wright in 1926 [5] and also it was used first in plants by Dewey Wolve to determine cause and effect relations between yield and the most important yield components. Mohammadi *et al*. [6] reported high correlation between grain yield and harvest index and called it as an important index to select productive varieties. Reynolds *et al*. [7] by evaluated different wheats in CIMMYT international center and concluded that there is a linear relation between drought stress and grain yield of wheat. Zarei *et al*. [8] in similar research which they performed about Iranian wheat laundresses, they revealed that the most effectiveness of traits is due to indirect effect of harvest index and biological yield, while these two traits had a high, direct and positive effect to grain yield. This investigation was done for determination cause and effect relations between yield and some of its related traits in wheat genotypes under end seasonal drought stress.

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MATERIALS AND METHODS

In order to evaluate morphological traits of wheat genotypes by path analysis under end seasonal drought stress condition, this project was performed in the Research Farm of Islamic Azad University, Ardabil branch located on lands of Hassan Barugh Village (5 Km west of Ardabil) at 2008-2009 agricultural year, latitude and longitude of these lands are 48.2° eastern and 38.15° north, respectively and their height from sea level is 1350 meter. Nine wheat genotypes were planted in a factorial split plot experiment on the basis of completely randomized blocks design with three replications. Each plot included three rows at a distance of 20 cm between each other and with three meter in length. There were three times spring irrigations and two times fall irrigations. In the attendances under drought stress, there was no two times irrigation after anthesis. Under-study traits in this research were included number of grain per spike, grain spike weight, straw yield, biological yield, harvest index and grain yield. Statistical analysis was comprised as simple correlation coefficients, step by step regression analysis and path analysis. For this purposes, software's like SPSS and Minitab-15 were used.

RESULTS AND DISCUSSION

Determination correlation between different traits, especially grain yield and its components and also determination of cause and effect relations between them allow breeders to select most suitable components which lead to higher yield. In these types of studies, selections on the basis of simple correlations can not lonely present optimal results. Therefore, it is essential to determine direct and indirect effectiveness of effective traits on grain yield [9, 10]. Also, path analysis of grain yield in wheat genotypes showed that number of grain per spike have the most effectiveness on spike grain yield by 1000 grain weight [11]. Amini *et al*. [12] and Golparvar *et al*. [13] reported that there is a positive and significant correlation between grain yield and harvest index, biological yield and 1000 grain weight which is inconsistent with results of this research. Also, Mohammadi *et al*. [6] reported that there is a positive and significant correlation between grain yield and harvest index and Amini and Rezaei [14], Bahari and Sabzi [15] and Moral *et al*. [16] reported that there is also positive and significant correlation between grain yield and 1000 grain weight, which these are inconsistent with results of this research. It is essential to say that in order to increase grain yield, we should more focus on traits like harvest index and biological yield which have a high correlation with grain yield and also should utilize them in breeding programs.

Path Analysis: In order to explain better the achieved results from simple correlations and stage regression and also to determine cause and effect relations to identify direct and indirect effect to components and entered traits into regression model, path analysis by the method of Dewey Wolve was applied [9]. With respect to achieved results from simple correlations and stage regression path analysis performed for three traits including harvest index, straw yield and grain yield in which the harvest index is divided into two parts, grain yield and straw yield and each of these parts is separated into relevant components on the basis of stage regression which results explain more as follow.

Harvest Index: According to results of path analysis, the direct effect of grain yield was positive and higher than direct effect of straw yield on harvest index which is negative and lower than it, but indirect effect of grain yield and straw yield on harvest index was positive and non significant (Table 2).

