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CHARACTERIZATION AND DIVERGENCE ANALYSIS OF DIFFERENT SUNFLOWER GENOTYPES

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Abstract

Twenty-one sunflower accessions were evaluated at the research field of Oilseed Research Centre (ORC), Bangladesh Agricultural Research Institute (BARI), Gazipur, to study the divergence within the genotypes. ORCGP-21 produced taller plants (160.4cm), thicker stems (2.2 cm), and maximum yield (525.2 g/plot). Maximum seed weight (80.0 g) was obtained from ORCGP-2 and ORCGP-13. ORCGP-15 produced the maximum oil percentage (40.3%). Significant and positive correlation of plot yield with days to 50% flowering (0.55**), plant height (0.80**), and stem diameter (0.56**) was observed. Days to 50% flowering had the highest direct positive contribution to on seed yield. Cluster analysis classified the 21 sunflower genotypes into two main groups. The maximum genetic divergence was observed between clusters I and cluster V. The phenotypic variability observed in this study suggests that these genotypes are potential germplasms for important traits and could be utilized in the development of superior sunflower cultivars.

Introduction

Sunflower (*Helianthus annuus* L.) is an oilseed crop, native to temperate regions of North America, and domesticated in Russia as an oil crop in the early eighteenth century. Now it is the world's 4th largest source of oilseed crop after Soybean, palm and rapeseed (Masvodza *et al*. 2014). Its seed contains about 50% of fat and 20% of protein and its oil is considered as premium oil as possessing high percentage of unsaturated fatty acids. Oleic and linoleic acid are primary fatty acids (approximately 90% unsaturated fatty acids) in sunflower oil (Arshad *et al.* 2007).

Sunflower is a thermoneutral crop, therefore, may be grown throughout Bangladesh both in rabi and kharif season. It is moderately drought tolerant crop which facilitates its cultivation in limited water area, like Barind tract. It is a short duration crop therefore can be grown in between aman and boro rice (Arshad *et al*. 2019). It is grown in wide ranges of soil types (from sand to clay) along with a wide range of soil pH (5.7-8). Sunflower tolerates approximately 8-12 dS/m threshold of salinity. It can be grown in the area of late rainfall or flooded areas where mustard or sesame is not possible to grow. In Bangladesh Sunflower is a non-conventional oilseed crop which started to cultivate since 1975 on a small scale (Habib *et al.* 2017). The area and production of sunflowers may be increased by high yield potential varieties. For variety with high-yielding, it is essential to find out morphological and physiological traits as selection criteria which have strong correlation with seed yield (Škorić *et al*. 2002). Seed yield is a quantitative trait and it is dependent on many morphological and physiological characters (Arshad *et al.* 2007). Correlation between seed yield and yield contributing characters helps researcher to select desirable cultivar. Therefore, the present study was taken to characterize and evaluate the sunflower germplasm for yield and yield contributing characters.

Materials and Methods

The experiment was conducted with 21 sunflower genotypes. The seed was sown during the rabi season at the research field of Oilseed Research Centre (ORC), BARI, Gazipur. Before

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sowing, seeds were treated with Vitavex-200 @ 3 g/kg seed to protect the seeds from soil and seed borne diseases. The experimental field was well prepared by ploughing with tractor and power tiller followed by laddering and cross laddering. Fertilizers of urea, TSP, MP, Gypsum, zinc sulphate, boric acid and cow dung were applied at the rate of 180, 160, 150, 150, 8,10 kg/ha and 8-10 ton/ha (FRG 2018). Half of the urea and full amount of the other fertilizers were applied at the time of final land ploughing. Remaining half of the urea was applied as top dress during 20-25 days and 40-45 days after emergence. Seeds were sown at 50cm between rows and 25 cm between plants within the row. The unit plot size was 2 rows of 4 m long and the distances between plots were maintained 1.5 m. A total of 3-4 seeds/per hill were sown and 1 healthy seedling/hill was kept for better growth and development. In total, three (25, 50 and 70 days after sowing) irrigations were applied throughout cropping period. Sunflower plants were grown by following all recommended cultural practices and plant protection measures. At maturity, 10 plants from each genotype were selected at random and observations were recorded on plant height (cm), head diameter (cm), stem diameter (cm), number of seeds/head, Seed weight/head (g), 1000 seed weight (g) and Oil content (%). The data on days to 50% flowering, days to maturity and yield/plot (g) was taken on plot basis. To find out the differences among the genotypes, the mean values of all the characters of 21 entries were evaluated. Correlation coefficient, path co-efficient analysis and cluster analysis were performed by using R Software (R Core Team 2023).

