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RELATIONSHIP BETWEEN YIELD AND RELATED TRAITS IN INBRED LINES OF SUNFLOWER (*Helianthus annuus* L.)

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Abstract

The present study aims to estimate the amount of genetic variability, expected genetic advance and the relationship between yield and yield components of 31 inbred lines of sunflower as well as to characterize the lines based on the quantitative characters. Thirty one inbred lines along with one OP variety were evaluated for the purposes at the research field of Bangladesh Agricultural Research Institute, Gazipur, Bangladesh during the rabi season of 2015-2016. The highest genotypic and phenotypic coefficients of variation were recorded for seed weight per head followed by seed yield, number of seeds per head and plant height. High heritability was obtained for plant height (92.49%) followed by seed yield (91.78%), days to maturity (78.25%), stem diameter (74.60%) and number of seeds per head (68.97%). The highest genetic advance as percent of mean was found for seed yield (308%), number of seed per head (79.58%) and plant height (41.50%). Positive correlation was observed between seeds per head with seed weight per head, days to maturity with plant height and stem diameter. Among the studied characters plant height showed the highest direct effect on the seed yield followed by days to maturity, number of seeds per head and head diameter. A gene pool can be generated by combining the traits of the best lines from the collection and could be used as a base population for the development of desirable populations in sunflower breeding.

Keywords: Genetic variability, heritability, correlation, seed yield.

Introduction

Sunflower (*Helianthus annus* L.) is a member of the Asteraceae family and typically the plant has a composite flower. Helianthus consists of 67 species though only 17 species are under cultivation. Others are mainly used for ornamental purpose.

The sunflower originated in the south east United States and Mexico (Heiser, 1976; Vranceaunu, 1974). It is a potential source of high quality edible oil next to soybean in the world (Jahangir *et al.*, 2006). Based on the oil consumption it ranks third after soybean and palm oil in worldwide vegetable oil production (Iqbal *et al.*, 2009). In Bangladesh sunflower is grown in many districts especially in the coastal areas. However the average production of sunflower per unit area in the country is comparatively low. The area under oil seeds cultivation in Bangladesh is decreasing over the years due to various economic and technical reasons (Miah *et al.,* 2014). Sunflower can be a good substitute when it is difficult to cultivate other oil seeds crop due to climatic hazards. This is because it has a greater potentiality to

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overcome adverse situation than other oilseed crops due to its C_4 anatomy. One kilogram of sunflower seeds yields 500 to 600 g oil, which is more than that of any other oilseeds (Anonymous, 2015). The area and production of sunflower is increasing with the initiatives of the Department of Agriculture Extension (DAE) as well as some NGOs like Bangladesh Rural Advancement Committee (BRAC) and Islamic Relief.

Bangladesh produces only 0.358 million ton edible oil against the annual demand of 1.6 million tons. The remaining 1.242 million tons of the country's domestic requirements is met through imports by using huge amount of hard currency (Hossain, 2014; Khatun *et al.,* 2016). This problem can be solved by increasing production of sunflower in Bangladesh by introducing or developing high yielding varieties. The development of high yielding varieties is dependent on the existence of genetic variability. The efficiency of selection also depends upon the magnitude of genetic variability present in the plant population. On the other hand, the success of genetic improvement in any character depends on the nature of variability present in the gene pool for that character. Hence an insight into the magnitude of variability present in the gene pool of a crop species is of outmost importance to a plant breeder for starting a judicious plant breeding program.

Quantitative traits with high heritability and genetic advance are very important in selection of genotype at early stages of breeding programs (Memon *et al.*, 2005). To plan an efficient development program, it is necessary to have an understanding of key traits, their inheritance, genetic and environmental factors that influence their expression coupled with statistical analysis of inheritance (Yap and Harvey, 1972; Srivastava and Dhamania, 1989). The objectives of the study were to estimate the amount of genetic variability, expected genetic advance and the relationships between yield and yield components of sunflower.

