



CORRELATION STUDIES AMONG MORPHO-PHYSIOLOGICAL CHARACTERS IN EIGHT SUNFLOWER PARENTS AND THEIR SIXTEEN F₁ HYBRIDS

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Abstract

Eight sunflower parents and their sixteen F₁ hybrids were evaluated at Agricultural Research Institute Tarnab, Peshawar during autumn 2006-07 to estimate correlation among different Morpho-physiological characters. A randomized complete block design with three replicates was used. The correlation study has indicated that days to maturity was positively linked with days to first flowering, days to 100 percent flowering, internodes length and stem girth. Plant height was positively correlated with stem girth, number of leaves, days to first flowering, days to 100 percent flowering and internodes length. As revealed from results obtained that to evolve sunflower hybrid with early maturity, short stature, focus should be given to select parents having maximum stem girth, number of leaves, leaf area and minimum days to maturity and internodes length.

Key Words: Correlation analysis; Flowering; Maturity; Plant Height; Stem Girth; Sunflower.

Introduction

In Agricultural Sciences one usually faces a group of variables which are associated due to complex interactions (Wright, 1921). The degree of correlation among such variables can be calculated through correlation analysis. Association between characters signify the importance of such genetic causes as pleiotropic action of gene, linkages, improvement brought by selection through related characters and natural selection (Ginzburg and Nikoro, 1973; Harlan, 1939). Although the degree of coordination among various traits can be estimated by correlation analysis, determine the direct influence of one trait on another. In this respect eight parents and their sixteen F₁ hybrids were studied using Simple Correlation Co-efficient to estimate the association among eight characteristics studied by using the method as elaborated by Gomez and Gomez (1976). Although different types of traits-associations have been reported in sunflower (Doddamani *et al.*, 1997). Information pertaining to the effect of breeding method on the association of component character is scarce in Sunflower breeding at Tarnab Peshawar. Hence the presence study was initiated to determine and compare the pattern and magnitude of 8 physio-morphological characters. In this backdrop the present study was

conducted, as in Pakistan, among food stuff edible oil emerged one of the major concern for research scientists, political stalwart and Government functionaries. Every year about 60 billion Rupees is spent on it import to meet country demand (MINFAL, 2009). Moreover, the import bill is increases @ 5-6% year⁻¹ due to mushrooming growth of population, whereas local production is increased hardly @ 2-3%. Therefore, the available sunflower genotypes are needed to be properly improved and subsequently exploited locally in Heterosis breeding programs.

Materials and Methods

This research project was conducted under field conditions at Agriculture Research Institute (ARI), Tarnab, Peshawar, North West Frontier Province (NWFP) Pakistan (34.0 ° N and 72.0 ° E, 900ft ASL, with annual precipitation of 270 mm, relative humidity ranges 50-80% and mean seasonal temperature of 14.12 to 30.9 °C) during fall 2006 and 2007.

Selection of Parents

Selection of parents in any crop plant to improve its genetic architecture through hybridization is a

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prerequisite in any plant breeding program to release a most suitable hybrid to boost up the economic output of the crop. In this way four cytoplasmic male sterile (CMS) lines TS-17, TS-18, TS-228 and TS-335 and four restorer lines 291RGI, R-25, TR-9 and TR-6023 were selected on the basis of sufficient variability for various characters i.e. TS-17 having maximum number of leaves and large head size. TS-18 is early maturing, short stature, maximum stem curvature and maximum harvest index. TS-228 with minimum stem curvature. TS-335 is late maturing and having large sterile zone diameter. 291RGI shows maximum height and low harvest index. R-25 is medium stem curvature type with minimum number of leaves. TR-9 and TR-6023 with small heads. These CMS and restorer lines are the selection made from the crosses between sunflower materials (lines) brought from North Dakota State University Fargo, USA and local genotypes, which were developed and being maintained by Pakistan Oilseed Development Board, at Peshawar, North West Frontier Province. The parentage and origin of the parental material are presented in Table 1.

