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EVALUATION OF SUNFLOWER GENOTYPES (*HELIANTHUS ANNUUS* L.) AS BEDDING PLANTS IN THE COASTAL ECOSYSTEM

B. Pamela Elisheba and R. Sudhagar
Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai nagar - 608 002, Chidambaram, Tamil Nadu, India.
e-mail: amazingrace2300@gmail.com

ABSTRACT

The 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. Fifty genotypes were evaluated which was laid out in a randomized block design replicated thrice. The experiment was conducted in the Floriculture Unit of the Department of Horticulture, Faculty of Agriculture, Annamalai University. The vegetative parameters viz., plant height, number of leaves, leaf area, foliage rating and the flowering parameters viz., days to first flowering, flower diameter, ray floret arrangement 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 vegetative and flowering parameters.

Keywords: Sunflower genotypes, bedding plant, vegetative parameters, flowering parameters

Introduction

Bedding plants are an essential part of garden design. They provide a temporary decorative seasonal display for beds, borders, containers and hanging baskets. A bedding plant is any common fast-growing garden plant typically found in a nursery or garden center in mass quantities to plant in flower beds, specifically grown for the purpose of decorating and filling in garden spaces. Bedding plants can be annuals, biennials, or perennials. Because bedding plants are relatively inexpensive, they provide the gardener an opportunity for instant blooms and quick coverage. They are also widely used in pots for decorating patios and decks. These plants may also be known as patio plants.

In the bedding plant industry, the competitive market seeks rapid dissemination of information through timely evaluations of new cultivars (Kelly *et al*., 2006). Sunflowers are generally used for the production of oil seeds, but nowadays they are also used for the ornamental purposes such as cut flowers and as bedding plants. Standards have not 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. This study was conducted to evaluate the sunflower genotypes performance in replicated trials to provide evaluations that may benefit the landscapers, researchers and seed companies.

Materials and Methods

The 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. Fifty genotypes were collected from 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 basal 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 foliage and flowers with the highest rating of 7. The foliage characteristics were rated within a scale as follows; 7 = higher number of leaves, uniformly distributed, free from pest symptoms; 4 = average density of foliage, minimal insect damage; 1 = sparse foliage, lodging of stem, full insect damage. 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 was 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 vegetative and floral characteristics at different stages of growth. The ideal bedding plant is one that blooms early after planting, is free of insects or diseases, is heat and drought tolerant, blooms for a long time, has attractive flowers and

foliage that suits the purpose of design in landscaping. The plants that grow more compactly and produce more flowers are considered to be more suitable as bedding plants.

Plant height

The data on plant height of different sunflower genotypes are presented in Table 1. Among the genotypes studied, significant differences were observed in plant height at various stages of growth. Observations recorded at 30 DAS, 45 DAS and 60 DAS showed that the mean plant height ranged between 16.93 cm to 57.55 cm, 70.93 cm to 163.18 cm and 85.25 cm to 210.53 cm respectively. The maximum plant height was observed in the genotype GMU 1044 (210.53 cm), whereas the minimum plant height was observed in Pacino (85.25 cm) at 60 DAS.

The genotypes with plant height more than 130 cm may be grouped as tall plants, 100 to 130 as medium tall and less than 100 cm as dwarf. Medium sized bedding plants generally have a plant height of less than or equal to 120 cm to be planted in the landscapes. At 60 DAS the genotypes that recorded plant height less than 120 cm were Music Box, Pacino, Ring of Fire, 6 D-1 L4 B, GMU 1052, GMU 1064, Morden, 18398, 18372, 18382, 18385, 18378 and RHA 372. The variation in the plant heights of the genotypes might be due to the genetical expression of the respective genotypes. Similar variation for plant height among the genotypes was observed by Aisyah *et al*. (2014) in sunflower and Kelly *et al*. (2007) in Petunia.

Number of leaves

The data on the number of leaves produced per plant at different stages of growth in different genotypes are presented in Table 2. The number of leaves produced per plant at different stages of growth varied significantly among the genotypes studied and the number of leaves per plant varied from to 8.23 to 20.78, 10.49 to 42.27 and 8.13 to 30.38 at 30, 45 and 60 DAS, respectively.

At 60 DAS, the maximum number of leaves (30.38) was recorded in the genotype GMU 987 and the minimum number of leaves (8.13) was obtained with GMU 1044. This variation may be due to the varietal character and plant structure. This was in accordance with the findings of da Silva *et al.* (2018) and Parmeshwar (2010) in sunflower.

