Research Journal of Agricultural Sciences
An International Journal

Res. Jr. of Agril. Sci. **12**(2): 428–432

P- ISSN: 0976-1675 | **E**- ISSN: 2249-4538

www.rjas.org

Research Paper

Screening of Sunflower Genotypes (*Helianthus annuus* L.) as Bedding Plants in the Coastal Ecosystem

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Received: 23 Dec 2020 | Revised accepted: 23 Feb 2021 | Published online: 11 Mar 2021

A B S T R A C T

The flowering parameters of around fifty sunflower genotypes were evaluated to check their suitability as bedding plants for use in future trials to standardize their production technology in the coastal ecosystem. The experiment was laid out in a randomized block design replicated thrice. The study was conducted in the Floriculture Unit of the Department of Horticulture, Faculty of Agriculture, Annamalai University. The flowering parameters viz. days to 50% flowering, number of flowers per plant, flower diameter, ray floret arrangement, ray floret length, disc floret diameter, ray floret disc floret ratio, ray floret colour, disc floret colour, carotenoid content and flower rating were observed. The cultivar with an outstanding overall performance was 'Ring of Fire' which has glowing golden yellow and reddish-brown petals forming an indistinct ring around the dark center. This cultivar was found to be suitable as bedding plant in the coastal ecosystem in terms of all the flowering parameters.

***Key words*:** Sunflower genotypes, Bedding plant, Flowering parameters, Screening, Coastal ecosystem

Ornamental sunflower (*Helianthus annuus* L.) is an important annual plant having large and bright yellow-colored inflorescences is gaining importance as cut flowers and ornamental plant markets [1] and are also commonly used in the landscape as bedding plants for borders or screening. The variety 'Ring of Fire' has a glowing golden yellow and reddish-brown petal forming an indistinct ring around the dark center which is suitable to be grown as bedding plants. Bedding plants are either residentially or commercially used to provide colour to the landscapes. These plants are also grown for their attractive foliage, unusual forms and textures. In the bedding plant industry, the competitive market seeks rapid dissemination of information through timely evaluations of new cultivars [2]. Generally, sunflowers are used for the production of oil seeds, but in the recent times they are also used for the ornamental purposes such as cut flowers and as bedding plants. There are no proper standards that has been developed for sunflowers to be used as bedding plants, especially in the coastal ecosystem. Hence cultivars are chosen and compared for evaluating their suitability to be grown as bedding plants.

MATERIALS AND METHODS

Around fifty sunflower germplasms were evaluated in a randomized block design, replicated thrice in the Floriculture Unit of the Department of Horticulture, Faculty of Agriculture, Annamalai University. The germplasms were collected from various sources such as, NBPGR, New Delhi; TNAU, Coimbatore; Creative farmer, Ernakulam; Kraft seeds, New Delhi, Seedscare, New Delhi and Benary Seeds, Germany.

Seeds were sown in beds of size 1.6 x 1.6 m with fifteen plants per plot and a spacing of 45 x 30 cm arranged in three rows across the bed with an equal area between the plots. The recommended dose of fertilizers and organic manures were incorporated during land preparation. Timely irrigation was given according to the soil requirements. Weeding was done periodically and integrated pest management was employed to control the pests and plant pathogens. A rating (1 to 7) was given for flowers with the highest rating of 7. The flower ratings were as follows 7 = higher number of flowers, attractive color, uniformly distributed, free from pest symptoms; 4 = average density of flowers, minimal insect damage; 1 = very less flowers, lodging of stem, full insect damage. For measuring the performance, ratings were added and divided by the total number of ratings (four per trial). The cultivar with the highest performance rating was selected as the best cultivar.

The measurements for the objective data were taken from five plants, and for subjective data, one rating value representing all fifteen plants in the plot was given. The data were analyzed using the analysis of variance (ANOVA) methods.

RESULTS AND DISCUSSION

The sunflower genotypes were evaluated for their floral characteristics. An ideal bedding plant blooms early after

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planting, free of insects or diseases, tolerant to heat and drought, long time blooming with attractive flowers and foliage making it suitable for the purpose of design in landscaping. These plants grow more compactly and produce more flowers are considered to be more suitable as bedding plants.