Materials and Methods

The present study was carried out with 31 inbred lines along with an OP variety of sunflower (Table 1). The experiment was carried out based on Randomized Complete Block Design (RCBD) with three replications at the research field of Bangladesh Agricultural Research Institute, Gazipur, Bangladesh during the rabi season of 2015-16. The plot size was 2.0 × 4.0 m. Standard cultural practices were followed for raising the crop (Berglund, 2007; BARI, 2011). Data were recorded on days to physiological maturity (DM), plant height (PH), head diameter (HD), stem diameter (SD), number of seeds per head (SH), seed weight per head (SW) and seed yield (SY). Data were subjected to analysis of variance for different charactersusing statistical package R as well as significance difference between means. The mean squares were used to estimate genotypic and phenotypic variance according to Johnson *et al.* (1955). The coefficient of variation was calculated based on the formula suggested by Burton (1952). The genotypic and phenotypic coefficient of variation and heritability were calculated according to the formula used by Singh and Choudhury (1985) and genetic advance by Allard (1960) as well as correlation coefficient by Zaman *et al.* (1982).

Table 1. List of inbred lines of sunflower used in the present study

Accessions			
BHAC-SH-037	BHAC-04016	GP-01004	GP-04018
Sun-W-101	Entry no-20	GP-01005	GP-04019
Sun-W-103	Entry no-21	GP-01009	GP-04023
BHAC-04032	Entry no-22	GP-04011	GP-04024
BHAC-PS-2	Entry no-23	GP-04012	GP-04026
BHAC-04038(1)	Entry-P-S-2(1)	GP-O4015	GP-04028
BHAC04026	BARI Sunflower-2	GP-04016	GP-04030
BHAC-04028	GP-01002	GP-04017	GP-04038(2)

Estimation of biometrical parameters

The phenotypic and genotypic coefficient of variation (PCV and GCV), broad sense heritability (h^2_b) and genetic gain were estimated according to Farshadfar (2013) from the components of variance and covariance as follows:

$$GCV = \frac{\sigma_g \times 100}{\bar{x}}$$

Where, σ_g = Genotypic standard deviation; $\bar{X}$ = Population mean

Similarly, the phenotypic co-efficient of variation was calculated from the following formula.

$$PCV = \frac{\sigma_P \times 100}{\bar{x}}$$

Where, σ_P = Phenotypic standard deviation; $\bar{X}$ = Population mean

$$h^2_b\% = \frac{\sigma^2_g}{\sigma^2_P} \times 100$$

Where, h^2_b = Heritability in broad sense; σ^2_g = Genotypic variance; σ^2_P = Phenotypic variance

$r_p = \frac{PCOV_{xy}}{\sqrt{PV_x PV_y}}$ Where, r_p = phenotypic correlation

$r_g = \frac{GCOV_{xy}}{\sqrt{GV_x GV_y}}$ Where, r_g = genotypic correlation

$GG = \left(i.\sigma^2_g / \sqrt{\sigma^2_P}\right)100/\bar{X}$ Where, GG =genetic gain

Results and Discussion

The analysis of variance showed significant differences among the inbred lines of sunflower for different yield and yield components (Table 2) indicating the presence of notable genetic variability among them. Thirty one inbred lines and an OP variety were characterized based on days to physiological maturity, plant height, head diameter, stem diameter, number of seeds per head, seed weight per head and seed yield per plot.

Wide ranges of phenotypic variability along with higher coefficient of variations were observed among the studied characters except days to maturity (Table 3). Higher coefficient of variations indicates higher variation among the materials. Large variations in source population indicate their potential use in any breeding program. The progress of a breeding program is conditioned by the nature and magnitude of the genotypic and non genotypic variation in the various characters since the inheritance most economic characters (e.g. seed yield) are complex and are greatly

Table 2. Analysis of variance for yield and yield contributing traits of 31 inbred lines of sunflower

Sources	Mean square							
	DF	DM	PH	HD	SD	SH	SW	SY
Replication	2	3.573	441.81	14.45	0.38	6855.41	646.56	12945.97
Genotypes	31	39.45**	1444.73**	20.78*	0.19**	9404.22**	91.11**	79265.81**
Error	62	8.58	108.51	11.82	0.05	2918.33	520.28	6511.55

DM= days to maturity, PH= plant height (cm), HD= head diameter (cm), SD= stem diameter (cm), SH= number of seeds per head, SW= seed weight per head (g), SY= Seed yield (g)

Table 3. Range, mean, standard error and co-efficient of variation of different characters of 31 inbred lines of sunflower

