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Evaluation Correlated Traits for Seed and Oil Yield in Sunflower (*Heliathus annuus* L.) Through Path Analysis in under Condition Relay Cropping

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Abstract: This experiment with nine genotypes consist of 8 sunflower hybrid along with Record cultivar were sown in a randomized complete block design with 4 replication at the experiment farm of uremia university in 2004. Twelve quantitative traits (Days to 50% flowering, days to physiological maturity, plant height, number of leaves per plant, head diameter, number of filled seed per head, 1000 seed weight, kernel percentage, unfilled seed percentage, oil percentage, seed tiled, oil yield) were evaluated and measured. Among evaluated traits, number of filled seeds/head (0.754**) 1000 seed weight (0.732**) and head diameter (0.723**) had highest positive and significant correlation with seed yield and seed yield (0.843**) had highest positive and significant correlation with oil yield. Stepwise regression for seed and oil yield indicated that five traits including number of filled seed/head, 1000 seed weight, head diameter, oil percentage. Regarding the direct and indirect effects of each effective traits in oil and seed yield, it seems that screening with emphasis of the number of filled seeds/head, 1000 seed weight and head diameter could be effected on maximum.

Key words: Sunflower, path analysis, regression, seed and oil yield

INTRODUCTION

Researche on sunflower oil plant is developing in our country and other parts of the world.

Many studies have been done to determine the rate of correlation between different traits in sunflower. In the experiments done by Tahir *et al*. (2002) the maximum correlation of seed yield have been reported with the number of filled 1 seed/head. The experiment results of Ozer *et al*. (2003) shows that seed yield, stem diameter, number of day to physiological maturity have maximum correlation with seed yield, respectively. The significant and positive correlation of oil percentage with the number of physiological maturity have been reported in the experiments done by Khan *et al*. (2005) but in their studies there was significant and negative correlation between oil content and the number of filled seed in head. To study traits relations, multiple regression analysis was applied. Chikadivayeh and Nadine (2002) experiment on yield and its parts in 54 sunflower genotypes showed that head oil yield and 1000 seed weight have maximum direct effect on seed yield/head. From the other hand under this experiment head oil yield causation analysis showed that maximum direct effect related to head seed yield and other traits were not significant except seed yield per head and direct and indirect effects of oil percent. In Tahir *et al*. (2002) it was reported that maximum direct effect on seed yield was number of filled seed per head and head diameter, respectively. The purpose of mentioned study is to recognize existing correlations between oil yield with other effective cultivation traits and also the study of direct and indirect effects of these traits with oil yield and to gain information about cause and effect relations between them.

MATERIALS AND METHODS

This experiment was done in the experiment farm of Uremia University in 2004 this region is in the latitude 37° and 32' north and longitude 45° and 5' east and its height is 1313 above sea level. Climate of the region is cold and semidry and the average rainfall and the area temperature according to 17 years statistics is 184 mm and 12°C, respectively Region soil texture is clay loam, Electric Conduct (EC) equal to 1.3 mm cm^{-1} and P.H is 8.2 in 0-3 cm depth of the soil. In this study 9 type of sunflower includes 8 hybrid named: Alexander, Pr, Boogy Melody, Tekny, Sanbro, Jazzy, Arena, Euroflor and type of commercial seeds named record, were evaluated and studied in a from of randomized complete blocks

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with 4 repetitions. The activities of preparing lands including ploughing, disking, grading and furrowing was done after clover is cropped in spring and types was cultivated in 5 line of 5 m with 60 cm line interval and 20 cm bushes interval in 8th of June. Before planting in order to suppress weeds, Terfelan herbicide with the amount of 2.5 L ha^{-1} was used. During growth season hand-weeding was done for necessary times, too.

Planting was performed with hand. One day after planting, irrigation was done in the from of oozing and totally 5 times irrigation was done with regard to existing humidity in soil and bush leaf condition.