Results and Discussion

Genetic variability in sunflower accessions for morphological traits is the first and basic step in germplasm evaluation. In some crop species like garlic (Panthee *et al*. 2006), melon (Lotti *et al*. 2008) and sunflower (Kholghi *et al*. 2011), morphological statistics has been used for determining the variability. Variability in sunflower accessions for quantitative morphological traits had also been reported by many researchers (Nehru and Manjunath 2003, Rao *et al*. 2003). Table 1 shows the variability of quantitative morphological characters. All the studied characters showed a great deal of variability among the genotypes which is revealed by the coefficient of variation (CV%) and their average values. The highest CV% was recorded for seed yield/head (60.22 g) followed by number of seeds/head (58.54) and plot yield (57.26 g). The morphological variation on the observed characters was found highly variable for some characters was also reported (Tan and Tan 2011).

Table 1. Variability of quantitative morphological characters of sunflower accessions.

Characters	Initial	Mean	Standard Deviation	CV%
Days to 50% flowering	DF	73	7.38	10.09
Days to maturity	DM	105	9.84	9.29
Plant height (cm)	PH	95.59	26.51	27.73
Stem diameter (cm)	SD	1.52	0.31	20.62
Head diameter (cm)	HD	11.44	2.98	26.12
No. seeds /head	SH	142.86	83.63	58.54
Yield/head (g)	YH	8.94	5.38	60.22
1000 seed weight (g)	SW	56.82	15.64	27.54
% oil content	% OC	38.37	0.87	2.23
Plot yield (g)	PY	248.13	142.10	57.26

Correlation coefficient determines the closeness of two important variables so that selection criteria could be reliably established. For the simultaneous improvement of traits in sunflower, Mogali and Virupakshappa (1994) studied the association of seed yield with yield related traits. In

the present study, both positive and negative correlations were found between different traits (Fig. 1). Greater positive association observed for the characters indicated that these characters could be simultaneously improved and further recommend that increase in any one would lead to improvement of other characters. Plot yield was positively and highly significantly correlated with days to 50% flowering (0.55**), plant height (0.80**) and stem diameter (0.56**). This indicates that strong association of these characters with plot yield could be fruitfully exploited for enhancing the yield potential in sunflower. So, selection of these characters for plot yield would be useful in selecting superior sunflower genotypes. Similar results were also reported by Nehru and Manjunath (2003) and Prasad *et al*. (2006).

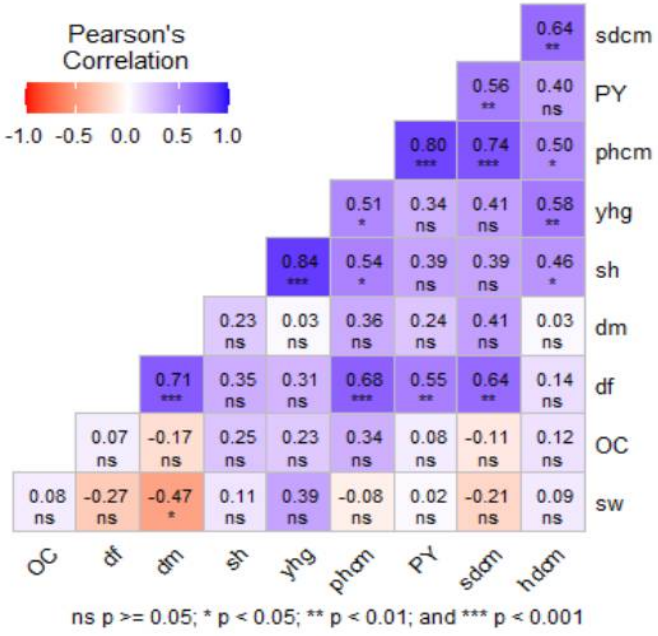

Fig. 1. Phenotypic correlations among different characteristics of 21 sunflower accessions.

Path coefficient analysis is a suitable technique that separates the phenotypic correlation coefficients into its direct and indirect effects so that the contribution of each trait to yield and yield contributing characters can be easily estimated. Shankar *et al*. (2006) and Darvishzadeh *et al*. (2011) noted that path-coefficient analyses offered greater insights into the direct and indirect effects of the examined characteristics on seed yield. In this study, the positive direct effects on seed yield were exhibited by days to flowering, plant height, head diameter, number of seeds/head and seed weight/head (Fig. 2). These traits therefore considered important to increase yield of sunflower. Similar results were also reported by Arshad *et al*. (2007) for days to flowering, plant height and head diameter; Machicowa and Saetang (2008) for head diameter and plant height (Yasin and Singh 2010) and for number of seeds/heads (Kholghi *et al*. 2011), 1000-seed weight and head diameter and for head diameter (Darvishzadeh *et al*. 2011). Behradfar *et al*. (2009) reported positive direct effects of 1000 seeds and total seed number per head on seed yield of sunflower. Positive direct effects of these traits on plot yield indicated their importance in determining these complex traits and therefore, should be kept through practicing selection aimed at the improvement of yield.