Characters	Range	Mean	SE(±)	Coefficient of Variation (%)
DM (day)	88-101	96	2.39	3.04
PH (cm)	48.29-137.67	97.25	8.50	10.71
HD (cm)	6.68-17.87	13.23	2.81	25.98
SD (cm)	1.12-2.27	1.60	0.19	14.96
SH (no.)	37-250	118.81	44.11	45.43
SW (g)	2.23-21.42	10.58	5.22	60.48
SY (g)	30.23-541.20	266.65	65.89	30.26

DM= days to maturity, PH= plant height (cm), HD= head diameter (cm), SD= stem diameter (cm), SH= number of seeds per head, SW= seed weight per head (g), SY= Seed yield (g)

influence by various environmental conditions. The study of heritability and genetic advance is very useful in order to estimate the scope for improvement by selection. Heritability magnitude indicates the reliability with which the genotype will be recognized by its phenotypic expression (Chandraba and Sharma, 1999). The phenotypic coefficient of variation and genotypic coefficient of variation were very close for the traits days to maturity, plant height, stem diameter and seed yield per plot (Table 4). The narrow range of differences between genotypic coefficient of variations and phenotypic coefficient of variations for most of the characters indicates less environmental influence on phenotypic expression of those traits. They were mostly governed by genetic factors and less influenced by environmental condition which is always desired for improvement through selection (Marinkovic, 1992; Satjawattana, 2005).

High estimates of heritability were observed for the character days to physiological maturity, plant height, head diameter, stem diameter, number of seeds per head, seed weight per head and seed yield per plot (Table 4). The heritability estimates for different characters depends on the genetic makeup of the breeding materials under study. Therefore, knowledge about these values in the materials in which breeders are interested is of great significance (Ahmad *et al*., 1991; Chikkadevaiah *et al*., 2002). High heritability estimates indicate that the selection for

Table 4. Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advanced for different characters of 31 inbred lines of sunflower

Characters	GCV (%)	PCV (%)	Heritability (%)	Genetic advance (%)	Genetic gain (%)
DM (day)	3.34	3.78	78.25	5.80	6.04
PH (cm)	21.70	22.56	92.49	41.50	42.67
HD (cm)	13.07	19.90	43.15	2.33	17.61
SD (cm)	13.55	15.69	74.60	0.38	23.75
SH (cm)	39.13	47.12	68.97	79.58	66.99
SW (g)	66.95	90.22	55.05	6.24	59.01
SY (g)	58.40	60.96	91.78	308.06	115.78

DM= days to maturity, PH= plant height (cm), HD= head diameter (cm), SD= stem diameter (cm), SH= number of seeds per head, SW= seed weight per head (g), SY= Seed yield (g)

these characters will be effective being less influenced by environmental effects. Heritability estimates have been found to be useful in indicating the relative value of selection based on phenotypic expression of different characters.

All the characters showed positive correlations with seed yield except number of seeds per head and seed weight per head. The correlation coefficients between number of seeds with seed weight per head (0.740), days to maturity with plant height (0.675), days to maturity and stem diameter (0.643), plant height with stem diameter (0.616) indicates high degree of positive association. These associations were supported by the results of many authors (Hladni *et al*., 2006; Srimuenwai, 2006; Kaya *et al*., 2007). But these results are in disagreement with Machikowa and Saetang (2008) who found negative correlation with number of seeds per head with days to flowering, plant height and head diameter. On the other hand, many researchers suggested that the selection for seed yield of sunflower, especially synthetic varieties should be made through the selection for head diameter and plant height (Kaya *et al*., 2007; Machikowa and Saetang, 2008).

Path coefficient analysis was used to partition the correlations between yield and characters related to yield into direct and indirect effects. Among the studied characters plant height showed the highest direct effect on the seed yield followed by days to maturity, number of seed per head and head diameter. Machikowa and Saetang (2008) also found head diameter and plant height had higher positive and direct effect on yield. Sowmya *et al*. (2010) found head diameter had the higher positive correlation and the higher direct effect on seed yield. Positive higher direct effect indicates opportunity for selection based on phenotypic characters. Stem diameter showed high negative direct effect on seed weight per head that indicates selection should be based on other characters to achieve higher yield. The results of this experiment could be used for improving synthetic varieties of sunflower.

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