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Research Note

Evaluation and characterization of sunflower germplasm accessions for quantitative characters

Vikas Kulkarni, I.Shankegoud and M.R. Govindappa
AICRP on Sunflower, Main Agriculture Research Station, UAS,Raichur
Email: vik_gene@rediffmail.com

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Abstract
Sunflower germplasm accessions (143) were evaluated for yield and yield contributing characters to study the extentof variation for different quantitative traits. The germplasm accessions were also characterized on qualitative traits. Highest phenotypic and genotypic coefficients of variation were recorded for seed yield per plant (53.4 % and 46.9% respectively) followed by head diameter, test weight, plant height,volume weight and oil content. High heritability was noticed for all the traits studied. High heritability coupled with high genetic advance over mean has been recorded for seed yield per plant (77 and 65.1) followed by head diameter, test weight and plant height. It was noticed that sunflower germplasm accessions exhibited wide range of variability for all the morphological characters studied like leaf shape, leaf color, leaf serrations, leaf hairiness, stem hairiness, indicator leaf, petiole anthocyanin, branching, leaf angle, petiole length, stem pigmentation and pollen color.

Keywords
Sunflower, heritability, genetic advance

Sunflower(*Helianthus annuus* L.) is one of the most important oilseed crops in India contributing major portion of edible oil requirements. In India,sunflower is cultivated in an area of 7.2 lakh hectare with an average production and yield of 5.81 lakh tonnes and 807kg/ha respectively during the year 2012. Karnataka state alone accounts for more than 45per cent of the total sunflower area in the country. However in recent years, the area under cultivation is decreasing mainly due to crop suffering from biotic and abiotic stress and due to increase in cultivation of more remunerative crops like Bt cotton and pigeon pea.This situation demands development of more productive hybrids of diverse durations to fit into different agro-climatic situations. Several research centers working on sunflower has collection of sunflower germplasm which needs to be evaluated to study the nature and magnitude of variation. Characterization and study of heritable components of variabilityof different quantitative traits will help to select suitable breeding methodologies to develop promising inbred lines.Characterization of germplasm lines is useful in identifying suitable lines and avoid duplications. Being stable over generations and environment, the qualitative characters are reliable for characterization of germplasm. Hence, the current study was planned to estimate genetic variability, heritability and genetic advance for yield and yield contributing traits and characterize sunflower germplasm accessions for different qualitative characters.

The experiment was conducted during *Kharif*-2011 at Main Agriculture Research Station, Raichur consisting of 143 sunflower germplasm accessions. Each accession was sown in two rows of 3m length with a spacing of 60cm between rows and 30cm between plants. The experiment was laid out in Randomized Block Design with two replications. The data on yield and yield contributing characters were recorded on five randomly selected plants in each replication.

The phenotypic and genotypic coefficient of variation(PCV & GCV) were computed and classified as suggested by Burton and Dewane (1953), heritability (h^2) as per Hanson *et al*., (1956) and expected genetic advance over mean (GAM) as suggested by Johnson *et al.,* (1955). The germplasm accessions were characterized based on different qualitative characters *viz.*,leaf shape, leaf color, leaf serrations, leaf hairiness, stem hairiness, indicator leaf, petiole anthocyanin, branching, leaf angle, petiole length, stem pigmentation, days to 50% flowering, pollen color, plant height, head diameter, oil content, seed yield per plant and test weight.

The variation present in sunflower germplasm accessions for all the seven quantitative characters is evident from the significant mean sum of squares (Table 1). Different parameters like range, phenotypic and genotypic variance, phenotypic and genotypic coefficients of variance, heritability estimates and predicated genetic advance over mean for seven quantitative characters were analyzed (Table 2). The PCV and GCV was found to be highest for seed yield per plant (53.4 % and

