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SCREENING OF SUNFLOWER POPULATIONS FOR SEED YIELD AND ITS COMPONENTS THROUGH STEP-WISE REGRESSION ANALYSIS

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Abstract

Improving achene yield is the principal breeding objective for sunflower improvement and its commercial acceptance. Therefore, selection was practiced in six sunflower populations for seed yield. Step-wise regression analysis revealed two variable model including head diameter and achene weight for the improvement of sunflower populations 2 and 3 accounting 48.7 and 73.0% variability in seed yield per plant, respectively. Sunflower population 5 accounted minimum variability 42.6% for improvement by including achene weight, leaves per plant and distance from head to soil surface. However, populations 1 and 4 accounted maximum variability of 73.0 and 74.3%, respectively for seed yield per plant. Four variable (head diameter, achene weight, bird damage and stem diameter) and five variable models (achene weight, head diameter, plant height, leaves per plant and internodal length) were best fitted for sunflower populations 4 and 1, respectively. From the study it is evident that selection of head diameter and 100-achene weight may be effective for seed yield improvement in sunflower.

Introduction

Edible oils constitute the largest food import commodity in Pakistan. The demand for vegetable oil situation is a consequence of an increase in total consumption for greater than increase in production. Our local production meets only about one-third of total domestic requirement. Thus Pakistan has to import large quantities of edible oil to meet the consumption requirement every year. At present the Government is realizing the significance of this problem and is striding hard to overcome the existing situation by improving the area and per acre yield of non-conventional oilseeds like sunflower. This crop plant has the tremendous potential for bridging the gap of edible oil requirements in Pakistan (Nisar *et al*., 2011).

In order to increase the yield potential of sunflower, selection based on seed yield is important, since yield itself is a dependent trait and offers low heritability for selection (Rauf, 2008). Therefore, information about the contribution of morphological traits to achene yield will be important while making selection criterion (Naveed *et al*., 2009, Rauf *et al*., 2009, Arshad *et al.,* 2010). Step-wise regression analysis provides information about the relevant plant traits according to maximum variation in seed yield. Previously various workers have made use of various multi regression models to determine the appropriate selection criteria. Results of these studies were shown to be variable, subjected to the environmental conditions and population in which selection was practiced (Ashok *et al*., 2000; Dagustu, 2002; Rauf *et al.*, 2008, Furrkh *et al.,* 2009). Therefore, the present research work was planned to observe the magnitude of variation in six sunflower populations to find out the selection criteria for seed yield improvement through step-wise regression analysis.

Materials and Methods

The research work was conducted at the experimental area of Department of Plant Breeding and Genetics, Postgraduate Agricultural Research Station., University of Agriculture, Faisalabad. The experimental material consisted of six cultivated sunflower (*Helianthus annuus* L.) populations named as population 1, population 2, population 3, population 4, population 5 and population 6. The best fifty plants from each population were selected and their seeds were harvested separately. Next year head to row progenies were sown with the help of a hand drill from the selected plants of each population. Plant to plant and row to row distance was kept 23 and 76 cm, respectively. Data were recorded for 9 selected plants from each row in each population for plant height, number of leaves per plant, internodal length, stem diameter, distance from head to soil surface, head diameter, 100-achene weight, bird damage and seed yield per plant.

The data recorded for the above mentioned plant traits were analyzed for estimating mean, range and step-wise regression for each population, respectively. The coefficients of determination (R^2) were calculated through multiple linear regression analysis where seed yield per plant was a dependent variable and other traits were independent (Steel & Torrie, 1980).

Results and Discussion

Mean and range for nine indicated traits of sunflower populations are given in Table 1. The results revealed that maximum range for plant height was observed in population 3 (67-156 cm) and population 5 (92-182 cm). However, population 3 was dwarf (113.17 cm) and differed significantly from the remaining sunflower populations. Medium plant height with small internodal length is desirable for seed yield improvement in sunflower due to its resistance to lodging and response to fertilizers (Javed *et al.,* 1996). Population 1 and 2 had more number of leaves per plant i.e., 26.93 and 26.94, respectively, with significant variation which was important for more photosynthesis.

Larger head diameter (14.98 cm), heavier 100-achene weight (4.24 g) and low bird damage (11.45%) was observed in sunflower population 6. Stem diameter (5.94 cm) and seed yield per plant (26.08 g) was greater for population 1 followed by population 6 with 5.85 cm and 24.54 g, respectively. Usually greater head diameter with filled achene, heavier 100-achene weight and thicker stem diameter reflect greater seed yield in sunflower. Distance from head to soil surface is also helpful in estimating the stem curvature. In sunflower greater value of stem curvature suggests stem weakness. The results showed a wide range of variation for different plant traits in population 1 and population 6. Hence improvement in these two populations could be done through simple selection. Previous studies have also shown significant variation to various plant traits. Seneviratne *et al*., (2004) observed wide range of variation for yield and its components in sunflower populations. Furthermore, simple phenotypic selection for yield and its components led to the positive selection differential for traits plant height, head diameter and seed yield (Seneviratne *et al*., 2004). However, very few studies demonstrated the impact of yield components on seed yield.

