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Effects of Morphological Traits on Qualitative and Quantitative Yield of Bread Wheat (*Triticum aestivum* L.) Cultivars

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Determination of the best selection indices in early generations through traits having heritability higher than yield as well as correlated significantly with seed yield is one of the most important breeding procedures. In order to determination of the most yielding bread wheat genotypes, identification of the traits affective on seed and protein yield as well as parents of the best crosses an experiment was conducted during 2014-2015. The randomized complete block design with three replications was used. Bread wheat genotypes comprised; Sepahan and Roshan cultivars as controls along with 18 lines entitled M-93-3 to M-93-20. Correlation analysis showed significant and positive reltionship among sedd yield and other traits. More over, step-wise regression and path analysis designated that grain filling rate, grain filling duration and no.spike/m² were the best indirect selection criteria to increase seed yield in common wheat. Increasingly, peduncle length, no. seed/spike and no. spikelet/spike were recommended to improve spike yield while peduncle diameter, days to flowering, days to maturity and plant height for photosynthetic reservoir improvement.

Key words: Common wheat, seed yield, indirect selection, path analysis.

Ever since its domestication, wheat has been particularly important and been planted across a large extent of farms. It is a key cereal in many corners of the world, constituting the staple food of man around the globe (Shewry *et al*., 2009; Rauf *et al*., 2007). The wheat breeders are, thus, interested in attaining genotypes desirable in terms of the grain yield and other agricultural properties. To this aim, they may begin to choose from the first generations or postpone the process until the genotype will reach an advanced generation (Abdmishani and Jafari, 1997; Golparvar *et al*., 2002). The grain yield in wheat is a function of the number of spikes per unit of area, number of grains in a spike, and the grain weight. The higher grain weight is a function of its filling rate and the longer duration of the process (Sofield *et al*., 1997). In the meantime, the grain yield is positively correlated with the plant height, number of leaves, and the chaff weight. Also, the genetic correlation is high between the grain yield and grains in a spike, a thousand grain weight as well as the harvest index, also known as HI (Ibrahim, 1994). While the path analysis of common wheat, as of now *Triticum aestivum* genotypes in India, grains per spike, a hundred grain weight, and the number of claws in the plant directly affected the grain yield.

However, the plant height and duration of treatment were of direct negative effect on the grain yield (Mondal *et al*., 1997). Therefore, with

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the aim of investigating the genotypic correlation of various properties with the grain yield and specifying the best regression model in order to eliminate the ineffective properties and, consequently, path analysis, the present study aimed at determining the best selection criteria to genetically enhance the properties in question.

MATERIALS AND METHODS

The experiment was conducted in the research farm of Kabootarabad station, Isfahan province, Iran in the agricultural year 2014-2015. In the course of the experiment 18 lines of *Triticum aestivum* along with two controls, i.e. Sepahan and Roshan, were examined. The experiment was conducted in the randomized complete block design with three replications.

The experimental units included 6 rows of shrubs with 2.5 meters length at 20cm line intervals. The tillage operation was carried out in mid-September and pilot cultivation in mid-October after preparing the ground and early fertilization according to the guidelines by Soil and Water research Unit. The amount of grain for each cultivar was determined based on a thousand grain weight and 400 grains per square meter.

The preparation involved mid-March plowing followed by disc harrowing, leveling, and terracing while the agricultural operation was done as usual and carefully. Analysis of correlation coefficients, stepwise regression and path analysis by means of Dewey and Lu (1959) method were conducted for yield as dependent and the other traits as independents. Also, all the statistical analyses were conducted via SAS, SPSS and $PATH_2$ software. The respective diagrams were drawn by means of Office Excel Software.

RESULTS AND DISCUSSION

The correlation analysis showed negative and significant relationship between the grain yield and number of grains per spike (0.63). On the other hand, there exists a direct significant relationship between grain yield and spikes per square meter (0.72), biological yield (0.81), HI (0.69) and the grain filling rate (0.83) as well as protein yield (0.79).

Apparently, the properties effective on grain yield could be identified using correlation coefficient analysis and utilized as indirect selection criteria, particularly in the preliminary generations. Of course, it is necessary that the selection criteria be capable of simple and inexpensive measurement and exhibit a high correlation with the yield. Furthermore, their narrow

Table 1. Stepwise regression for grain yield (dependent variable) compared to other traits (independent variables)

Variables entered to model	b*	SE	Prob	R^2
Grain Filling Rate	26.54	2.35	0	70
Grain Filing Duration	10.89	3.65	0	78
No.Spikes/m^2	14.35	4.25	0	83
Peduncle Length	23.78	5.12	0.04	85
Intercept	-17.35	3.26	0.014	

* Regression coefficient values were t-tested relative to zero.

Table 2. Path analysis of grain yield in *Triticum aestivum* genotypes

Variables	Grain Filling Rate	Grain Filling Duration	No.Spikes/m^2	Peduncle Length	Sum of effects
Grain Filling Rate	1.46	-0.56	0.18	-0.12	0.87
Grain Filling Duration	-0.85	0.72	-0.12	-0.21	-0.37
No.Spikes/m^2	0.63	-0.32	0.22	-0.1	0.43
Peduncle Length	-0.18	-0.11	-0.19	0.32	-0.16
Residual	0.05				

sense heritability must be far greater than the yield (Falconer, 2011; Fehr, 2011).

The analysis of stepwise regression was conducted by taking into account the grain yield as the dependent variable and the rest of properties as independent variables in *Triticum aestivum* genotype. The results of processing various linear regression models, as shown in Table 1, indicated that properties like the grain filling rate, grain filling duration, number of spikes per square meter, and peduncle length pose a significant effect on the model.

On the whole, these traits accounted for 85% of the grain yield variations. The grain filing rate alone accounted for 70% of the variations. However, this is also verified by the findings by some other researchers (Subhashchandra *et al*, 2009; Gashaw, *et al*, 2007). The extension of the duration and sufficient rate for grain filling provided the time needed to transfer to the florets the photosynthetic materials reserved in the peduncle.

Consequently, together with the number of spikes and the peduncle length, these properties might better serve to improve the grain yield (Blum, 2011). Furthermore, with respect to the grain performance, the properties that had the greatest effect on the regression model, indeed, i.e. the grain filling rate, grain filling duration, peduncle length, and spike harvest index, also had the majority portion and positive coefficients.

Improvement in the grain yield seems to be capable of increasing the protein yield as well (Subhashchandra *et al*., 2009; Gashaw *et al*., 2007; Simmonds, 1995). The results of path analysis, as shown in Table 2, indicated that grain filling rate and grain filling duration had the highest direct positive effect on the grain yield. Besides, the grain filling rate and number of spikes per square meter had positive significant correlation coefficients proportionate to the grain yield which were of the same symbol as their direct effect on this property.

Although the indirect effect of grain filing rate on the grain yield through the grain filling duration was a negative value, in total, due to the sizable direct effect of this property, its correlation with grain yield was highly considerable. So, it is the best criterion for selection to improve the grain yield.

Nonetheless, using the path analysis, Moghaddam *et al*. (1997) reported a thousand grain weight and number of grains per spike could be the best indirect selection criteria to increase the grain yield in *Triticum aestivum.* Also, Ehdaie and Wianes (1989) proposed a thousand grain weight, number of grains per spike, and HI to that effect.

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