Table 1 Floral characteristics of the evaluated sunflower genotypes

Genotypes	Days to 50% flowering/plot	No. of flowers/ Plant	Flower diameter (cm)	Ray floret arrangement	Ray floret colour
Music Box	51.08	7.12	4.34	Dense	Bright yellow
Pacino	52.35	10.32	6.23	Dense	Pale yellow
Ring of Fire	52.02	12.45	12.37	Dense	Bright yellow with reddish brown ring
6 D-1 J7 2017	51.43	4.23	11.39	Sparse	Yellow
6 D-1 K1	51.63	6.19	9.52	Dense	Pale Yellow
6 D-1 K2	51.07	6.35	11.55	Sparse	Yellow
6 D-1 L1 A	52.56	7.28	11.09	Sparse	Yellow
6 D-1 L1 C	54.23	8.54	16.54	Sparse	Yellow
6 D-1 L3 A	51.09	7.41	9.68	Sparse	Bright yellow
6 D-1 L3 B	51.10	6.62	9.23	Dense	Yellow
6 D-1 L4 A	63.11	5.27	13.66	Sparse	Yellow
6 D-1 L4 B	51.23	5.43	6.71	Sparse	Bright yellow
GMU 999	59.27	1.12	7.54	Dense	Pale yellow
GMU 997	63.41	1.23	13.52	Sparse	Bright yellow
GMU 996	51.06	1.45	14.15	Dense	Pale yellow
GMU 918	64.56	1.03	6.89	Sparse	Bright yellow
GMU 690	56.15	1.67	12.52	Sparse	Bright yellow
GMU 945	58.84	1.32	8.31	Sparse	Yellow
GMU 1102	66.22	1.18	8.25	Sparse	Bright yellow
GMU 646	63.88	1.97	7.76	Sparse	Bright yellow
GMU 987	52.84	1.29	7.11	Sparse	Yellow
GMU 946	54.73	1.77	9.49	Sparse	Yellow
GMU 1044	60.61	1.43	12.78	Sparse	Yellow
GMU 754	60.41	1.83	9.50	Sparse	Bright yellow
GMU 1052	53.19	1.14	12.45	Sparse	Yellow
GMU 928 A	51.05	1.41	15.22	Sparse	Pale yellow
GMU 1100	59.23	1.67	14.49	Dense	Yellow
GMU 1064	65.18	1.28	17.58	Dense	Yellow
GMU 949	55.26	1.55	9.18	Dense	Yellow
GMU 1043	61.21	1.81	14.58	Sparse	Bright yellow
GMU 982	65.19	1.95	8.20	Dense	Yellow
GMU 980	67.25	1.02	11.26	Sparse	Pale yellow
GMU 947	55.61	1.32	7.17	Sparse	Yellow
GMU 746	55.87	1.47	11.53	Sparse	Pale yellow
GMU 767	63.14	1.81	9.52	Dense	Yellow
GMU 1082	66.19	1.66	14.51	Dense	Yellow
GMU 928	58.86	1.19	8.39	Sparse	Yellow
Morden	54.22	1.09	10.26	Sparse	Yellow
18398	53.32	1.21	12.60	Dense	Yellow
18389	55.45	3.44	9.18	Dense	Yellow
18372	59.78	1.55	15.71	Dense	Yellow
18382	66.83	1.39	11.25	Dense	Bright yellow
CO 4	62.12	1.17	16.10	Dense	Yellow
18385	60.75	1.89	15.90	Sparse	Yellow
18378	52.16	2.93	11.54	Dense	Yellow
CO(SFV)5	58.13	1.61	11.07	Dense	Yellow
18387	55.66	3.58	6.08	Dense	Bright yellow
RHA272	65.71	1.76	13.60	Dense	Yellow
LTRO7	61.84	2.39	14.28	Dense	Yellow
18399	61.11	2.13	16.16	Dense	Yellow
S.ED.	0.10	0.01	0.06	-	-
C.D. (0.05)	0.21	0.02	0.13	-	-

