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Full Length Article

Effects of Direct Selection Process for Plant Height on some Yield Components in Common Wheat (*Triticum aestivum*) Genotypes

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Abstract

In this study, estimation of narrow sense heritability, genetic correlations and relative effects of direct versus indirect selection were aimed for peduncle length, spike length, number of spikelet per spike and number of kernels per spike as selection was applied for shorter plant height in common wheat population of (Golia × Atilla-12) cross. While the indirect effect of direct selection for plant height was observed negative on number of kernels per spike, positive effect was obtained on peduncle length. It was understood that selection of peduncle length can be done indirectly through the selection for short plant height in the (Golia × Atilla-12), but while it had no effect on other components. Therefore, it was concluded that direct selection for short plant height can be done successfully, and on various selection practices and studies are necessary for the spike length, number of spikelet per spike and number of kernels per spike. © 2013 Friends Science Publishers

Keywords: Common wheat; Genetic correlation; Heritability; Direct and indirect selection methods

Introduction

Determination of parents, which have combination of required properties is the most important and initial step in a plant breeding program. The secondary important phase is selection of the plants contained desirable properties with higher heritability in F_2 generation (Richards, 1996). The narrow-sense heritability is the ratio of additive genetic variance to the total phenotypic variance. It is related with relative effects of inheritance and environment. The most important function of the heritability of metric characters is its predictive role, expressing the reliability of the phenotypic value as guide to the breeding value (Falconer and Mackay, 1996). Heritability of an investigated yield components obtains useful information about transferring of the component from parents to next generations, thus success of selection is increased (Khan *et al.*, 2003). Reliable estimations of genetic and environmental variations have a great importance for determination of heritability and the degree of genetic advance as the result of selection (Ghandorah and El-Shawaf, 1993; Rauf *et al.*, 2009). It was pointed out that heritability is not enough for a successful selection in next generations. However, it has great importance to determine of genetic improvement, which expresses degree of advance obtained from a trait under a certain selection pressure. Therefore genetic gain is an important parameter for a breeder in plant breeding programs (Shukla *et al*., 2004; Eid, 2009; Rahman *et al*., 2012).

Selection for a trait in plant breeding can be held in two ways; direct selection by measuring this trait as a classical method or indirect selection considering with other traits. Indirect selection was described as an estimation of alteration in second trait as a result of selection for main trait in the same environment by Hill *et al.* (1999). Indirect selection method is not widely used in a large scale breeding programs because of limited information about indirect effects of the traits (Richards, 1996; Prasad *et al*., 2007). Efficiency of indirect selection by comparison with direct selection in the same selection intensity depends on genetic correlation between direct and indirect traits and heritability of indirect traits (Falconer and Mackay, 1996; Prasad *et al.*, 2007).

In the frame of the main purpose to develop shorter statue of the common wheat cultivars for rainfed conditions to cope with drought effects, determination of heritability for some yield parameters, genetic correlations and relative effect of indirect selection comparing to direct selection were the aims of this study.

Materials and Methods

In this research, which was aimed to improve a common wheat *(Triticum aestivum* L.) cultivar having middle plant height regarding its parents, common wheat varieties Golia and Atilla-12 originated from Italy and Hungary respectively were crossed in 2005-2006 growing season. Main differences between these varieties are that Golia has considerably short plant height than the Atilla-12 and it has lower values than Atilla-12 for all agronomical characters except for leaf area. F_1 populations and their parents were grown in the 2006-2007 and also their backcrosses were obtained in the same year. Single plant selection from F_2

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population was made in 2007-2008 growing season. The parents, all generations and also selected lines were sowed according to completely randomized block design with three replications. The trials were conducted at the experimental area of Department of Field Crops, Faculty of Agriculture, Ege University. Each plot consisted of two rows 2 m long spaced and 30 cm apart, where the seeds were drill-planted 10 cm spacing within the row.

Observations were done in P_1 (10 plants), P_2 (10 plants), F_1 (90 plants), F_2 (111 plants), BC_1 (40 plants), BC_2 (40 plants) and 17 F_3 plants selected according to 15% selection intensity, also measurements were made for plant height (cm), peduncle length (cm) (the length from below the spike to node of flag leaf), spike length (cm), spikelet number per spike and number of kernels per spike as described by Acevedo *et al.* (2002).

Using Warner (1952)'s method, narrow-sense heritability (h^2) for all characters and expected direct genetic gains (Allard, 1964) besides indirect genetic responses (Falconer and Mackay, 1996) were determined, and the genetic correlations (r_G) between plant height and other traits were calculated using covariance method which was according to Yıldırım and İkiz (1973). Similarly, relative effects of direct selection for plant height component on indirect selection to other traits were calculated as proposed formula by Falconer and Mackay (1996).

$$CR / R = r_G \times h_x / h_y$$

Where,

CR: response of indirect selection.

R: response of direct selection.

h_x: square root of narrow-sense heritability for the plant height.

h_y: square root of narrow-sense heritability for the second trait.