Table 1. Mean and range for nine indicated traits of six sunflower populations.

Traits*	Mean/ Range	Sunflower populations					
		1	2	3	4	5	6
PLIHT	Mean/ Range	129.72a ± 8.10 87-167	124.43a ± 7.04 82-160	113.17b ± 7.36 67-156	125.49a ± 6.76 81-165	127.12a ± 7.91 98-182	128.29a ± 6.72 85-166
NLPP	Mean/ Range	26.93a ± 1.87 18-36	26.94a ± 1.72 19-36	25.24ab ± 1.87 17.35	25.74a ± 1.76 16-36	25.98a ± 1.16 20-33	23.62b ± 1.72 17-34
INLE	Mean/ Range	5.51a ± 0.47 3-8	5.53ba ± 0.60 3-9	5.06b ± 0.49 3-8	5.76a ± 0.64 3-10	5.74a ± 0.56 4-9	5.66a ± 0.65 4-10
SDIA	Mean/ Range	5.94a ± 0.67 3-10	5.27bc ± 0.48 3-8	5.18c ± 0.58 3-8	5.55abc ± 0.49 3-8	5.75ac ± 0.58 3-9	5.85a ± 0.56 3-9
DHSS	Mean/ Range	71.41ab ± 10.43 30-130	67.87bc ± 11.02 29-141	65.97c ± 8.59 29-120	68.99bc ± 8.61 17-117	66.51bc ± 9.12 23-126	74.49a ± 10.57 19-140
HDIA	Mean/ Range	14.48ab ± 1.26 9-22	13.56bc ± 1.30 8-22	13.37c ± 1.31 8-22	14.20abc ± 1.62 8-25	14.43ab ± 1.65 9-26	14.98a ± 1.18 10-23
ACWT	Mean/Range	3.97ab ± 0.55 1.97-7.15	3.73b ± 0.55 2.01-7.51	3.70b ± 0.55 1.96-8.4	3.95ab ± 0.47 1.79-7.27	4.09a ± 0.14 2.17-7.57	4.24a ± 0.12 2.07-12.80
BRDM	Mean/Range	17.73a ± 8.12 5-90	12.24b ± 5.12 5-60	18.08a ± 7.31 5-80	15.59ab ± 6.09 5-70	12.80b ± 7.47 5-80	11.54a ± 7.50 5-80
SYPP	Mean/Range	26.08a ± 6.01 6.7-73.7	20.63bc ± 6.74 6.3-45.8	19.16c ± 4.88 4.6-60	22.06abc ± 6.11 3.4-73.1	22.46abc ± 5.06 4.7-64	24.54ab ± 4.54 8.7-59.5

PLIHT: Plant height (cm); NLPP: Number of leaves per plant; INLE: Internodal length (cm); SDIA: Stem diameter (cm); DHSS: Distance from head to soil surface; HDIA: Head diameter (cm); ACWT: 100-achene weight; BRDM: Bird damage (%); SYPP: Seed yield per plant (g)

± : Standard error of means.

Historically, sunflower has been subjected to the human selection and has shown tremendous improvement in various plant traits. López *et al.,* (1999) evaluated the historic set of sunflower cultivar released during 1935-1995 in Argentina and showed that marked yield improvement was due to increased seed numbers which were lighter in weight. It was also proposed that future yield improvement may be achieved by increasing the grain weight.

The best fitting regression models with R^2 values for the dependent variable seed yield per plant of sunflower populations 1, 2 and 3 are presented in Table 2. On single factor basis the maximum value (48.6%) of R^2 (coefficient of determination) in population 1 was estimated for 100-achene weight. A two variables model using 100-achene weight and head diameter factors accounted for 67.0 % of the variability in seed yield per plant. A further improvement in seed yield up to 78.0 % was obtained in population 1 when plant height, number of leaves per plant and internodal length were added to the two variables model. Therefore the results indicated that head diameter, 100-achene weight, plant height, number of leaves per plant and internodal length are the traits responsible for significantly increasing the seed yield in population 1 but head diameter and 100-achene weight have the most direct effect on seed yield and selection of these plant traits may be desirable for the improvement of seed yield. Likewise in sunflower populations 2 and 3 (Table 2), two variables regression model using head diameter and 100-achene weight accounted for 48.7 and 73.9 % variability in seed yield per plant, respectively. Hence it is evident with addition of more independent variables to the two variables regression model there is no meaningful improvement in R^2 values. Therefore, results revealed that 100-achene weight and head diameter are the most important traits responsible for enhancing the seed yield in sunflower populations 2 and 3 (Nirmala *et al*., 2000; Sridhar *et al*., 2005; Kaya *et al*., 2009; Kaleem and Hassan, 2010). The results are in disagreement with Marinkovic (1992) and