Table 1 ……. Continued

Genotypes	Disc floret colour	Ray floret length (cm)	Disc floret diameter (cm)	Ray floret disc floret ratio	Carotenoid content (mg/g)	Flower rating
Music Box	Dark yellow	3.01	1.33	2.26	1.11	5.52
Pacino	Dark brown	4.12	2.11	1.95	0.79	5.20
Ring of Fire	Dark brown	6.22	6.15	1.01	1.27	5.90
6 D-1 J7 2017	Dark yellow	3.21	8.18	0.39	0.61	5.26
6 D-1 K1	Dark yellow	4.44	5.02	0.88	0.49	5.39
6 D-1 K2	Dark yellow	5.10	6.45	0.79	0.95	5.36
6 D-1 L1 A	Brown	5.55	5.54	1.00	0.77	5.17
6 D-1 L1 C	Dark yellow	8.05	8.49	0.94	0.53	5.27
6 D-1 L3 A	Dark yellow	3.57	6.11	0.58	1.05	5.13
6 D-1 L3 B	Yellow	3.07	6.16	0.49	0.85	5.26
6 D-1 L4 A	Dark yellow	6.76	6.90	0.97	0.54	5.18
6 D-1 L4 B	Brown	3.41	3.30	1.03	1.06	5.27
GMU 999	Yellow	3.77	3.77	1.00	0.39	3.93
GMU 997	Dark yellow	6.82	6.70	1.01	1.19	4.11
GMU 996	Dark yellow	7.08	7.07	1.00	0.44	3.74
GMU 918	Yellow	4.11	2.78	1.47	1.03	4.82
GMU 690	Brown	6.35	6.17	1.03	1.00	4.85
GMU 945	Yellow	4.19	4.12	1.01	0.59	3.49
GMU 1102	Dark yellow	3.58	4.67	0.76	1.09	3.34
GMU 646	Dark yellow	3.89	3.87	1.00	1.05	4.44
GMU 987	Dark yellow	3.55	3.56	0.99	0.52	3.92
GMU 946	Dark yellow	4.74	4.75	0.99	0.92	3.15
GMU 1044	Dark yellow	6.32	6.46	0.97	0.69	4.48
GMU 754	Yellow	4.63	4.87	0.95	1.06	4.23
GMU 1052	Yellow	6.27	6.18	1.01	0.95	4.17
GMU 928 A	Yellow	7.21	8.01	0.90	0.45	4.38
GMU 1100	Dark brown	4.83	9.66	0.50	0.88	4.92
GMU 1064	Dark yellow	8.21	9.37	0.87	0.57	4.52
GMU 949	Yellow	4.59	4.59	1.00	0.51	3.57
GMU 1043	Dark yellow	7.30	7.28	1.00	1.17	4.79
GMU 982	Brown	4.10	4.10	1.00	0.75	4.57
GMU 980	Dark yellow	5.64	5.62	1.00	0.41	4.48
GMU 947	Yellow	3.61	3.56	1.01	0.93	4.77
GMU 746	Dark yellow	5.72	5.81	0.98	0.48	4.72
GMU 767	Yellow	4.53	4.99	0.90	0.50	4.43
GMU 1082	Yellow	7.25	7.26	0.99	0.64	4.94
GMU 928	Dark yellow	4.26	4.13	1.03	0.90	4.65
Morden	Brown	4.95	5.31	0.93	0.83	3.21
18398	Dark yellow	6.11	6.49	0.94	0.55	4.02
18389	Yellow	5.24	3.94	1.32	0.58	4.36
18372	Yellow	7.85	7.86	0.99	0.74	3.96
18382	Brown	4.87	6.38	0.76	1.07	3.82
CO 4	Yellow	7.97	8.13	0.98	0.70	4.72
18385	Yellow	7.04	8.86	0.79	0.81	4.71
18378	Yellow	4.80	6.74	0.71	0.64	4.16
CO(SFV)5	Dark yellow	5.47	5.60	0.97	0.66	4.96
18387	Brown	3.49	2.59	1.34	1.14	4.45
RHA272	Yellow	6.75	6.85	0.98	0.86	4.19
LTRO7	Dark yellow	7.14	7.14	1.00	0.73	4.63
18399	Yellow	8.03	8.13	0.98	0.82	5.11
S.ED.	-	0.05	0.06	0.02	0.13	0.05
C.D. (0.05)	-	0.11	0.12	0.04	0.26	0.11

Days to 50% flowering

The data on the days to 50% flowering are presented in (Table 1), ranging from 51.05 days to 67.25 days. Among the genotypes evaluated, the earliest flowering was noticed in 6D-1 L3 B (51.05 days) which was on par with GMU 996 (51.06 days), 6D-1 K2 (51.07 days), 6D-1 L3 A (51.09 days). GMU 928 A (51.10 days), 6D-1 J7 2017 (51.43 days) and 6D-1 K1 (51.63 days) followed by Ring of Fire (52.02 days), 18378 (52.16 days) and Pacino (52.35 days), whereas delayed flowering (67.25 days) was seen in GMU 980. This significant variation might be due to the genetical expression of the respective genotypes. Earlier findings on variation in days to 50% flowering were reported by [3] in china aster and [4] in marigold.

