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Evaluation of Gaillardia (*Gaillardia pulchella* Foug) Genotypes for Loose Flower and Garden Display Purpose

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A B S T R A C T

Gaillardia (*Gaillardia puchella* Foug.) occupies one of the most important traditional flower in southern states of India, with respect to its commercial cultivation. The location specific cultivars are not available. This experiment was to evaluate the performance and adaptability of different gaillardia genotypes under Northern dry zone of Karnataka condition and to identify the best suitable genotypes for loose flower and garden display. For this purpose, a Randomized block experimental design with fifteen treatments and two replications was established. Based on the performance, the genotype UHSBGL-14 was identified to be superior with respect to growth and flower characters such as plant height (52.29 cm), Plant spread E-W & N-S (47.91 and 48.32 cm), Number of secondary branches/plant (27.75), early flower bud appearance(59.00 days), early 50% flowering (69.05 days) flowering duration (131.00 days) and maximum shelf life. Genotype UHSBGL-10 recorded maximum flower disc diameter (4.35 cm) and highest individual flower weight (8.99 g) was recorded in UHSBGL-5. Number of flower/plant (203.30), and Flower yield/plant (2.10 kg) was also recorded maximum for the genotype UHSBGL-14. Highest scores for loose flower characters such as flower colour, size, shape and absence of disc and garden display characters such as, uniformity in growth, flowering and landscape impact were obtained for genotype UHSBGL-14 by consumer analysis.

Introduction

Gaillardia (*Gaillardia pulchella* Foug.) is commonly known as “Blanket Flower” because of its wide array of colours and patterns including Mexican blankets, gold tipped with russet-red centers but recent introductions have expanded the colour range. Gaillardia is also referred to as fire wheel or Indian blanket or brown eyed susan in European countries (Helen *et al*., 2007). It is called as “Galatehoovu” and “saventige” in vernacular language of Karnataka. It is one of the important hardiest annual flower crop which belongs to the family Asteraceae with the basic chromosomes number of x=18 and 2n=36 (Srivastava and Kandpal, 2006). It is native to Florida and western United States.

The generic name of Gaillardia was proposed in honour of Gaillard de Marentonneau in 18th century, a French supporter of Botany (Bailey, 1929).

It is a herbaceous annual or short-lived perennial growing up to a height of 30 to 150 cm. Out of twenty species available in the genus, only *Gaillardia pulchella* is annual and *Gaillardia aristata*, is a perennial one in cultivation (Anon., 1950). The annual types grow to a height of 30 to 90 cm. The leaves that appear in initial stages are large, up to15-20 cm length and more lobed than those that appear in the later stages. The characteristics such as leaf shape and size are highly variable in nature. Leaves may be basal and linear to lanceolate, grayish green and very hirsute.

The flowers of gaillardia are small and numerous; born in solitary, usually showy heads which is known as capitulam with 4 to 6 cm in diameter. Individual flowers in a capitulam are called as florets which range from one to ten according to cultivars or genotypes. As a member of Asteraceae family it has both ray and disc florets which are pistillate and hermaphrodite in nature respectively. The flower has a long hairy stalk and single, semidouble and double types with single or multicolored heads. The crop produces flowers in a wide range of colours such as yellow, orange, cream, scarlet, bronze, brick-red and red and can be grown all around the year.

Materials and Methods

The present investigation entitled “Evaluation of Gaillardia (*Gaillardia pulchella* Foug.) Genotypes for loose flower and garden display purpose” was undertaken at Department of Floriculture and landscape, College of Horticulture, Bagalkot during the year 2017-18.The experiment was laid out in simple randomized block design with two replication and fifteen treatments. Forty-five days old seedlings were transplanted on the main field with a spacing of 30 X 45 cm. Observations were recorded on five randomly selected plants in each replication at 30 days interval after transplanting upto harvest and sensory evaluation for consumer acceptance, for both loose and garden display was done using 5 point (Table 1) and 3 point (Table 2) hedonic scale respectively.

Results and Discussion

Growth parameters

The vegetative growth was measured in terms of plant height (cm) per plant, number of secondary branches per plant, plant spread East-West and North-South (cm) per plant and number of leaves per plant (Table 3).