46.9 % respectively) followed by head diameter (23.9% and 21.9%respectively), test weight (20.8% and 19.9% respectively), plant height (17% and 15.6% respectively), oil content (16% and 10.2% respectively) and volume weight (12.% and 11.8% respectively). However, days to 50 % flowering showed least PCV and GCV (4.42 % and 4.13% respectively) among the characters studied. High percentage of both PCV & GCV indicates the presence of greater variability, which gives ample scope for improvement of these traits by adopting simple selection methodology. The high percentage of PCV and GCV observed for seed yield per plant and test weight are in confirmation with earlier reports of Suma and Virupakshappa (1994);Reddy and Reddy (2006). Whereas,moderate level of PCV and GCV has been recorded for head diameter and plant height. However, lower PCV and GCV values for days to 50% flowering are in accordance with earlier studies by Lakshamanaiah (1978), Alam*et al*, (1987), Gangappa (1991), Suma and Virupakshappa (1994) and Reddy and Reddy (2006). The low variability for these traits emphasizes the need for generating more variability involving diverse sunflower germplasm.

All the seven quantitative characters recorded high level of heritability. High heritability coupled with high genetic advance over mean has been recorded for seed yield per plant (77 and 65.1) followed by head diameter (84 and 41.64%), test weight (91 and 39.2) and plant height (84 and 29.4). These observations for seed yield, head diameter, test weight and plant height suggests that simple direct selection is effective in improving such characters. Similar observations were reported by Gangappa (1991), Jayaramaiah*et al* (1994) and Reddy and Reddy (2006). High heritability with moderate genetic advance has been observed for days to 50 % flowering and volume weight. High heritability coupled with low genetic advance has been recorded for oil content, indicating greater influence of environmental factors on the expression of such characters. Therefore simple direct selection methodologies would be less effective to improve these characters.

In present study, characterization was done as per IBPGR descriptors (Anon., 1985) and UPOV guidelines. The germplasm lines were characterized with regard to leaf shape, leaf color, leaf serrations, leaf hairiness, stem hairiness, indicator leaf, petiole anthocyanin, branching, leaf angle, petiole length, stem pigmentation, days to 50% flowering, pollen color, plant height, head diameter, oil content, seed yield per plant and test weight(Table 2).

The morphological characterization is very important for selection, identification and classification of various germplasm / inbred lines. Morphological characterization helps to screen lines/parents resistant to insect pests based on the morphological traits such as leaf and stem hairiness which inhibit oviposition (Zimmerman and Fick, 1973) leatheriness of leaves, seed color and size (Balakrishnan*et al*., 1994). Besides this, morphological traits are also helpful for screening of diseases as well as attraction to insects for pollination (Sinha and Atwal,1996; Pathak *et al*., 2000)

A total of 143 germplasm accessions of sunflower were characterized for various qualitative and quantitative characters. It was noticed that these germplasm accessions exhibited wide range of variability for all the characters studied (Table 3). Most of the accessions showed dark green chordate leaf shape having anthocyanin pigmentation on petiole and stem. Similar observations were reported by Virupakshappa and Sindagi (1987) and Suma and Virupakshappa (1994). All 143 germplasm accessions were having yellow pollen colour showing the predominance of this character in sunflower germplasm.

Leaf characters such as leaf shape, leaf angle and leaf color play an important role in identification and are often associated with yielding ability of plant species. Erect orientation of leaves permit greater penetration and more even distribution of light into the crop canopy and thus higher photosynthetic activity. Thicker and dark green leaves usually have higher densities of chlorophyll per unit area and hence have greater photosynthetic abilities. Leaf serration provides tolerance to the plant against invading pests.

Most of the germplasm lines possessed chordate leaf shape (100 out of 143) which were in accordance with results obtained by Virupakshappa and Sindagi (1987) and Suma and Virupakshappa (1994) whereasJayaramaiah*et al*, (1994) and Gowda (1994) observed more occurrence of triangular leaf shape.

Leaf angle was acute between 45 to 60^{o} in majority of the germplasm lines (122 out of 143), however Anulaxmi (2009) reported leaf angle less than 45^{o} in majority of sunflower germplasm. Petiole length was medium (10-20 cm) in majority of germplasm lines (118 out of 143) which is in accordance with Gowda (1994), Satisha (1995) and Sujatha (2000).