Number of flowers per plant

The data on the number of flowers are presented in (Table 1) which ranged between 1.02 to 12.45. The maximum

number of flowers was observed in the genotype 'Ring of Fire' followed by Pacino (10.32) whereas the least number of flowers were observed in the genotype GMU 980 (1.02). The genotypes that had branching habit produced more number of blooms when compared to the non-branching types that produced a single bloom per plant. The genotypes that produced multiple flowers are Music Box, Pacino, Ring of Fire, 6D-1 J7 2017, 6D-1 K1, 6D-1 K2, 6D-1 L1 A, 6D-1 L1 C, 6D-1 L3 A, 6D-1 L3 B, LD-1 L4 A and 6D-1 L4 B. Similar variation in the number of flowers among different genotypes was observed by [5] in gerbera and [6] in marigold.

Flower diameter

The data presented in (Table 1) on the flower diameter which ranges from 4.25 cm to 16.54 cm. The maximum flower diameter was observed in the genotype 6 D-1 L1 C (16.54 cm) followed by the genotype 6 D-1 L1 C (16.54 cm) and the minimum flower diameter (4.25 cm) was recorded in GMU 1102. This variation might be due to the variation in the length of the ray floret and disc floret diameter. The results were in accordance with the findings of [7] in sunflower and [8] in gerbera.

Ray floret arrangement

The data on the ray floret arrangement are given in (Table 1). which ranges from sparse to dense arrangement. This variation in the ray floret arrangement is due to the genetic makeup of the genotypes and such variations were earlier reported by [9] in ornamental sunflower.

Ray floret length

Table 1. represents the data on ray floret length which ranged from 3.01 cm to 8.21 cm. The maximum ray floret length was recorded in the genotype GMU 1064 (8.21 cm) followed by the genotypes 6 D-1 L1 C (8.05 cm) and 18399 (8.03 cm) whereas the shortest ray floret length was observed in the genotype Music Box (3.01 cm). Earlier findings by [10] in chrysanthemum and [11] in gerbera reported such significant variation in ray floret length of the flowers.

Disc floret diameter

Significant variation was recorded in the disc floret diameter and the data are presented in (Table 1). The diameter of the disc floret ranged from 1.33 cm to 9.66 cm. The maximum disc floret diameter was observed in the genotype GMU 1100 (9.66 cm) followed by the genotype GMU 1064 recording 9.37 cm and the minimum disc floret diameter was recorded in the genotype Music Box (1.33 cm). Similar trend was noticed by [12] in gerbera and [13] in gerbera.

Ray floret disc floret ratio

The data pertaining to the ray floret disc floret ratio are presented in (Table 1). The ratio ranged from 0.39 (6 D-1 J7 2017) to 2.26 (Music Box). The genotypes that had a balanced ray floret length and disc floret diameter were Ring of Fire, 6 D-1 L1 A, 6 D-1 L4 B, GMU 999, GMU 997, GMU 996, GMU 690, GMU 945, GMU 646, GMU 1052, GMU 949, GMU 1043, GMU 982, GMU 980, GMU 947, GMU 928 and LTRO7.

Ray floret colour

A range of colours with different shades of yellow were noted among the fifty germplasms studied. The colours that were observed in the ray florets are bright yellow, yellow and pale yellow. The genotypes with the bright yellow colour were Music Box, 6 D-1 L3 A, 6 D-1 L4 B, GMU 997, GMU 918, GMU 690, GMU 1102, GMU 646, GMU 754, GMU 1043, 18382 and 18387. Majority of the genotypes exhibited yellow colour namely 6 D-1 J7 2017, 6 D-1 K2, 6D-1 L1 A, 6 D-1 L1 C, 6 D-1 L3 B, 6 D-1 L4 A, GMU 945, GMU 987, GMU 946, GMU 1044, GMU 1052, GMU 1100, GMU 1064, GMU 949, GMU 982, GMU 947, GMU 767, GMU 1082, GMU 928, Morden, 18398, 18389, 18372, CO 4, 18385, 18378, CO(SFV)5, RHA 272, LTRO7 and 18399. Pale yellow colour was obtained in the genotypes Pacino, 6 D-1 K1, GMU 999, GMU 996, GMU 928 A, GMU 980, GMU 746 and a significant bright yellow colour with reddish brown ring was obtained in the genotype Ring of Fire. Similar variation in the ray floret colour was earlier reported by [14] in chrysanthemum and [15] in gerbera.