Leaf area

The data on the leaf area at different stages of plant growth are presented in Table 2. The leaf area at 30 DAS, 45 DAS and 60 DAS ranged from 34.60 to 193.19 cm^2, 70.28 to 470.40 cm^2 and 449.94 to 1580.87 cm^2 respectively. The maximum leaf area of 1580.87 cm^2 was obtained with GMU 918 followed by GMU 996 (1456.93 cm^2) whereas the minimum leaf area (449.94 cm^2) was recorded in the genotype 18399 at 60 DAS. The significant variation in leaf area might be due to the genetic variation and the leaf area increased upto 60 days then reduced due to leaf shedding. Similar type of genotypic difference in leaf area was observed by Wantoo (2007) in China aster.

Foliage rating

In Table 2, the data on the foliage rating has also been presented and it ranged from 3.22 to 5.85. GMU 754 recorded the highest score of foliage rating (5.85) followed by GMU 1102 (5.47) and the lowest (3.22) was obtained in 6 D-1 J 7 2017. The variation in the foliage rating was ascribed to the number of leaves, uniform distribution of leaves and the incidence of pest and diseases. Similar findings were observed in petunia by Kelly *et al.* (2007).

Days to first flowering

The data on the days to first flowering are presented in Table 3, ranging from 42.21 to 60.21 days. Among the genotypes evaluated, the earliest flowering was noticed in GMU 928 A (42.21 days) which was on par with 6 D-1 K 1 (42.42 days), whereas delayed flowering (60.21 days) was seen in GMU 1102. Earlier findings on variation in days to first flowering were reported by Mladenovic *et al.* (2016) in ornamental sunflower.

Flower diameter

Table 3 presents the data 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) and the minimum flower diameter (4.25 cm) was recorded in GMU 1102. The results were in accordance with the findings of Sloan and Harkness (2006) in sunflower.

Ray floret arrangement

The data on the ray floret arrangement are given in Table 3. which ranges from sparse to dense arrangement. This variation in the ray floret arrangement was earlier reported by Mladenovic *et al.* (2016) in ornamental 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. The results are in accordance with the findings of Kelly *et al.* (2006) in viola.

Among the fifty genotypes studied, 'Ring of Fire' was found to be the promising genotype as a bedding plant based on various parameters. It recorded the suitable plant height (25.13, 84.82, 94.19 cm at 30 DAS, 45 DAS and 60 DAS respectively), more number of leaves (14.11, 25.16 and 23.04 at 30 DAS, 45 DAS and 60 DAS respectively.), suitable leaf area (145.10, 235.08, 725.36 cm^2 30 at DAS, 45 DAS and 60 DAS respectively), earlier flowering (45.22 days), suitable flower diameter (12.37 cm) and dense ray floret arrangement. It also recorded the higher foliage rating (5.31) and flower rating (5.90) with attractive golden yellow and reddish brown petals with an indistinct ring around the dark center which indicates that it is suitable to be grown as bedding plants. The overall appearance of the foliage and flowers were more attractive when compared to all the other genotypes.

Conclusion

The results of the experiment showed that almost all the evaluated genotypes showed significant variation in all the vegetative parameters (plant height, number of leaves, leaf area, foliage rating) and the flowering parameters (days to first flowering, flower diameter and flower rating) except ray floret arrangement. However the genotype 'Ring of Fire' performed better than all the other genotypes and proved to be the most suitable genotype as a bedding plant in the coastal ecosystem.

