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Research article

RELATIONS OF AGRONOMIC TRAITS IN SOME HYBRIDS OF SUNFLOWER *(HELIANTHUS ANNUUS* L.)

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ABSTRACT: To investigate the relations of agronomic traits in some hybrids of sunflower, 20 hybrids obtained from line × tester crosses of five cytoplasmic male sterile lines with four fertility restorer lines were evaluated in a randomized complete block design with three replications at Agricultural Research Station of the University of Tabriz. Data were collected for agronomic traits such as date of flowering initiation, date of flowering end, plant height, stem diameter, head diameter, date of maturity, head dry weight, number of seeds per head, empty seed number per head, grain weight per head, grain yield, 1000-seed weight and oil content. Positive and significant correlation were found between the grain yield and stem diameter, head diameter, number of seeds per head, plant height, grain weight per head, head dry weight; and between the oil content with the grain weight per head and number of seeds per head. Multiple regression analysis and path analyses of grain yield with yield components and some agronomic traits indicated that head diameter, number of seeds per head and stem diameter are important factors demonstrating grain yield. It seems that indirect selection for grain yield in segregating generations through these traits will be effective for extracting desirable genotypes.

Key words: sunflower, path analysis, correlation, regression analysis

INTRODUCTION

The Relationships between the traits is important in plant breeding, because it is evaluating rate and type of relation among two or more traits. The correlation of traits can be originated from gene linkage or the existence of a genetic interaction with an environmental component. Depending on whether they are positive or negative correlated, these traits have an influence on selection route. The positive correlations among useful traits are suitable, due to the fact that they do not limit the intensity of selection, while in negative correlation, the selection of traits around the mean is obligatory. Furthermore, multiple selections in those traits that are selected simultaneously, often brings down the intensity of selection [18]. Due to the fact that the calculation of simple correlations does not provide detailed information about cause and effect relationship in the appearance of a trait, it is suitable to use the path analysis, which was created by Swall Wright in 1934, for analyzing simple correlations to direct and indirect effects. It should be considered that path analysis method does not apply for demonstrating the cause and effect relations in observed correlations among a group of related variable, but this method should be applied through designing cause and effect system which is based on prior knowledge with sure hypothesis [3]. In the other hands, one of the useful and functional methods for analyzing genetic and phenotypic correlations and discovering the direct and indirect effects is adapting path coefficient. The path analysis is one of the ways of studying the principle of causality among groups of variables [4]. In fact coefficient of correlation between each causation variable and effect variable is divided into two parts: one of them is direct effects and another one is in direct effects. For this reason, coefficient of correlation can not be judged by itself [17]. A non significant correlation reported between grain yield and oil yield by Kaya et al. [10]. But Hladni et al. [9] and Ozer et al. [15] reported a significant correlation between grain yield and oil yield. It has been indicated that there is a high correlation between the stem diameter and oil yield [Ozer et al., 15]. In the experiment conducted by Zamani et al. [21], through using stepwise regression method, it is revealed that the 1000-seed weight and number of seeds per head justify 80% and 15% of the changes of grain yield, respectively.

Moghaddam et al. [13] reported that stem diameter and head diameter were the most effective traits in expression the regression equation in which the number of full seed has been considered as the dependent variable. Shabana [19] concluded that in grain yield, first the 1000-seed weight and then number of seeds per head and plant height play the main role. Gaffari [6] reported that the number of full seed and 1000-seed weight are the most effective traits on the yield of seed and oi. This study aimed at finding the relation of traits with each other and recognizing the best effective traits in grain yield in sunflower.

MATERIALS AND METHODS

The experiment was conducted in 2010 at Agricultural Research Station of the University of Tabriz, located in Karkaj area as far as 12 kilometers to the east of Tabriz. Plant materials included 20 single cross hybrids obtained from the line × tester crosses of five cytoplasmic male sterile lines with four fertility restorer lines in the research center of agricultural and natural resources of Khoy (Table 1). The experiment was conducted in randomized complete block design with three replications. The field was prepared in May 2010. Planting was conducted in May 30th and 31th. The row-to-row spacing was 0.6m and plant-to-plant spacing was 0.25m. Date of flowering initiation, date of flowering end, stem diameter, plant height, head diameter and date of maturity was measured during the growing season. Head dry weight, number of seeds per head, empty seed number per head, grain weight per head, grain yield based on each plant, 1000-seed weight and oil content, was obtained after harvesting. For preventing the damage made by birds, the plants of each plot were covered after pollination to protect them from the possible damage of sparrows. After ripening, the plants were harvested and the seeds separated from the plant manually. The SPSS16 were used for statistical analysis.

