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Principal component analysis and determination of the selection criteria in bread wheat (*Triticum aestivum* L.) genotypes

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ABSTRACT: Wheat (*Triticum aestivum* L.) is the major cereal crop in Iran on which the food security rests. Determination of the best selection criteria is the most important aim in wheat breeding programs. In order to evaluate and classify morphological and morpho-physiological traits of bread wheat genotypes, 18 cultivars were sown in randomised complete block design with three replications. Principal component analysis indicated that four important components accounted for about 76 percent of the total variation among traits in bread wheat cultivars. The first component assigned 38 percent of total variation between traits and was significantly related with spike yield and it's components. Therefore, this component was regarded as spike seed yield. Other components accounted for 15, 12 and 11 percent of variation between traits and were entitled as tillering, seed weight and seed yield components, respectively. Overall, results revealed importance of spike and seed yield components in breeding of spike yield and seed production ability in nread wheat cultivars.

Key words: Bread wheat, Principal Component Analysis, Seed Yield, Selection Criteria.

INTRODUCTION

Selection for seed yield and production of the cultivars with high yield potential is the main objective of breeding programs. Many researchers (Quarrie et al., 1999; Richards, 1996) believed that genetic improvement of seed yield must be done via genetic improvement of physiological traits. In determining the potential of genetically different lines and cultivars, breeders have to observe many different characters that influence yield. Accurate evaluation of these characters is made more difficult by the genotype by environment interaction (Tadesse and Bekele, 2001).

Harvest index and biological yield introduced as the most important traits in this connection (Quarrie et al., 1999). In small-grained cereals increase in harvest index may causes yield improvement, without increase in plant water use (Quarrie et al., 1999, Richards, 1996). Indirect selection in early generations through traits correlated with seed yield is one of the most important strategies in plant breeding.

Principal component analyses helps researchers to distinguish significant relationship between traits. This is a multivariate analysis method that aims to explain the correlation between a large set of variables in terms of a small number of underlying independent factors.

Briggs and Shebeski (1972) reported change in number of factors and its related characters by the genotype by environment interaction. In this research, seven factors were extracted that explained 90.7% of variation between traits. Walton (1971) found four components that explained 98.4% of variability between traits. First component named as flag leaf area, second as photosyntetic, third as yield and fourth as spike density.

Mohamed (1999) determined two factors for explain relation of traits in bread wheat genotypes. These factors accounted for 80.8% of variation between traits and entitled as seed yield and spike density, respectively.

Ledent and Moss (1979) evaluated relation between yield and its components in winter wheat cultivars using factor analysis. They reported strong relation of yield with other traits.

Leilah and Al-Khateeb (2005) studied bread wheat genotypes under drought stress condition using different multivariate techniques. In this study revealed that three factors accounted for 74.4% of total variation

exist between traits. First factor related with number of spikes/plant, 100-seed weight, spike yield and biological yield. Therefore, this factor was regarded as a yield factor. Second factor was strongly associated with plant height, spike length and number of seed/spike. This factor entitled as a biomass factor. Third factor has significant loading factor for spike diameter and harvest index. This factor regarded as a harvest index factor.
This study was cinducted in order to determine the dependence relationship between yield, yield components and some morphological characters of bread wheat cultivars using principal component analysis.

MATERIALS AND METHODS

In this study, 18 bread wheat cultivars randomly selected from collection were planted at the beginning of November 2011 at the Research field of Jehad and Agriculture research institute of Isfahan, Isfahan, Iran. The plots were 2m long and 0.4m apart with 6 planting rows per plot. Amount of precipitation was 135mm. In spring 2012, measurements for 12 traits; seed yield (g), plant height (cm), No.tiller, days to tillering, days to flowering, days to ripening, No.spike, spike weight (g), spike length, number of seed/spike and spike yield (g) were achieved on 10 normal plants randomly selected from each plot.

Relationships between traits investigated using simple correlation coefficients. Then it is assumed that each of the variables measured depends upon the underlying factors but is also subject to random errors. The principal component analysis method explained by Harman (1976) was followed in the extraction of the components. The percentage variability explained by each component were determined (Harman, 1976; Sharma, 1996; Tadesse and bekele, 2001). Correlation and principal component analysis as well as biplot graphical display were performed using Statgraphics and $SAS_{9.1}$ softwares for all the traits of bread wheat cultivars.

RESULTS AND DISCUSSION

Correlation coefficients for all the traits showed that seed yield positively correlated with all the other traits. Correlation of spike yield with another traits was positive and highly significant except with spike weight and peduncle length. Principal component analysis indicated that only 4 first components, which account for 76% of the total variance are important (Table 1 and Figure 1).

The first principal component, which accounted for about 38% of the variation, was strongly associated with spike weight, number of seed/spike, spike yield and the other spike yield components (Table 1 and Figure 1). This component was regarded as a spike yield component since it included several traits, which are components of spike yield. The sign of the loading indicates the direction of the relationship between the component and the variable.

The second principal component, which accounted for about 15% of the total variation was named as tillering component because it consisted of days to tillring and plant height (Table 1).