Leaf color was dark in 125 out of 143 germplasm lines. Similar findings were also observed by Gowda (1994), Sujatha (2000) and Reddy and Reddy (2006). For leaf serration, majority of lines exhibited medium serration (95 out of 143). Similar results were reported by Jayaramaiah*et al*, (1994), Gowda (1994) and Satisha (1995). Whereas Suma

and Virupakshappa (1994) reported most of the accessions with coarse leaf serration.

Leaf, petiole and stem characters like pigmentation and hairiness are of significant importance in the field of hybrid seed production which can be used as suitable phenotypic marker for germplasm identification. Sparse leaf hairiness was noticed in 120 out of 143 germplasm lines which are in line with results obtained by Reddy and Reddy (2006) and Anulaxmi (2009). However, most of the germplasm lines (113 out of 143) showed dense stem hairiness, which are in line with reports of Reddy and Reddy (2006) and Shashikumar (2007).

Leaves are vitally essential organs for photosynthesis, which is a major process affecting crop growth rates and is affected by either number or area of leaves. In addition, leaves play a vital part in controlling water loss by plants (Karadogan and Akgun, 2009). Indicator leaves on the head help for identification of germplasm lines as well as quick transport of photosynthate to the developing head and seeds. Larger portion of germplasm lines (124 out of 143) were lacking indicator leaves in the present study.

Majority of the germplasm lines (126 out of 143) showed absence of petiole pigmentation. These results are in accordance with Sujatha (2000) whereasSatisha (1995) and Shashikumar (2007) recorded contradictory observations.

Branching determines the plant type of particular line or parent, which directly or indirectly influences the yielding ability of the genotype. Non-branching types were common in most of the germplasm lines (122 out of 143) and these results are in accordance with the findings of Virupakshappa and Sindagi (1987), Satisha (1995), Sujatha (2000) and Anulaxmi (2009).

The germplasm accession GP6-358 (54 days) and GP6-420 (55 days) were early flowering types whereas accession GP6-969 (60 days) and GP6-341 (63 days) were late types. These accessions can be used to breed for early maturing hybrids in sunflower to suit the demanding cropping system. The accessions GP6-1725 (65 days) found to be the dwarf plant type followed by GP6-46 (80cm)whereas, GP6-326 (195cm) had a tall plant type. Largest capitulumsize has been observed in GP6-303, GP6-282 and GP6-286 (22cm), whereas smallest head size of 7cm has been noticed in GP6-371. The accessions GP6-1468 recorded highest test weight of 7.8g followed by GP6-358 (7.6g) and GP6-18-1 (7.4g). Maximum seed yield per plant was observed in accession GP6-63 (41g) followed by GP6-451 (40g) and GP6-122 (40g), which can be used for breeding for high yielding sunflower lines and hybrids.

Thus, it can be concluded that no germplasm accession is found to be good for all the quantitative characters. However, different accessions have been identified as promising for different traits. Three germplasm accessions GP6-656, GP6-366 and GP6-1102 were found to be good for both seed yield per plant and higher oil content. Whereas, GP6-312 and GP6-326 were early as well as having higher seed yield per plant. These different better performing lines for different quantitative characters could be used to constitute gene pool. Promising sunflower population and lines can be generated by using gene pools as base population.

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Table 1 : Mean sum of squares for quantitative characters in Sunflower

Source	df	Plant Height (cm)	Head diameter (cm)	Days to 50% flowering	Test weight (g)	Volume weight (g/100 ml)	Seed yield per plant (g)	Oil content (%)
Genotypes	142	1077.8	22.75	12.7	1.98	39.67	229.7	46.49
Replication	1	481.2	36.44	1.39	0.48	1.94	716.8	10.04
Error	142	95.2	1.94	0.86	0.09	0.64	29.37	19.69
CV %		6.86	9.5	1.57	6.25	2.13	19.44	12.33