Table 1-Sunflower hybrids obtained from the line × tester crosses of cytoplasmic male sterile lines with fertility restorer lines

Hybrids	Inbreds	Restorers		Hybrids	Inbreds	Restorers
1	52	R23		11	222	R26
2	52	R25		12	222	R50
3	52	R26		13	330	R23
4	52	R50		14	330	R25
5	148	R23		15	330	R26
6	148	R25		16	330	R50
7	148	R26		17	344	R23
8	148	R50		18	344	R25
9	222	R23		19	344	R26
10	222	R25		20	344	R50

RESULTS AND DISCUSSION

Phenotypic correlation coefficients of measured traits in hybrids of sunflower are presented in Table 2. Grain yield d is a complicated trait that is a function of the changes of other different traits which is called yield components. Recognizing and understanding relations between traits which have high correlation with yield are very important. Grain yield with traits of stem diameter [8, 7] head diameter [8, 7, 2] number of seeds per head [8, 7, 20] plant height [5, 11, 16, 19], head dry weight and grain weight per head showed positive and significant correlation. In this study, the correlation of grain yield with oil content and 1000-seed weight was not significant. Oil content with grain weight per head and number of seeds per head had a positive and significant correlation and with 1000-seed weight negative and significant correlation. 1000-seed weight with empty seed number per head had a positive and significant correlation and with number of seeds per head had a negative and significant correlation. The 1000-seed weight is one of the most important components of yield and its high 1000-seed weight increase the yield. The 1000-seed weight depends on four factors such as the term of seed filling, the number of the active leaves in the term of reproduction, leaf surface and stem dry weight [12]. Number of seeds per head was positively correlated with stem diameter, head dry weight and grain weight per head but, a negative and significant correlation with the empty seed number per head. The grain weight per head with the head diameter, stem diameter and plant height had a positive and significant correlation. There was a positive and significant correlation between head diameter with stem diameter and plant height. The increase in head diameter can result in the increase in the number of seeds per head and increase in the yield [12]. There was a positive and significant correlation between stem diameter and traits of date of flowering initiation, date of flowering end, date of maturity and plant height. There was a positive and significant correlation between traits of date of flowering initiation, date of flowering end and date of maturity.

Nabipoor et al. [14] referred to the positive correlation between the period of time of growth and the time interval for the seed to be filled. Better recognition of the nature of relations between traits through other statistical procedures such as multiple regression analysis and path analysis can provide more exact measures for selection. The result of stepwise regression for grain yield is presented in Table 3. The estimates related to the standardized regression coefficient are also being presented in Table4. The value of VIF which is a measure for determining multiple collinearity was low for all of the traits and it has been concluded that there is no multiple collinearity among attributes. In the final equation, the traits of the stem diameter, head diameter and number of seeds per head with standardized regression coefficient of 0.291, 0.402 and 0.319, respectively, had a significant effect on grain yield, and the rest of the traits did not present in the final equation. The high corrected coefficient of determination (r^2 =0.674) for the equation shows justification of grain yield through these traits.