Table 1. Pedigrees and Origin of the Parental Material

Sl. No.	Inbred Lines	Parentage	Origin
1.	TS-17	S-2 x F-6201 x DM-6	USA
2.	TS-18	S-4 x F-11 x F-15	USA
3.	TS-228	TS-7 x TF-6201 x DM-7	Pakistan
4.	TS-335	TS-17 x TF-11 x TF-7	Pakistan
5.	291RGI	RHA-365 x R-8	USA
6.	R-25	R-8 x R-III	Pakistan
7.	TR-9	TRL-13 x RHA-857	Pakistan
8.	TR-6023	TRL-13 x R-5	Pakistan

Hybridization to Produce F₁s

During September 2003, the parental genotypes were sown in sixteen blocks having four rows of five meter length. Each cytoplasmic male sterile line was crossed with four restorer lines. In this way, each block, two rows of one of the cytoplasmic male sterile lines and two rows of one of the restorer were planted in alternate fashion. The cytoplasmic male sterile lines were bagged during last week of October 2003. Crosses were made manually in the morning from 8:00 am to 10:00 am in each block. Each cytoplasmic male sterile line head was pollinated by restorer line three times to ensure the pollination success. After pollination the heads were re-bagged to avoid contamination and to ensure genetic purity. In this way, sixteen F₁ hybrids i.e. TS-17 x 291RGI, TS-17 x R-25, TS-17 x TR-9, TS-17 x TR-6023, TS-18 x 291RGI, TS-18 x R-25, TS-18 x TR-9, TS-18 x TR-6023, TS-228 x 291RGI, TS-228 x R-25, TS-228 x TR-9, TS-228 x TR-

6023, TS-335 x 291RGI, TS-335 x R-25, TS-335 x TR-9 and TS-335 x TR-6023 were obtained.

Germplasm Evaluation

The F₁ hybrids along with their parents were evaluated in September 2006 in a randomized complete block design (RCBD) using three replications. Each hybrid and parental line was planted in five-meter long rows with plant-to-plant distance of 0.3m and row-to-row distance of 0.75m in each plot.

Soil was well prepared for sowing, firstly deep ploughed with Mould Board Plough followed by Disk Harrow to make the soil well pulverized and to maintain its level. Ridges (0.75 m apart) were made in the field through Rigger. A basal fertilizer dose of 120 kg ha⁻¹ Nitrogen (Urea) and 60 kg ha⁻¹ of Phosphorus (Diammonium Phosphate) were applied. Full dose of DAP and half dose of Nitrogen were applied at the time of sowing. Sowing was done by dibbling method @ of five seeds drill⁻¹. After germination, when the seedlings gained 10 cm height, thinning was manually practiced all weak and abnormal seedlings were uprooted. After thirty days of germination, the field was well irrigated. At the stage of emergence during forth week weeding / inter-culturing was manually exercised through hand tools (Spade and Bar harrow). Second irrigation was given to the experimental block after two weeks of first irrigation at the stage of button formation. The remaining half dose of Nitrogen was applied just before head initiation. Third irrigation was applied at the stage of head initiation and forth irrigation was applied subsequently at the stage of seed setting. At the stage of physiological maturity in December 2007 when the back of the head turned yellow and leaves became grayish white, heads were cut with Sickle from the standing crop and were spread in open field for drying. Seeds of individual head were threshed by beating the backside of the head with a small wooden stick. Data were recorded at various stages from germination till maturity as; Days to first flowering were recorded as the number of days taken from the date of sowing till the opening of first flower in each plot. Days to 100 % flowering was recorded as the number of days from the date of sowing till the opening of 100 % flowering. Days to maturity were recorded as the number of days from the date of sowing to the physiological maturity of plant in each plot. Plant height (cm) was measured in centimeters from the ground level to the attachment of head (capitulum) to the stem on five randomly selected plants per genotype in each plot by using measuring tape at the time of physiological maturity. Stem girth (cm) was measured on five randomly selected plants per genotype in each plot using Vernier Calliper in centimeters. Stem curvature (percent) was calculated by

subtracting the distance of the head from the soil surface from the plant height (stem length) by using measuring tape. Number of leaves on the stem of randomly selected five plants per genotype in each plot was calculated. Internodes length (cm) is the distance between nodes at the base mid and top of stem was calculated in randomly selected five plants per genotype in each plot by using measuring tape. Leaf area (cm)² was calculated as, at the stage near to physiological maturity leaves were detached from the base mid and top of the stem from five randomly selected plants per genotype in each plot to record leaf area through leaf area meter.

Statistical Analysis

The data collected were subjected to analysis of variance technique as given by Steel and Torrie (1980) for all the characters to study the differences among F₁ hybrids and parents using statistical software MSTAT-C (Bricker, 1991). Least significant difference (LSD) and t-test was used for mean separation of the parents and hybrids.