Results and Discussion

Mean values of plant height, peduncle length, spike length, number of spikelet per spike and number of kernels per spike of the parents, F_1, F_2, BC_1, BC_2 and F_3 (selected) generations of Golia × Atilla-12 crosses were presented in Table 1. It was observed that Golia had lower values than Atilla-12 in terms of examined yield components. Also, except for number of kernels per spike the mean values of all examined traits in the F_1 were higher than those of the F_2. It was pointed out that except for the number of kernels per spike the mean values of all other traits in the backcross generation with Atilla-12 (BC_2) were higher than the mean values of same traits in the backcross generation with the Golia (BC_1). Erkul and Ünay (2009a) determined that BC_1 generation had higher mean values for the number of spikelet per spike and number of kernel per spike while BC_2 generation had higher mean value for the spike length in Golia × Cumhuriyet 75. Erkul and Ünay (2009b), the backcross generation with Cumhuriyet 75 was identified to have higher mean values for plant height and peduncle length.

Seventeen plants, which had shorter plant height, were selected considering plant height in F_2 generation consisted of 111 single plants (15% selection intensity). F_3 progenies of selected 17 plants were grown and the same traits were measured in these progenies. Plant heights of the F_3 progenies of the selected 17 plants were obtained as lower than the mean plant height in F_2 generation. However, the mean values of peduncle length and spike length in F_3 generation were determined higher than the mean values of same traits in F_2 generation, the mean values of number of spikelet per spike and number of kernel per spike in F_3 generation were observed as very low (Table 1). These changes may arise from the different inheritance pattern of the other traits when selection was done based on plant height. Besides, these phenotypic values in F_3 generations could be result from effects of (genotype-environment) interaction and very low genetic correlations between plant height and other traits along with genetic effects. Schmalhausen (1949) pointed out that there were strong interactions among all plant characters thus unexpected changes could be occurred in the unselected traits under selection.

Plant height of Golia × Atilla-12 was aimed to reduce through selection for shorter plant height in this study. The values of narrow sense heritability that used to estimation of genetic advance and indicate the proportion of additive variance were identified at very high level for peduncle length and number of spikelet per spike (Table 2). From previous studies in common wheat Memon *et al.* (2007) and Erkul and Ünay (2009a) implied that heritability values of number of kernel per spike varied by crosses. Eid (2009) reported low heritability value, while Laghari *et al.* (2010) found high heritability value for same trait. In early heritability studies for peduncle length, Khan et al. (2003) and Erkul and Ünay (2009b) stated high values and Laghari *et al.* (2010) reported medium heritability values. Also, Memon *et al.* (2007) and Mangi *et al.* (2010) obtained different heritability values for the number of spikelet per spike in different cross combinations.

The expected genetic advance from direct selection for shorter plant height in F_2 population occurred 100% in F_3 population (Table 1 and 2) and the genetic advance values for other traits except for number of spikelet per spike were observed relatively higher (Table 2). Indirect genetic advance values of other traits were investigated by selecting genotypes having short plant height in the study. When the relations between direct and indirect genetic advances values are examined, these values are very close to each other for number of kernel per spike, however quite different for other components. Otherwise, genetic correlations of plant height between peduncle length and number of kernels per spike were higher than genetic correlations of plant height between other traits (Table 2). Khaliq *et al.* (2004) reported different results compare to our findings and found negative

Table 1: Mean values and standard errors for some yield traits in Golia × Atilla-12

Generation	Plant height (cm)	Peduncle length (cm)	Spike length (cm)	Spikelet number per spike	Number of kernels per spike
Golia	51.3±1.25	18.3±0.75	9.4±0.31	19.8±0.55	29.6±0.55
Atilla-12	94.5±1.00	33.8±0.66	12.7±0.26	20.8±0.26	33.8±2.61
F_1	83.4±0.56	29.8±0.25	10.6±0.11	19.3±0.25	38.9±0.92
F_2	72.8±1.12	26.4±0.50	9.9±0.14	18.5±0.33	40.7±1.26
BC_1	71.1±0.82	27.1±0.48	9.3±0.19	19.1±0.36	46.8±1.34
BC_2	80.0±1.30	28.6±0.71	11.8±0.26	20.7±0.46	45.5±1.81
F_3 (Selected)	66.0±3.65	29.6±2.45	14.7±0.90	17.4±1.24	25.5±4.15

Table 2: Estimation of genetic parameter for examined yield components

Variables	Plant height (cm)	Peduncle length (cm)	Spike length (cm)	Spikelet number per spike	Number of kernels per spike
Narrow-sense heritability (h^2)	0.46	0.69	0.51	0.70	0.02
Expected genetic gain (*R*)	5.96	4.31	1.02	2.87	0.35
Expected indirect genetic gain (*CR*)	–	1.06	0.05	0.17	0.29
Genetic correlation (r_G)	–	0.40	0.05	0.07	0.15
CR/R	–	0.33	0.05	0.06	0.73

correlations (r = -0.24 and r = -0.23, respectively) of plant height between these two traits.

CR/R values, which show effects of indirect selection on other traits of direct selection for plant height, could be effective for number of kernel per spike and peduncle length. However, it is understood that selection of shorter plant height cause to reduce number of kernel per spike, when the values of number of kernels per spike in F_3 generation are considered (Table 1). Nevertheless, F_3 generation values for peduncle length were observed higher than F_2 generation values.

Conclusion

Our results showed that effective selection of peduncle length through direct selection for short plant height can be made successfully. However, the results also showed that there is no any influence of indirect selection for spike length, spikelet number per spike and number of kernels per spike. In conclusion, effective direct selection for short plant height and indirect selection for peduncle length can be done but separate selection procedures should be implemented for other traits.

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