Table 2- Phenotypic correlation coefficients for quantitative characters in sunflower

	SF	EF	H	SD	HD	MAT	WDH	N FS	NS	SW	Y	W1000	POIL
SF	**1**												
EF	**0/96***	**1**											
H	**0/38^{ns}**	**0/51***	**1**										
SD	**0/47***	**0/58****	**0/75**	**1**									
HD	**0/06^{ns}**	**0/15^{ns}**	**0/50***	**0/59****	**1**								
MAT	**0/64****	**0/69****	**0/25^{ns}**	**0/55****	**0/25^{ns}**	**1**							
WDH	**0/15^{ns}**	**0/27^{ns}**	**0/47***	**0/77****	**0/68****	**0/36^{ns}**	**1**						
NFS	**-0/44***	**-/35^{ns}**	**0/17^{ns}**	**-0/15^{ns}**	**0/42^{ns}**	**-0/31^{ns}**	**-0/08^{ns}**	**1**					
NS	**0/37^{ns}**	**0/41^{ns}**	**0/27^{ns}**	**0/62****	**0/19^{ns}**	**0/22^{ns}**	**0/75****	**-0/44***	**1**				
SW	**0/19^{ns}**	**0/31^{ns}**	**0/46***	**0/76****	**0/54****	**0/33^{ns}**	**0/96****	**-0/18^{ns}**	**0/83****	**1**			
Y	**0/18^{ns}**	**0/30^{ns}**	**0/54****	**0/82****	**0/72****	**0/32^{ns}**	**0/93****	**-0/04^{ns}**	**0/74****	**0/93****	**1**		
W1000	**-0/24^{ns}**	**-0/14^{ns}**	**0/13^{ns}**	**-0/06^{ns}**	**0/34^{ns}**	**0/20^{ns}**	**-0/15^{ns}**	**0/45***	**-0/70****	**-0/26^{ns}**	**-0/15^{ns}**	**1**	
POIL	**0/088^{ns}**	**0/11^{ns}**	**0/25^{ns}**	**0/24^{ns}**	**-0/23^{ns}**	**0/10^{ns}**	**0/38^{ns}**	**-0/33^{ns}**	**0/57****	**0/45***	**0/29^{ns}**	**-/53****	**1**

SF (date of flowering initiation), EF (time of flowering end), H (plant height), SD (stem diameter), HD (head diameter), MAT (date of maturity), WDH (head dry weight), NFS (empty seed number per head), NS (number of seeds per head), SW (grain weight per head), Y (grain yield), W1000 (1000-seed weight), Poil (oil content).
ns ، * ، ** Nonsignificant, significant at 5% and 1% levels, respectively

The result of path analysis for grain yield with the traits of head diameter, number of seeds per head and stem diameter is presented in Table 5. Head diameter, number of seeds per head and stem diameter have had the most direct effect on grain yield. Stem diameter was effective in grain yield mainly indirectly and through having an effect on head diameter and number of seeds per head. Various studies have shown the effect of the number of seeds per head on yield. In Gaffari's [6] experiment, the effect of full seeds was more than 1000-seed weight on the justification of grain yield. In another experiment, Alvarez et al. [1] reported that the most direct effect on grain yield relates to the effect of the 1000-seed weight, plant height and head diameter with coefficient of 0.446, 0.260 and 0.109, respectively. While in this experiment the role of a number of seeds per head was more effective than the 1000-seed weight on the final justification of grain yield. It seems that different examined genotypes and environmental conditions are the reasons of difference in the role of traits that have influence on grain yield.

Table 3- Stepwise regression analysis for grain yield in sunflower hybrids

Source of variation	Degree of freedom	**Mean squares**
Regression	3	**177/73
Deviation from regression	56	42/63
Total	59	

Table 4- Standardized regression coefficient, value of VIF in sunflower hybrids

	Stem diameter	**Head diameter**	**Number of seeds per head**
Standardized regression coefficient	**0/9**	0/40	0/32
Value of VIF	1/68	2/84	1/93

Table 5- Direct and indirect effects for effective agronomic traits in grain yield in sunflower

Trait	Direct effect	indirect effect trough			Phenotypic correlation of independent variants with dependent variant (grain yield)
		Stem diameter	Number of seeds per head	Head diameter	
Head diameter	0/402**	0/172	0/060	-	0/718
Number of seeds per head	0/319**	0/182	-	0/076	0/740
Stem diameter	0/291*	-	0/199	0/237	0/820

ns ،* ،** Nonsignificant, significant at 5% and 1% levels, respectively

CONCLUSION

From the above mentioned results it would be reasonable to suggest that a breeder engaged in the improvement of sunflower yield must pay more emphasis on the head diameter, number of seeds per head and stem diameter through in the breeding programs.

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