Table 1: Plant height of sunflower genotypes at different stages of growth

Genotypes	Plant height (cm)		
	30 DAS	**45 DAS**	**60 DAS**
Music Box	24.57	87.25	99.12
Pacino	16.93	70.93	85.25
Ring of Fire	25.13	84.82	94.19
6 D-1 J7 2017	27.08	97.89	113.08
6 D-1 K1	42.25	123.68	152.45
6 D-1 K2	31.78	132.18	153.42
6 D-1 L1 A	39.09	125.98	143.49
6 D-1 L1 C	31.78	95.24	132.17
6 D-1 L3 A	30.22	97.22	147.50
6 D-1 L3 B	35.29	106.55	166.55
6 D-1 L4 A	27.97	96.90	146.49
6 D-1 L4 B	20.13	78.94	107.35
GMU 999	31.46	106.80	136.41
GMU 997	38.56	123.28	156.38
GMU 996	45.60	150.95	187.45
GMU 918	41.35	156.88	168.65
GMU 690	42.09	128.97	132.65
GMU 945	48.19	109.74	120.20
GMU 1102	42.20	109.60	125.34
GMU 646	27.97	108.86	127.46
GMU 987	38.15	135.37	150.67
GMU 946	30.25	141.74	159.71
GMU 1044	57.55	163.18	210.53
GMU 754	35.37	135.27	148.55
GMU 1052	26.54	94.35	116.48
GMU 928 A	26.94	104.25	125.37
GMU 1100	28.17	109.13	126.37
GMU 1064	25.53	93.83	117.26
GMU 949	29.56	133.35	159.45
GMU 1043	43.18	162.17	180.27
GMU 982	25.56	122.82	140.17
GMU 980	35.27	137.85	161.38
GMU 947	41.18	108.52	120.54
GMU 746	50.24	170.36	192.76
GMU 767	33.37	133.78	140.28
GMU 1082	25.24	110.65	133.48
GMU 928	45.14	135.60	146.18
Morden	22.51	65.27	70.28
18398	27.34	66.14	90.39
18389	30.46	81.23	113.25
18372	28.37	79.37	90.25
18382	18.36	83.24	105.41
CO 4	33.19	100.78	140.38
18385	28.17	84.93	100.23
18378	25.50	94.30	113.54
CO(SFV)5	27.92	96.53	128.24
18387	30.51	65.46	134.19
RHA272	29.48	99.08	110.28
LTRO7	25.36	103.77	132.44
18399	24.25	93.12	125.31
S.ED.	0.22	0.12	0.10
C.D. (0.05)	0.45	0.24	0.20

Table 2: Foliage characteristics of sunflower genotypes at different stages of growth

GENOTYPES	NUMBER OF LEAVES			LEAF AREA (cm^2)			FOLIAGE RATING
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS	
Music Box	20.78	42.27	22.04	131.10	292.53	572.21	4.29
Pacino	15.88	20.92	19.90	73.38	167.58	505.93	4.38
Ring of Fire	14.11	25.16	23.04	145.10	235.08	725.36	5.31
6 D-1 J7 2017	12.20	18.30	18.93	77.91	173.89	615.18	3.22
6 D-1 K1	13.96	23.21	15.89	93.75	251.07	765.16	5.10
6 D-1 K2	14.04	24.02	15.18	118.96	343.74	813.97	5.34
6 D-1 L1 A	14.93	25.56	16.97	118.13	327.09	789.81	4.38
6 D-1 L1 C	12.69	20.74	16.11	69.87	206.93	673.09	4.55
6 D-1 L3 A	11.52	18.67	15.27	47.98	189.73	498.45	4.64
6 D-1 L3 B	11.36	20.85	16.52	68.97	206.57	774.44	4.70
6 D-1 L4 A	12.53	22.88	15.94	65.17	259.13	973.30	4.79
6 D-1 L4 B	8.32	22.42	18.72	52.53	184.54	852.80	4.32
GMU 999	12.17	18.52	17.46	80.37	267.95	926.33	4.20
GMU 997	14.69	22.44	27.20	155.38	400.00	1432.46	4.75
GMU 996	14.47	23.57	24.39	193.19	434.18	1456.93	5.18
GMU 918	19.25	27.18	17.58	180.17	470.40	1580.87	5.27
GMU 690	13.34	25.48	24.85	152.29	303.75	990.86	5.42
GMU 945	13.28	29.73	18.28	89.63	157.88	573.19	5.34
GMU 1102	15.57	16.89	15.78	120.69	149.87	495.32	5.47
GMU 646	13.48	22.96	18.25	66.45	152.70	580.33	4.56
GMU 987	16.29	27.16	8.13	157.18	386.86	1078.28	5.36
GMU 946	15.26	20.37	15.84	85.83	225.47	925.67	4.98
GMU 1044	14.63	27.57	30.38	141.45	420.77	1315.47	5.37
GMU 754	14.97	29.45	14.55	104.78	271.38	957.24	5.85
GMU 1052	15.82	20.27	16.48	62.28	185.45	872.51	5.23
GMU 928 A	12.35	25.85	27.75	67.72	157.35	774.67	4.75
GMU 1100	15.25	22.71	15.18	67.86	176.56	892.96	4.38
GMU 1064	14.15	26.01	23.44	74.27	151.44	914.38	4.83
GMU 949	11.75	25.85	14.97	103.53	167.23	942.46	4.64
GMU 1043	14.86	29.14	24.15	160.61	292.57	991.44	5.17
GMU 982	10.45	23.31	22.37	115.18	281.67	899.91	4.75
GMU 980	14.18	24.34	15.63	100.25	144.67	792.91	4.98
GMU 947	13.28	24.36	15.55	109.34	100.17	693.68	5.35
GMU 746	15.73	21.55	15.36	145.55	235.83	983.57	4.85
GMU 767	15.85	26.18	26.73	44.73	103.69	599.67	5.15
GMU 1082	11.27	18.23	18.98	104.91	153.43	842.20	4.97
GMU 928	12.34	19.45	20.33	71.73	99.66	600.36	4.86
Morden	10.55	10.67	14.24	66.17	70.28	567.36	3.56
18398	10.47	16.90	18.40	89.34	107.92	644.56	3.79
18389	10.57	12.81	23.70	57.31	85.96	536.27	5.19
18372	10.17	14.24	17.92	65.80	145.61	722.84	4.92
18382	10.77	15.20	18.16	20.59	72.16	489.61	4.48
CO 4	11.81	15.38	24.31	65.19	89.33	513.38	5.03
18385	8.37	10.49	22.27	65.68	139.71	715.42	4.41
18378	8.74	15.42	19.36	51.68	111.24	556.31	4.62
CO(SFV)5	9.17	10.99	17.72	58.21	116.73	627.11	4.80
18387	9.21	13.86	14.69	39.32	135.81	749.22	4.62
RHA272	9.41	14.68	18.40	34.69	93.40	487.40	4.44
LTRO7	9.63	14.60	21.78	38.53	126.25	841.69	4.86
18399	8.23	13.46	18.60	34.60	91.11	449.94	4.45
S.ED.	0.09	0.11	0.07	0.10	0.13	0.10	0.05
C.D. (0.05)	0.19	0.21	0.15	0.20	0.26	0.20	0.11