Among the 15 genotypes evaluated, plant height was varied significantly in different genotypes throughout the experimental period (Table 3). The genotypes UHSBGL-14, UHSBGL-5, UHSBGL-3 and UHSBGL-10 showed vigorous growth in terms of plant height. The genotype UHSSBGL-4 recorded minimum plant height. Plant height being a genetically controlled factor, it varied among the genotypes as well as influence of the growing environmental conditions, production technology and cultural practices. Similar variation in plant height due to cultivars was also observed in gaillardia by Girange *et al.,* (2016), Tamut (2013); Vikas *et al.,* (2011) and Ajeetkumar *et al.,* (2015) in dahlia; Namitha *et al.,* (2008) and Narsude *et al.,* (2010) in marigold.

Significant difference with respect to number of secondary branches produced per plant was noticed (Table 3). Number of branches was more in genotype UHSBGL-14 and UHSBGL-5, the genotype UHSBGL-4 recorded minimum branches. The difference in number of branches could be attributed to the genetic makeup of the cultivars. Increased number of branches leads to production of more number of leaves in turn it will enhance the yield of flowers and tubers by increasing source and sink relationship. Similar trend was noticed by Bhaskarwar *et al.,* (2016), Girange *et al.,* (2016), in gaillardia and Munikrishnappa (2013) in different genotypes of China aster.

Plant spread is an important growth factor for flower crops. It helps to utilize the sunlight to maximum extent. Plant spread during different growth periods varied significantly among the gaillardia genotypes (Table 3). Maximum plant spread was recorded in genotypes UHSBGL-5 and UHSBGL-14 throughout the growth period. This may due to more number of branches produced by these genotypes and vigorous growth character. Whereas, the genotype UHSBGL-15 produced minimum plant spread and this may be due to varietal differences and less vigor in growth. Similar results were recorded by Tamut (2013) in gaillardia; Paru *et al.,* (2011), Simrat *et al.,* (2012) in chrysanthemum.

Significant differences were observed among the genotypes with respect to number of leaves per plant (Table 3). The maximum number of leaves per plant recorded in the genotype UHSBGL-14 whereas, minimum number of leaves per plant was recorded in UHSBGL-4. Since two characters number of branches and leaves are inter-related, the plants with the maximum number of branches are expected to produce the highest number of leaves because the leaves are the functioning units for photosynthesis on which growth and flower yield depend greatly. Variation in leaf production could also be attributed to genetic character of genotypes. These results are in conformity with that of Talukdar *et al.,* (2006) in chrysanthemum and Vikas *et al.,* (2011), Ajeethkumar *et al.,* (2013) in dahlia.

Flower parameters

Flowering parameters includes number of days for first flower bud appearance, number of days taken for 50 percent flowering, duration of flowering, days to harvest and shelf life (Table 4).

Number of days taken for flower appearance of first flower bud is an important character that determines earliness or late flowering of the genotype, which determines the flower availability (Table 4). The genotype UHSBGL-14 took minimum number of days for appearance of first flower followed by UHSBGL-15 whereas, the genotypes UHSBGL-4 took maximum number of days. The variation in time taken for flowering may be dependent on the basis of the concept that proper amount of stored carbohydrates are necessary for inducing the plant from vegetative phase to flowering phase along with which genetic makeup and effect of environment on genotype also plays a vital role. Similar, variations were also reported by Bhaskarwar *et al.,* (2016), Girange *et al.,* (2016), Tamut (2013) in gaillardia; Singh *et al.,* (2014), Bharthi and jwaharlal (2014); Chandrashekara *et al.,* (2005) in marigold.

The genotype UHSBGL-14 took minimum number of days to reach 50 per cent flowering and it was on par with the genotype UHSBGL-15 whereas, genotype UHSBGL-4 maximum days for 50 percent flowering followed by UHSBGL-1 (Table 4). This could be attributed to the inherent early flower bud initiation factor which significantly influenced the days to 50% flowering. These results are in conformity with the reports of Girange *et al.,* (2016), Tamut (2013) in gaillardia; Zosimliana *et al.,* (2013) in China aster and Suma and Patil (2006) in Daisy.

Duration of flowering is highly economical and out most concerned character to growers as it decides the market demand, based on which we can chose the early or late flowering varieties (Table 4). With respect to flowering duration is concerned, the genotype UHSBGL-14 flowered for maximum duration followed by UHSBGL-15 whereas, minimum duration of flowering was found in UHSBGL-4 followed by UHSBGL-1. The variation in flowering duration among the genotypes can be attributed to genetics of the plant, environmental influence, stored carbohydrates and other management factors. Similar results were reported by Bhaskarwar *et al.,* (2016) in gaillardia; Chandrashekar *et al.,* (2005), Narsude *et al.,* (2016) in marigold and Deepa and Chezhiyan (2002) in chrysanthemum.