Disc floret colour

A variety of disc floret colours namely yellow, dark yellow, brown and dark brown were observed among the various genotypes studied. Yellow coloured disc florets were recorded in the genotypes 6D-1 L3 B, GMU 999, GMU 918, GMU 945, GMU 754, GMU 1052, GMU 928 A, GMU 949, GMU 947, GMU 767, GMU 1082, 18389, 18372, CO 4, 18385, 18378, RHA272 and 18399. The following genotypes exhibited dark yellow coloured disc florets namely, Music Box, 6 D-1 J7 2017, 6 D-1 K1, 6 D-1 K2, 6 D-1 L1 C, 6 D-1 L3 A, 6 D-1 L4 A, GMU 997, GMU 996, GMU 1102, GMU 646, GMU 987, GMU 946, GMU 1044, GMU 1064, GMU 1043, GMU 980, GMU 746, GMU 928, 18398, CO(SFV)5 and LTRO7. The brown-coloured disc florets were recorded in the genotypes, 6 D-1 L1 A, 6 D-1 L4 B, GMU 690, GMU 982, Morden, 18382 and 18387 whereas the dark brown coloured disc florets were observed in Pacino, Ring of Fire and GMU 1100.

Carotenoid content

The data on the carotenoid content of the flowers are presented in (Table 1) ranging from 0.39 mg/g and 1.27 mg/g. The maximum carotenoid content was recorded in the genotype Ring of Fire (1.27 mg/g) which was on par with GMU 997 (1.19 mg/g), GMU 1043 (1.17 mg/g), 18387 (1.14 mg/g), Music Box (1.11 mg/g), GMU 1102 (1.09 mg/g), 18382 (1.07 mg/g), 6 D-1 L4 B (1.06 mg/g), GMU 754 (1.06 mg/g), 6 D-1 L3 A (1.05 mg/g), GMU 646 (1.05mg/g) and GMU 918 (1.03 mg/g) whereas the minimum carotenoid content was observed in the genotype GMU 999 (0.39 mg/g). Significant variation in carotenoid content was also reported by [16] in sunflower.

Flower rating

The flower rating ranged from 3.15 to 5.90 and is presented in (Table 3). The maximum flower rating of 5.90 was recorded in the genotype 'Ring of Fire' and the lowest rating (3.15) was obtained with the genotype GMU 946. The variation in the flower rating was ascribed to the number of flowers, attractive color, uniform distribution of flowers and the incidence of pest and diseases [17].

Selection of genotypes

Among the fifty genotypes evaluated, cultivars with the suitable flowering characteristics for bedding plants were grouped under 'class standard'. Early flowering is generally best suited for bedding plants and therefore the genotypes that flowered earlier than 55 days were grouped under class standard namely Music Box, Pacino, Ring of Fire, 6 D-1 J7

2017, 6 D-1 K1, 6 D-1 K2, 6D-1 L1 A, 6D-1 L1 C, 6D-1 L3 A, 6 D-1 L3 B, 6 D-1 L4 B, GMU 996, GMU 987, GMU 946, GMU 1052, GMU 928 A, Morden, 18398 and 18378.

A good bedding plant must produce more number of blooms and therefore such genotypes were grouped under class standard such as Music Box, Pacino, Ring of Fire, 6D-1 J7 2017, 6D-1 K1, 6D-1 K2, 6D-1 L1 A, 6D-1 L1 C, 6D-1 L3 A, 6D-1 L3 B, LD-1 L4 A and 6D-1 L4 B. The genotypes which produced flowers with dense arrangement of ray florets being more attractive in appearance were classified under class standard namely Music Box, Pacino, Ring of Fire, 6 D-1 K1, 6 D-1 L3 B, GMU 999, GMU 996, GMU 1100, GMU 1064, GMU 949, GMU 982, GMU 767, GMU 1082, 18398, 18389, 18372, 18382, CO 4, 18378, CO(SFV)5, 18387, RHA272, LTRO7 and 18399.

The genotypes with the ray floret disc floret ratio that is evenly balanced were grouped under class standard because evenly balanced flowers will be more aesthetic than unevenly balanced flowers and the genotypes with such ratio were Ring of Fire, 6 D-1 L1 A, 6 D-1 L4 B, GMU 999, GMU 997, GMU 996, GMU 690, GMU 945, GMU 646, GMU 1052, GMU 949, GMU 1043, GMU 982, GMU 980, GMU 947, GMU 928 and LTRO7. In respect to flower rating, only the genotype Ring of Fire scored more than 80 percentage rating and was grouped under class standard. Among the fifty genotypes evaluated, the genotype Ring of Fire was the only genotype that was present in all the class standards. This genotype also had attractive bright yellow flowers with a distinct reddish-brown ring and recorded the highest carotenoid content. Thus, the genotype Ring of Fire is proved to be the most suitable genotype as bedding plant in the coastal ecosystem.

CONCLUSION

The results of the study revealed that almost all the evaluated genotypes showed significant variation in all the flowering parameters. However, the genotype ‘Ring of Fire’ performed better in all the flowering characteristics than all the other genotypes and showed best suitability as a bedding plant in the coastal ecosystem.

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