Table 3: Floral characteristics of sunflower genotypes

Genotypes	Days to first flowering	Flower diameter (cm)	Ray floret arrangement	Flower rating
Music Box	43.23	4.34	Dense	4.77
Pacino	45.02	6.23	Dense	5.20
Ring of Fire	45.22	12.37	Dense	5.90
6 D-1 J7 2017	49.38	11.39	Sparse	4.23
6 D-1 K1	42.42	9.52	Dense	4.79
6 D-1 K2	45.06	11.55	Sparse	5.36
6 D-1 L1 A	44.45	11.09	Sparse	4.43
6 D-1 L1 C	47.16	16.54	Sparse	5.27
6 D-1 L3 A	44.04	13.66	Sparse	4.65
6 D-1 L3 B	44.55	9.23	Dense	4.71
6 D-1 L4 A	56.06	13.66	Sparse	4.45
6 D-1 L4 B	45.22	6.71	Sparse	4.19
GMU 999	52.22	7.54	Dense	3.93
GMU 997	55.21	13.52	Sparse	4.11
GMU 996	44.08	14.15	Dense	3.74
GMU 918	58.42	6.89	Sparse	4.82
GMU 690	49.09	12.52	Sparse	4.85
GMU 945	51.91	8.31	Sparse	3.49
GMU 1102	60.21	4.25	Sparse	3.34
GMU 646	56.98	7.76	Sparse	4.44
GMU 987	44.74	7.11	Sparse	3.92
GMU 946	46.99	9.49	Sparse	3.15
GMU 1044	53.82	12.78	Sparse	4.48
GMU 754	52.91	9.50	Sparse	5.26
GMU 1052	46.38	12.45	Sparse	4.17
GMU 928 A	42.21	15.21	Sparse	4.38
GMU 1100	52.19	14.49	Dense	4.92
GMU 1064	58.10	17.58	Dense	4.52
GMU 949	47.18	9.18	Dense	3.57
GMU 1043	54.18	14.58	Sparse	5.39
GMU 982	58.06	8.20	Dense	4.57
GMU 980	59.28	11.26	Sparse	4.48
GMU 947	48.53	7.17	Sparse	5.52
GMU 746	48.74	11.53	Sparse	4.72
GMU 767	55.06	9.52	Dense	5.17
GMU 1082	58.10	14.51	Dense	4.94
GMU 928	51.92	8.39	Sparse	5.13
Morden	48.05	10.26	Sparse	3.21
18398	45.24	12.60	Dense	4.02
18389	47.36	9.18	Dense	4.36
18372	51.81	15.71	Dense	3.96
18382	59.91	11.25	Dense	3.82
CO 4	55.10	16.10	Dense	4.72
18385	53.95	15.90	Sparse	5.26
18378	44.00	11.54	Dense	4.16
CO(SFV)5	50.08	11.07	Dense	4.96
18387	49.77	6.08	Dense	5.18
RHA272	57.92	13.60	Dense	5.27
LTRO7	54.93	14.28	Dense	4.63
18399	53.15	16.16	Dense	5.11
S.ED.	0.31	0.06	-	0.05
C.D. (0.05)	0.62	0.12	-	0.11

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