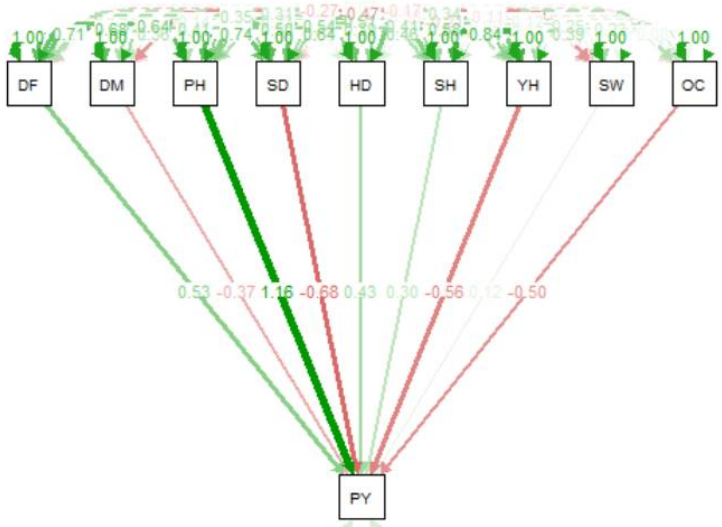

Fig. 2. Effects of different characteristics on seed yield of sunflower accessions.

Cluster analysis indicates the extent of genetic diversity in the material that could be used as parental lines in variety development. Cluster analysis using R software classified the 21 sunflower genotypes into two main groups than again five sub group (Fig. 3). A large number of accessions was placed in cluster V (6 accessions) followed by cluster I (5 accessions), cluster III (4 accessions) and cluster II and IV contains only three accessions. The maximum variability was observed between clusters I and cluster V which would give very good cross combination. As the selection is valuable for those characters having high variability, the lower variability coefficients indicated that there was less variation for those traits in the material evaluated.

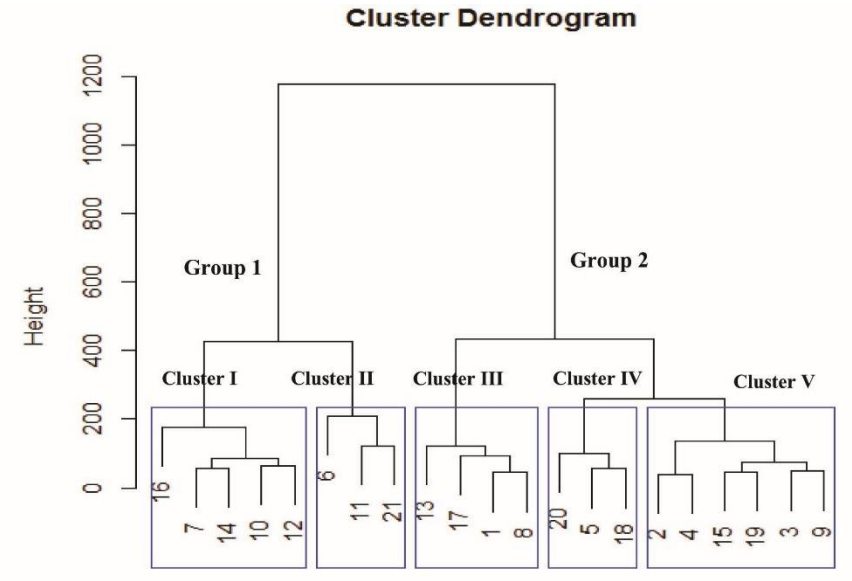

Fig. 3. Cluster dendrogram of 21 sunflower accessions used for morphological analysis.

Besides quantitative traits, wide variability was also observed for some qualitative traits. As shown in Fig. 2, the sunflower accessions show variability in size and shape of leaves (Figs 4A and 4B), in different size and shape of head (Figs 4C and 4D), and different size, shape and color of both ray and disc floret (Figs 4E and 4F). Different size leaf in sunflower was reported by Atlagic and Skoric (1999) while different shape leaf in sunflower was reported by Terzic *et al.* (2006). Atlagic and Skoric (1999), Nikolova *et al*. (2004) reported a larger head diameter in the sunflower F_1 hybrids. Dudhe (2012) reported elongated type ray floret in sunflower F_1 hybrids. These diverse genotypes would be potential source for the development of high yield potential sunflower variety.