Table 1: Simple correlation coefficients between traits for wheat genotypes under drought stress

	Seed number per spike	Seed weight per spike	1000 grain weight	Spike length	Spike weight	Straw yield	Biological yield	Harvest index
Seed weight per spike	**896.0	1.0						
1000 grain weight	**864.0-	530.0-	1.0					
Spike length	088.0-	004.0-	168.0-	1.0				
Spike weight	**892.0	**992.0	539.0-	055.0	1.0			
Straw yield	310.0-	196.0-	392.0	029.0	191.0-	1.0		
Biological yield	053.0-	121.0	271.0	133.0-	127.0	**891.0	1	
Harvest index	561.0	*668.0	283.0-	328.0-	659.0	366.0-	0930.	1.0
Grain yield	212.0	408.0	093.0	264.0-	413.0	591.0	**893.0	528.0

* and ** Significantly at $p < 0.05$ and < 0.01, respectively

Table 2: Coefficient correlation analysis with direct and indirect effects on harvest index components

Path	Direct effect	Indirect effect	Total correlation
Direct effect of grain yield on harvest index			
Direct effect	1.143		
Indirect effect by the way of straw yield		-0.616	
Total correlation			ns 0.527
Effect of straw yield on harvest index			
Direct effect	-1.042		
Indirect effect by the way of grain yield		0.675	
Total correlation			ns –0.366
Residue		0.121	

Table 3: Coefficient correlation analysis with direct and indirect effects for straw yield components

Path	Direct effect	Indirect effect	Total correlation
Direct effect of biological yield on straw yield			
Direct effect	**954/0		
Indirect effect by spike length		024/0-	
Indirect effect by spike weight		041/0-	
Total correlation			** 889/0
Effect of spike length with straw yield			
Direct effect	173/0		
Indirect effect by the way of spike weight		018/0-	
Indirect effect by the way of biological yield		128/0-	
Total correlation			ns 028/0-
Effect of spike weight with straw yield			
Direct effect	332/0-		
Indirect effect by the way of biological yield		121/0	
Indirect effect by the way of spike length		009/0	
Total correlation			ns 191/0-
Residue		287/0	

Table 4: Coefficient correlation analysis with direct and indirect effects for grain yield

Path	Direct effect	Indirect effect	Total correlation
Effect of biological yield with grain yield			
Direct effect	**853/0		
Indirect effect by the way of seed number per spike		035/0	
Indirect effect by the way of seed weight per spike		089/0	
Indirect effect by the way of 1000 grain weight		086/0-	
Total correlation			** 893/0
Effect of seed number per spike with grain yield			
Direct effect	*676/0-		
Indirect effect by the way of biological yield		046/0-	
Indirect effect by the way of seed weight per spike		665/0	
Indirect effect by the way of 1000 grain weight		267/0	
Total correlation			ns 211/0
Effect of seed weight per spike with grain yield			
Direct effect	**742/0		
Indirect effect by the way of biological yield		103/0	
Indirect effect by the way of seed number per spike		606/0-	
Indirect effect by the way of 1000 grain weight		167/0	
Total correlation			ns 407/0-
Effect of 1000 grain weight with grain yield			
Direct effect	ns 317/0-		
Indirect effect by the way of biological yield		231/0	
Indirect effect by the way of seed number per spike		571/0	
Indirect effect by the way of seed weight per spike		394/0-	
Total correlation			ns 093/0
Residue		328/0	

* and ** Significantly at $p < 0.05$ and < 0.01, respectively

Straw Yield: According to results of path analysis, the direct effect of biological yield on straw yield was positive and significant. The direct effect of spike length was also positive and higher than direct effect of spike weight, while indirect effect of spike weight was positive by biological yield and indirect effect of biological yield was negative and lower than spike length and spike weight (Table 3).

Grain Yield: According to results of yield path analysis, direct effect of biological yield and grain yield had the most contribution in grain yield and also this effect was positive and significant and trait of number of grain per spike had a significant, negative and direct effect and 1000 grain weight showed negative and direct effect. Also, indirect effect of grain weight per spike with grain number per spike on yield as well as effect of number of grain per spike with 1000 grain weight on yield was significant and positive. Also, indirect effect of number of grain per spike with grain weight per spike on yield was negative and significant. Results of path analysis in indirect effect of 1000 grain weight with biological yield, biological yield with number of grain per spike and grain weight with 1000 grain weight had a negative correlation, but other traits had a positive effect with each other, indirectly (Table 4).

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