The third principal component was named seed weight component since positively correlated with 100-seed weight and no.tiller. This factor accounted for 12% of the variation (Table 1 and Figure 1). The fourth principal component, accounted for 11% of the variation. In this component, correlation of seed yield and its components were highly positive. Because of that this component entitled as seed yield factor (Table 1 and Figure 1).

Correlation analysis helps to determination effective traits in order to indirect selection superior genotypes. On the other hands, principal component analysis is suitable multivariate technique in identify and determination of independent principal components that are effective on plant traits separately. Therefore, correlation and principal component analysis helps breeders to genetic improvement traits such as yield that have low heritability specifically in early generations via indirect selection for traits effective on this (Quarrie et al., 1999; Mohamed, 1999; Tadesse and Bekele, 2001; Golparvar et al., 2003 a,b; Leilah and Al-Khateeb, 2005; Golparvar et al., 2006).

In this study revealed that in order to genetic improvement of spike yield the breeders could be selected the superior cultivars having the highest no.spike, spike weight, spike length, number of seed/spike and spike yield. Furthermore, selection of the genotypes with the highest amounts of seed yield and its components are recommende as on of the best breeding strategy to genetic impronement of seed yield in bread wheat (Table 1 and Figure 1). These results have been emphasized in many researches (Quarrie et al., 1999; Mohamed, 1999; Golparvar et al., 2003 a,b; Leilah and Al-Khateeb, 2005).

In order to genetic improvement of spike yield selection via traits plant and spike harvest index and number of seed/spike in non-drought stress condition and traits spike weight, number of seed/plant, biological yield, number of seed/spike and 1000-seed weight in drought stress condition were proposed by Golparvar et al. (2006) and Arain et al. (2011). Increasing seed yield in drought and non-drought stress condition could enable breeders to better realize the desired increment in drought stress resistance of bread wheat genotypes.

Traits number of seed/plant and peduncle length can improve assimilate transmission in bread wheat genotypes. Surprisingly, reverse effect of spike weight and spike length that could decrease spike density. This probability because of competition between spikelets for receive assimilates that decrease seed weight as well as spike density in stress condition (Mohamed, 1999; Leilah and Al-Khateeb, 2005). Results of correlation analysis also emphasized on positive relation of spike length with 1000-seed weight.

In conclusion, indirect selection via traits no.spike, spike weight, spike length, number of seed/spike and spike yield and seed weight which have higher heritability relative to seed yield especially in early generations and strongly associated with this trait is emphasized in this study for genetic improvement of plant yield. Chowdhry et al. (1999), Quarrie et al. (1999), Golparvar et al. (2006) and Arain et al. (2011) have reported similar results for breeding these important traits in bread wheat genotypes.

Table 1. Principal component analysis for the measured traits in bread wheat cultivars

Principal component	Variance (%)	Cumulative variance (%)
1	38	38
2	15	53
3	12	65
4	11	76

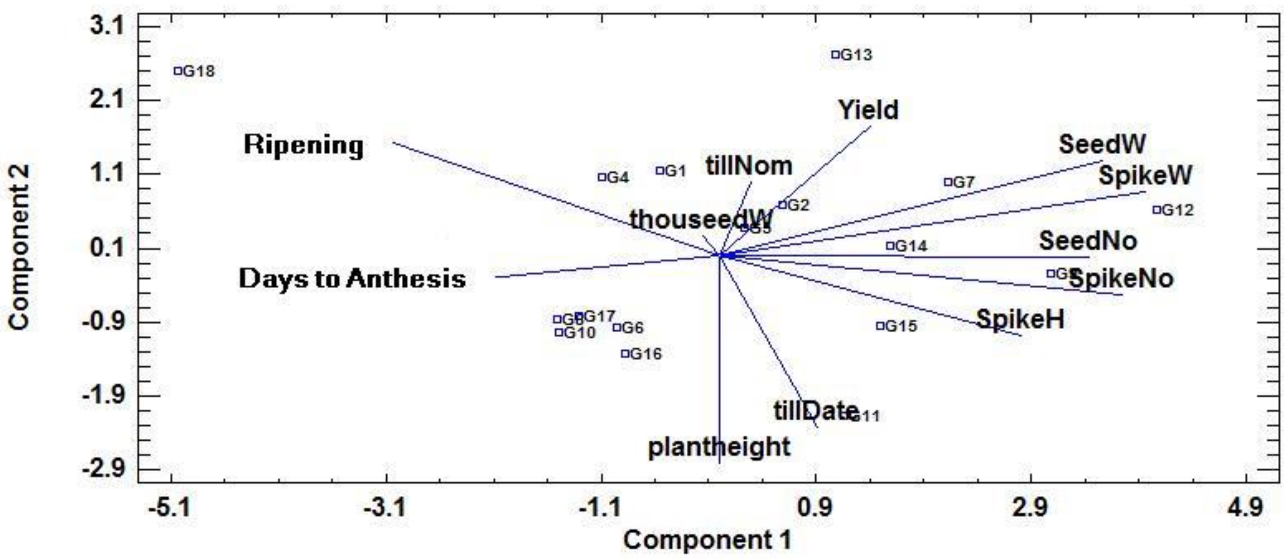

Figure 1. Biplot graphical display of the measured traits in bread wheat cultivars

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