Table 2. Variability parameters for quantitative traits in sunflower

	Range	Mean	PCV (%)	GCV (%)	Heritability (%)	GA (% of mean)
Plant height (cm)	52-195	142	17	15.6	84	29.4
Head diameter (cm)	7-22	14.7	23.9	21.9	84	41.64
Days to 50% flowering	54-68	59.2	4.42	4.13	87	7.94
Test weight (g)	2.9-7.8	4.9	20.8	19.9	91	39.2
Volume weight (g/100 ml)	27-47	38.1	12	11.8	96	23.9
Seed yield / plant (g)	1.7-53	21.3	53.4	46.9	77	65.1
Oil content (%)	20.9-42.9	36.3	16	10.2	41	13.3

Table 3: Grouping of sunflower germplasm accessions based on qualitative characters

Sl. No.	Character	Grouping	No. of Lines
01.	Leaf Shape	Cordate	100
		Triangular	43
02.	Leaf Color	Dark Green	125
		Light Green	18
03.	Leaf Serrations	Fine	22
		Medium	95
		Coarse	26
04.	Leaf Hairiness	Dense	23
		Sparse	120
05.	Stem Hairiness	Dense	113
		Sparse	30
06.	Indicator Leaf	Absent	124
		Present	19
07.	Petiole Anthocyanin	Absent	126
		Present	17
08.	Branching	Absent	122
		Top Branching	08
		Full Branching	13
09.	Leaf Angle	Small (< 45)	10
		Medium (46 to 60)	122
		Large (> 60)	11
10.	Petiole Length	Small (< 10 cm)	20
		Medium (10 – 20 cm)	118
		Large (> 20 cm)	05
11.	Stem Pigmentation	Absent	129
		Present	14
12.	Days to 50% flowering	Early (< 57 days)	125
		Late (> 57 days)	18
13.	Pollen color	Yellow	143
		White	00
14.	Plant Height	Dwarf (< 90 cm)	46
		Medium (91 – 160 cm)	34
		Tall (> 160 cm)	63
15.	Head diameter	Small (< 10 cm)	110
		Medium (11-20 cm)	26
		Large (> 20 cm)	07
16.	Oil content	Low (< 30)	92
		Medium (31 to 37)	44
		High (> 37)	07
17.	Seed yield/plant	Low (< 20 g)	58
		Medium (21 – 35 g)	73
		High (> 35 g)	12
18.	Test Weight	Low (< 2.5 g)	74
		Medium (2.6 – 6.5 g)	43
		High (> 6.5 g)	26

Table 4: Promising sunflower accessions for different economic characters

Characters	Germplasm accession
Plant Height (< 90cm)	GP6-1725, GP6-46, GP6-371, GP6-1665
Head Diameter (>20cm)	GP6-303, GP6-282, GP6-286, GP6-135, GP6-341, GP6-1127, GP6-18-1, GP6-332, GP6-1350, GP6-160
Days to 50% flowering (<57 days)	GP6-358, GP6-1217, GP6-420, GP6-303, GP6-286, GP6-18-1, GP6-332, GP6-327, GP6-326, GP6-1072, GP6-312, GP6-534, GP6-990, GP6-967, GP6-442
Test weight (> 6.5 g)	GP6-1468, GP6-358, GP6-18-1, GP6-656, GP6-175, GP6-1533, GP6-1477, GP6-332, GP6-282
Seed yield / plant (>35 g)	GP6-63, GP6-451, GP6-122, GP6-310, GP6-656, GP6-374, GP6-370, GP6-313, GP6-109, GP6-366, GP6-1102, GP6-357, GP6-326, GP6-764, GP6-312
Oil content (>37%)	GP6-883, GP6-1576, GP6-1063, GP6-1020, GP6-967, GP6-331, GP6-1573, GP6-1588, GP6-366, GP6-1075, GP6-1450, GP6-1665, GP6-1468, GP6-1060, GP6-1023, GP6-1001, GP6-1477, GP6-1135, GP6-1102, GP6-1254, GP6-11, GP6-965, GP6-18, GP6-325, GP6-1228, GP6-951, GP6-656, GP6-917, GP6-792, GP6-912, GP6-1518, GP6-699, GP6-714, GP6-534, GP6-1436, GP6-586, GP6-615, GP6-1207