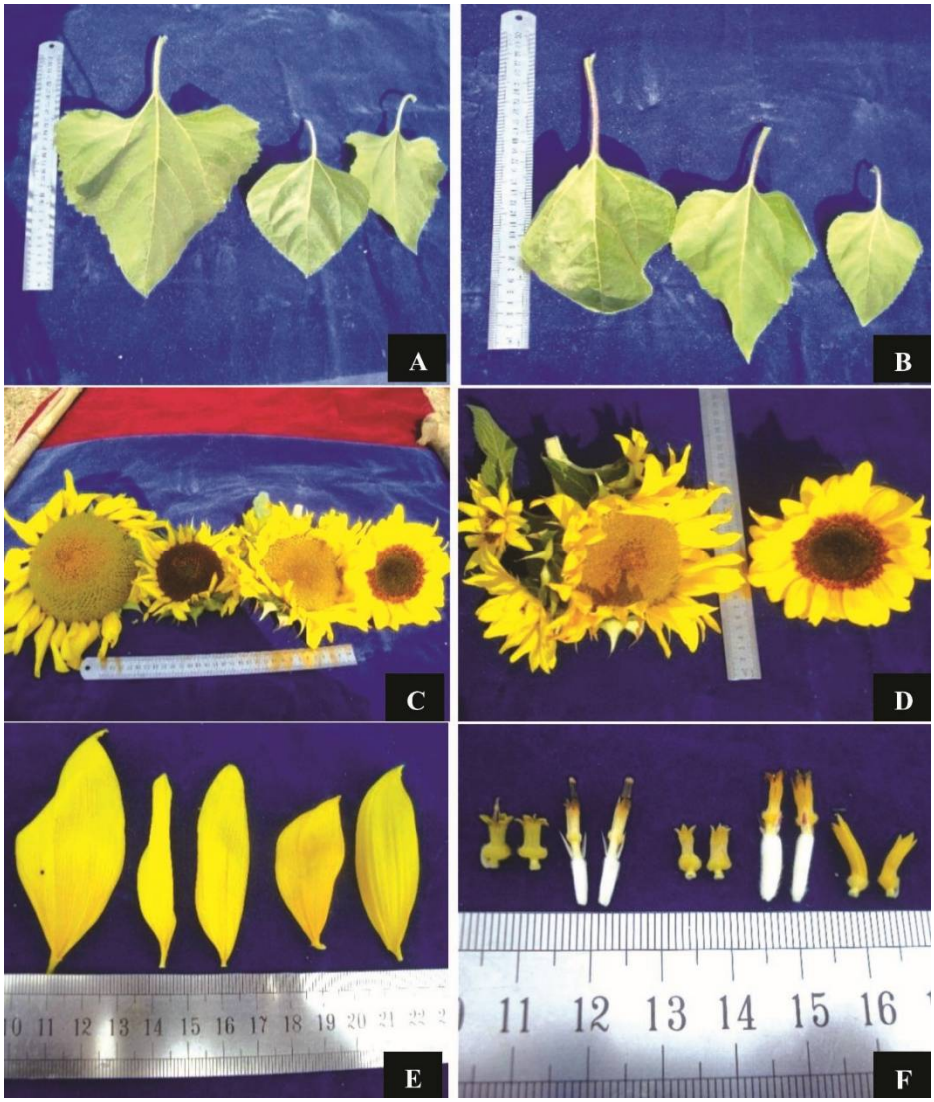

Fig. 4. Variability of some qualitative traits in sunflower. A: Size of leaves, B: Shape of leaves, C: Size of head, D: Shape of head, E: Size, shape and color ray floret, and F: Size, shape and color disc floret.

Twenty-one sunflower germplasms were characterized and evaluated for their yield and yield-related components. These genotypes appeared as potential germplasm for developing superior sunflower cultivars. The highest CV% was recorded for the character seed yield/head (60.2g) followed by number of seeds/head (58.5) and plot yield (57.3). From the correlation coefficient determinants, plot yield was found positively and highly significantly correlated with days to 50% flowering (0.55**), plant height (0.80**) and stem diameter (0.56**). The path analysis revealed that positive direct effects on seed yield per plant were exhibited by days to flowering, head diameter and number of seeds/head. Cluster analysis indicated the extent of genetic diversity in the studied material. Therefore, combination of these diversified sunflower accessions with desired characters perhaps potential breeding materials to develop high yielding sunflower variety in Bangladesh.

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