Simple Correlation Co-Efficient Analysis

Simple correlation co-efficient were determined to estimate the association among various characteristics studied by using the following formula as elaborated by Gomez and Gomez (1976).

$$r_{xy} = \frac{n \sum XY - (\sum X)(\sum Y)}{\sqrt{[n \sum X^2 - (\sum X)^2][n \sum Y^2 - (\sum Y)^2]}}$$

Wherein,

n	=	number of observations.
r	=	simple correlation coefficient
$\sum X$	=	sum of means of first trait.
$\sum Y$	=	sum of means of 2 nd trait.
$\sum xy$	=	sum of products of means of both traits.

Results and Discussion

Days to first flowering

Days to first flowering formation exhibited significant positive correlation with days to 100 % flowering, days to maturity and internodes length while it showed non-significant correlation with plant height and stem girth. The relationship of days to first flowering was negative and non-significant with stem curvature and number of leaves (Table II). The present study is supported by the previous work of Hanif *et al* (1996) and Patil *et al* (1996), They found positive association of days to first flowering to the morpho-physiological and seed yield related traits.

Days to 100 % flowering

Days to 100 % flower formation were positively and significantly associated with days to first flowering, days to maturity and internodes length whereas positively and

non-significantly associated with plant height and stem girth. This character was negatively and significantly associated with stem curvature while negatively and non-significantly correlated with number of leaves (Table II). The results are in agreement with the findings of Hanif *et al* (1996) and Patil *et al* (1996), they found positive correlation of days to 100 percent flowering to the morpho-physiological and seed yield related traits.

Days to maturity

Days to maturity manifested positive and significant correlation with internodes length, whereas it was non-significantly associated with days to first flowering, days to 100 % flowering and stem girth. This character exhibited negative and significant association with stem curvature whereas negative and non-significant correlation was observed with plant height and number of leaves (Table II). The results are in an agreement with findings of Virupakshappa *et al* (1997) and contrast with Singh and Labana (1990).

Plant height

Plant height revealed positive and significant association with stem girth and number of leaves whereas manifested and non-significant correlation with days to first flowering, days to 100 % flowering, days to maturity and internodes length. Plant height exhibited negative and non-significant correlation with stem curvature (Table II). The results are in agreement with the research findings of Gill *et al* (2003), Punia and Gill (1994) they reported that plant height was significantly correlated with other morpho-physiological and yield related traits.

Table II. Simple correlation coefficients for various morpho-physiological attributes in 24 sunflower genotypes.

	Days to 100 % flowering	Days to maturity	Plant height	Stem girth	Stem curvature	No. of leaves	Internodes length
Days to first flowering	0.78924*	0.68333*	0.13559	0.08313	-0.38543	-0.23939	0.40029*
Days to 100 % flowering		0.84926*	0.05082	0.02274	-0.45199*	-0.26097	0.41810*
Days to maturity			-0.07751	0.13295	-0.51147*	-0.38480	0.50617*
Plant height				0.51500*	-0.20233	0.64365*	0.15377
Stem girth					-0.20292	0.31947	0.46546*
Stem curvature						0.17461	-0.55291*
No. of leaves							-0.14343

* Significant p < 0.5 %

Stem girth

Stem girth manifested positive and significant association with internodes length and non-significant association with number of leaves. This character was negatively and significantly associated with days to 100 % flowering and non-significantly associated with days to first flowering, plant height and stem curvature (Table II). The results obtained are in agreement with the research work of Punia and Gill (1994), Hanif *et al* (1996),

Narayana and Patel (1998) and Gill *et al* (2003). They found that high association exists for this character with morpho-physiological and seed yield related traits.

Stem curvature

Stem curvature exhibited positive and non-significant association with number of leaves and significantly correlated with days to 100 % flowering, days to maturity and internodes length. Whereas it remained negatively and non-significantly associated with days to first flowering, plant height and stem girth (Table II).

Number of leaves

Number of leaves manifested positive and significant association with plant height while remained non-significantly correlated with stem girth and stem curvature. Number of leaves exhibited negative and non-significant association with the rest of traits (days to first flowering, days to 100 % flowering, days to maturity and internodes length) (Table II). The findings are supported by the research results of Dagustu (2002).