Tariq *et al.*, (1992) who reported that head diameter and 100-achene weight had no effect on seed yield in sunflower. In sunflower population 4 (Table 3) four variables regression model (head diameter, 100-achene weight, bird damage percent and stem diameter) accounted for 74.3 % variability and was best fitted for seed yield improvement Three variables model (Table 3) using 100-achene weight, number of leaves per plant and distance from head to soil surface in sunflower population 5 accounted for 42.6 % variability. However, for the sunflower population 6 five variables regression model (Table 3) using 100-achene weight, number of leaves per plant, head diameter, bird damage percent and distance from head to soil surface with R^2 values of 69.7 % was the best for seed yield improvement (Rauf *et al*., 2008; Kaya *et al*., 2009). Overall the best fitting regression model across sunflower populations (Table 4) revealed that head diameter, 100-achene weight, plant height and internodal length were the most important plant traits for enhancing seed yield. Studies indicated that these plant traits were playing a meaningful role in determining seed yield in sunflower as already reported by Javed *et al*., (1996), Dagustu (2002), Arshad *et al*.,(2007), Furrkh *et al.*, (2009) and Kaya *et al*., (2009).

Table 2. Best fitting regression models for the dependent variable seed yield per plant of sunflower populations 1, 2 and 3.

Number in model	R^2	Variables in model*
	Population-1	
1	0.486	ACWT
2	0.670	ACWT,HDIA
3	0.699	ACWT,HDIA,PLHT
4	0.735	ACWT,HDIA,PLHT,NLPP
5	0.780	ACWT,HDIA,PLHT,NLPP,INLE
	Population-2	
1	0.393	HDIA
2	0.487	HDIA,ACWT
	Population-3	
1	0.639	HDIA
2	0.739	HDIA,ACWT

*PLHT= Plant height (cm), NLPP= No of leaves per plant, INLE= Internodal length (cm)
HDIA= Head diameter (cm) and ACWT= 100-achene weight (g)

Table 3. Best fitting regression models for the dependent variable seed yield per plant of sunflower populations 4, 5 and 6.

Number in model	R^2	Variables in model*
	Population-4	
1	0.494	HDIA
2	0.668	HDIA, ACWT
3	0.716	HDIA, ACWT, BRDA
4	0.743	HDIA, ACWT, BRDA,SDIA
	Population-5	
1	0.298	ACWT
2	0.384	ACWT, NLPP
3	0.426	ACWT, NLPP, HSSD
	Population-6	
1	0.479	ACWT
2	0.588	ACWT, NLPP
3	0.620	ACWT, NLPP, HDIA,
4	0.669	ACWT, NLPP, HDIA, BRDA
5	0.697	ACWT, NLPP, HDIA, BRDA, DHSS

*NLPP= No of leaves per plant, HDIA= Head diameter (cm) and ACWT= 100-achene weight (g), NLPP= Number of leaves per plant, BRDA= Bird damage (%), DHSS= Distance from head to soil surface

Table 4. Best fitting regression models for the dependent variable seed yield per plant of sunflower across populations.

Number in model	R^2	Variables in model*
1	0.440	HDIA
2	0.588	HDIA, ACWT
3	0.604	HDIA, ACWT, PLHT
4	0.610	HDIA, ACWT, PLHT, INLE

*HDIA= Head diameter (cm) and ACWT= 100-achene weight (g), PLHT= Plant height (cm) and INLE= Internodal length (cm)

Conclusions

Like different biometrical techniques, step-wise regression analysis is also an important statistical tool to identify plant traits which can be used as selection criterion for seed yield improvement in sunflower. From present research study it is concluded that selection of two simple traits (head diameter and 100-achene weight) may be effective for seed yield improvement in sunflower populations 1, 3 and 4. However, for sunflower populations 5 and 6, the two traits selection (number of leaves per plant and 100-achene weight) may be helpful for enhancing seed yield.

Therefore, it is emphasized that the selection based on number of leaves per plant, head diameter and 100-achene weight will be more effective for seed yield improvement in sunflower.

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