In this study, 5 bushes was selected from the middle part of each plot randomly and all traits of examined cases including seed without kernel percentage, kernel percentage, 1000 seed weight, number of filled seed in head, head diameter, number of leaver, height of bush, date of maturity, date of flowering and seed yield was noted. The oil percentage of the samples to be considered in oil analysis laboratory was computed by NMR method and oil yield was determined according to oil percentage and seed yield. In order to causation analysis firstly simple correlation coefficients between traits was computed. Then in order to access the most appropriate regression equation with several variables and introduce variables that are actually effective in yield, step-wise regression method was used by SPSS software.

RESULTS AND DISCUSSION

Correlation between traits: Due to lack of importance of other cultivation traits connected with oil and seed yield in presence of introduced traits in regression model, Table 1 includes only those variables that have maximum effect on oil and seed yield. In the genotypes under study the correlation between head diameter and 1000 seed weight was significant and positive (Table 1). Also, Tahir *et al.* (2002) and Khan *et al.* (2005) have refereed to the significant and positive correlation of head diameter and 1000 seed weight but in Ozer (2003) experiment the correlation of head diameter and 1000 seed weight was insignificant. Regarding highest correlation of oil and seed yield, one can take into consideration the measured traits correlation with seed yield and other traits excluding oil percentage shown significant and positive correlation with seed yield. Similar reports in this case (Tahir *et al.*, 2002) had been presented. Results showed that oil percentage trait have no significant correlation with none of introduced traits in the model. This case is also observable in others reports (Khan *et al.*, 2005; Ozer *et al.*, 2003).

Step-wise regression: Regarding dependent variable of oil and seed yield, the rate of measured traits participation as a independent variable on these traits was computed by multiple stepwise regression analysis. Related coefficients to each of introduced traits have been presented in the model of Table 2 and 3.

Table 1: Simple correlation of introduced cultivation traits in regression model of oil and seed yield

	1	2	3	4	5	6
Head diameter	1					
Number of filled seed per head	0.635**	1				
1000 seed weight	0.635**	0.683**	1			
Oil percentage	0.026**	0.025	-0.06ns	1		
Seed yield	0.723**	0.754	0.732**	+0.001ns	1	
Oil yield	0.3080ns	0.755**	0.687**	0.627**	0.843**	1

ns and **are insignificant and significant per probability level 1%, respectively

Table 2: β standard regression coefficients, T amounts and significant levels of introduced variables to the model in seed yield study

	Head diameter	Number of filled seed/head	1000 seed weight	Oil (%)
β standard regression coefficient	00.552	00.785	00.442	-0.055
T amount	26.990	28.530	26.250	-2.565
Significant level	00.000	00.000	00.000	0.000

The above explaining coefficient for equation (R^2 = 0.998) indicate justification of the variety of dependent variable due to dependent variables. Surely, the big amount of R^2 did not necessarily implicate good regression model. Because adding a variable to the model always increases the amount of R^2 regardless of the variable participated in the model or not. Therefore statisticians prefer to use adjusted R^2 statistics (Rezaye and Soltani 2004). In the regression equation, the R^2 amount is high and equals 0.988 that indicates introduction of terms with significant participation in model processing and terms without significant participation have been removed from the model.

The results from this study showed that in the final equation related to oil yield only 6 variables including head diameter, 1000 seed weight, number of filled seed in head, oil percentage, seed yield and oil yield have been introduced and other 6 variables lost their importance in presence of above 6 variables and did not exist in the equation.

In a multiple variables regression equation of seed yield, in spite of insignificant correlation of oil percentage with seed yield, this part of yield was presented in final equation. Whatever, mentioned above is justifiable considering the lack of introducing other variables that have significant correlation and importance of oil percentage in condition with. The lack of these variables.