Internodes length

Internodes length exhibited positive and significant association with days to first flowering, days to 100 % flowering, days to maturity and stem girth whereas it remained non-significantly associated with plant height. Internodes length remained negatively and significantly associated with stem curvature and non-significantly correlated with number of leaves (Table II).

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References

- Bricker, B. 1991. MSTATC: "A computer program for the design management and analysis of agronomic research experiments" Crop and Science Department, MSU, East Lansing MI 48824, USA.
- Chikkadevaiah and Nandini, R., 2003. Isozymes as markers of differentiating sunflower genotypes. *Helia*, 26:51-57.
- Dagustu, N. 2002. Correlations and path coefficient analysis of seed yield components in sunflower (*Helianthus annuus* L.). *Turkish J. Field Crops*. 7(1):15-19.
- Doddamani, I. K., Patil, S.A. and Ravikumar, R. L. 1997. Relationship of autogamy and self fertility with seed yield per plant and yield components in sunflower. *Helia*, 20: 95-102.
- Fick, G. N., Putt, E. D. and Smith, D. L. 1978. Sunflower Sci. and Technology. In: Carter, J. F. (ed) Morphology and anatomy. No. 19. ASA, CSSA, SSSA, Madison Wisconsin. USA, PP., 55-85.
- Gill, H. S., R. K. Sheoran and A. Shahid. 2003. Correlation and path coefficient analysis for oil yield in sunflower (*Helianthus annuus* L.). *National J. Plant Improvement*. 5 (1):43-46.
- Gill, H. S., R. K. Sheoran and A. Shahid. 2003. Correlation and path coefficient analysis for oil yield in sunflower (*Helianthus annuus* L.). *National J. Plant Improvement*. 5 (1): 43-46.
- Gunzburg, E. K.H. and Nikoro, Z.S. 1973. On the problem of genetic correlation. I. Pleiotropy and non-equilibrium. *Genetika*. 9: 45-54.
- Hanif, M., Farhatullah and Raziuddin. 1996. Correlation studies of grain yield and other characters in sunflower varieties. *Sarhad J. Agric.*, 12(6): 649-652.
- Harlan, S.C. 1939. The genetics of cotton, Jonathan Cape, London, pp:1-193.
- Heiser, C. B. 1957. A revision for the South American species of *Helianthus*. *Brittania*, 8(4): 284-290.
- Khalil, I. A., and Jan, A. 2002. Text Book of Agri. Cropping Technology. National Book foundation, Islamabad, Pakistan.
- MINFAL (Ministry of Food, Agriculture and Livestock). 2009. Economic Survey of Pakistan. Finance Division. Govt. of Pakistan, Islamabad. Pp: 9-20.
- Narayana, E. and J. C. Patel. 1998. Correlation studies in sunflower. *Gujarat Agric. University Res. J.*, 23(2):100-102.
- Patil, B. R., M. Rudraradhya, C. H. M. Vijayakumar, H. Basappa and R. S. Kulkarni. 1996. Correlation and path analysis in sunflower. *J. Oilseeds Res.*, 13(2): 162-166.
- Punia, M. S. and H. S. Gill. 1994. Correlations and path coefficient analysis for seed yield traits in sunflower (*Helianthus annuus* L.). *Helia*, 17(20):7-11.
- Semelczi, K. A. 1975. Acclimatization and dissemination of the sunflower in Europe. *Acta Ethnogr. Acad. Sci. Hung.*, 24: 47-88.
- Singh, S. B and K. S. Labana. 1990. Correlation and path analysis in sunflower. *Crop Improvement.*, 17(1):49-53.
- Virupakshappa, K., S. D. Nehru, Jayaram. Gowda, Subramanya. Hegde, J. Gowda and S. Hegde. 1997. Selection of testers for combining ability analysis and relationship between super performance and GCA in sunflower (*Helianthus annuus* L.). *Helia*, 20(26): 79-88.

- Vischi, M., N. Di Bernardo, I. Scotti, S. Della Casa, Seiller, G. Olivier A. M., 2004. Cucumerifolius and their hybrids from the African coast of Indian Ocean and the USA using molecular markers. Comparison of populations of *Helianthus argophyllus* and *Helianthus debilis* ssp. *Helia*, 27:123-131.
- Wright, S. 1921. Correlation and causation. *J. Agric. Res.*, 20: 557-585.