Path analysis: Path analysis was used for simple correlations analysis to direct and indirect effects because simple correlation computation doesn't present exact information of cause and effect relations in demonstrating are dependent trait. For this purpose, at first with step-

Table 3: β standard regression coefficients, T amount and significant levels of introduced variables to the model in oil yield study

	Head diameter	Number of filled seed per head	1000 seed weight	Oil (%)	Seed yield
β standard regression coefficient	-0.008	-0.087	0.020	00.770	00.918
T amount	-7.379	-4.675	7.370	28.040	29.750
Significant level	0.025	0.000	0.024	00.000	00.000

Table 4: The direct and indirect effects of effective cultivation traits on yield

		Indirect effects through				
Traits	Direct effects	Head diameter	Number of filled seed per head	1000 seed weight	Oil (%)	Total effects
Head diameter	0.552	-	0.097	-00017	0.091	0.723
Number of filled seed per head	0.785	-0.078	-	0.005	-0.018	0.754
1000 seed weight	0.442	-0.024	0.315	-	-0.001	0.732
Oil percentage	-0.055	-0.010	0.061	0.005	-	0.001

Table 5: The direct and indirect effects of effective cultivation traits on oil yield

		Indirect effects through					
Traits	Direct effects	Head diameter	Number of filled seed per head	1000 seed weight	Oil (%)	Seed yield	Total effects
Head diameter	-0.008	-	0.00	0.008	-00067	0.369	0.308
Number of filled seed per head	-0.081	0.000	-	-0.010	0.0400	0.806	0.755
1000 seed weight	0.020	-0.099	-0.09	-	0.0900	0.766	0.987
Oil percentage	0.110	0.072	-0.00	0.008	-	-0.103	0.627
Seed yield	0.918	-0.03	-0.05	-0.09	0.095	-	0.843

wise regression method the effective variables in oil and seed yield was recognized and then the direct and indirect effects of each effective variables in oil and seed yield were determined (Table 4 and 5).

The direct effect of number of filled seed per head on seed yield is 0.785 positive and significant.

Increasing direct effect of number of filled seed per head indicates partial importance of effect of this trait compared with traits under study on seed yield. Furthermore the existence of partial indirect effects of number of filled seed per head on seed yield through other traits indicate immediate and close relationship of seed yield per head with number of filled seed per head. In addition the direct effect of head diameter on seed yield have been considerable and positive that many researchers have pointed out to direct and upper part of head diameter on seed yield (Ozer *et al*., 2003; Tahir *et al*., 2002). The 1000 seed weight have had high direct effect on seed yield that many researchers results have shown that 1000 seed weight have strong and positive direct effect on sunflower seed yield (Khan *et al*., 2005; Ozer *et al*., 2003).

Regarding causation coefficient we observe that seed yield trait have considerable direct coefficient on head and oil yield (0.843) relates to the trait.

Also in other studies, oil yield causation analysis has been suggested that sunflower oil yield increases through seed yield (Khan *et al*., 2005; Ozer *et al*., 2003). As it was expected also oil percentage has considerable direct effect on plant oil yield and this trait have had negative indirect effect by seed yield (-0.10). Since, this negative effect somehow decreases by positive indirect traits, therefore using this trait in order to increase oil yield is advisable. Maximum indirect effect between traits under study is related to the number of filled seed per head exerted through seed yield (0.806). The direct effect of this trait on oil yield is negative but have ignorable and little amount (0.081). Therefore, number of filled seed per head exerted its effect on plant oil yield indirectly and through seed yield 1000 seed oil has positive direct and indirect effect on oil yield in a manner that its indirect effect is by far more. (0.766) against (0.02) and forms grates part of correlation coefficient of this trait with seed trait (r = 0.687) 1000 seed weight exerted its maximum indirect effect positively through head yield (0.766) and its indirect effects through other traits is ignorable and little.

Chikadivaye and Nadine (2002) in their studies came to such a conclusion.

Head diameter like filled seed/head have low (-0.008) and negative direct effect on oil yield and its indirect effect per head is high and positive by seed yield (0.389) Chikkadevaiah and Nadine (2002) came to such a conclusion on the plant oil yield study too.

Regarding the direct and indirect effects of each effective trait in oil and seed yield, it seems that screening with emphasis of the number of filled seeds per head, 1000 seed weight and head diameter could be affected on maximum.

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