The genotype UHSBGL-1 took minimum number of days to harvest and it was on par with UHSBGL-4 (Table 4), whereas, genotype UHSBGL-5 took maximum days which could be attributed to genetic behavior of genotypes and number of whorls present in the flower more number of whorls present more of days required to reach harvesting stage as lose flowers are mainly harvested at full bloom stage. These results are in conformity with the reports of Girange *et al.,* (2016), Tamut (2013) in gaillardia and Zosimliana *et al.,* (2013) in China aster.

It is a parameter which decides the market distance, harvest chain handling system of any flower crop grown, (Table 4) the genotype UHSBGL-14 had maximum shelf life whereas, minimum shelf life was observed in genotype UHSBGL-1 followed by UHSBGL-3. This variation may be due to different genetic makeup of genotypes and influenced by prevailing environmental conditions which affect the physiological processes of flower like cell turgidity, water loss through evapotranspiration and break down of the reserve food which governs the shelf life of the flower. Similar results were noted by Bhaskarwar *et al.,* (2016), Girange *et al.,* (2016) in gaillardia and Chandrashekar *et al.,* (2005), Narsude *et al.,* (2016) in marigold.

Individual flower weight is ultimate factor on which grower is of out most concerned, In this study the average individual flower weight was highest in genotype UHSBGL-5 whereas, lowest flower weight was recorded by genotype UHSBGL-3. The variation among the genotypes was mainly because of increased flower size. Bhaskarwar *et al.,* (2016), Girange *et al.,* (2016) in gaillardia; Narsude *et al.,* (2010), Raghuvanshi and Sharma (2011) reported similar results in marigold.

Yield parameters

All the parameter discussed above, ultimately contribute to yield, which is the most important to any grower, such as number of flowers per plant and flower yield per hectare (Table 5).

Significant differences were observed among the genotypes with respect to number of flowers per plant (Table 5). Maximum number of flowers per plant was produced in the genotype UHSBGL-14, followed by UHSBGL-5 and while least was in UHSBGL-4. It may be directly related to the number of branches, leaves produced per plant, plant spread, rate of photosynthates produced in various genotypes. Similar results were reported by Bhaskarwar *et al.,* (2016), Girange *et al.,* (2016), Tamut (2013) in gaillardia; Patil *et al.,* (2011) and Naik *et al.,* (2005); Zosiamliana *et al.,* (2013) and Munikrishnappa *et al.,* (2013) in China aster.

Table.1 Specific rating for loose flower purpose given below (Tamut, 2013)

Flower colour	Flower shape	Flower size	Overall acceptance	Score
Attractive	Excellent	Excellent	Highly acceptable	4.1-5.0
Better	Better	Better	Moderately acceptable	3.1-4.0
Good	Good	Good	Acceptable	2.1-3.0
Average	Average	Average	Slightly acceptable	1.1-2.0
No attraction	Poor	Poor	Not acceptable	0.1-1.0

Table.2 Specific rating for uniformity, flowering, and landscape impact given below (Helen *et al.*, 2007)

Uniformity	Flowering	Landscape Impact	Score
Low	No flower present	Negative aesthetic impact	0-1
Medium	1-20 percent flower present	Slightly positive aesthetic impact	1.1-2
High	>20 percent flower present	Highly positive aesthetic impact	2.1-3

Table.3 Growth parameters in various genotypes of gaillardia

Genotypes	Plant height (cm) per plant	Number of Primary branches per plant	Number of Secondary branches per plant	Plant spread (cm) per plant (180 DAT)		Number of leaves per plant
	(180 DAT)	(180 DAT)		E-W	N-S	(180 DAT)
UHSBGL-1	45.00	5.50	13.85	41.37	41.77	307.10
UHSBGL-2	44.86	7.65	13.60	42.01	42.01	295.10
UHSBGL-3	49.88	7.50	16.04	47.02	47.02	406.80
UHSBGL-4	34.69	4.30	9.05	35.05	37.10	268.30
UHSBGL-5	50.92	13.76	17.00	49.60	49.60	421.50
UHABGL-6	45.00	10.77	18.00	44.31	44.31	401.80
UHSBGL-7	43.90	12.00	17.65	44.88	44.88	367.20
UHSBGL-8	40.04	7.00	14.75	39.75	39.75	311.10
UHSBGL-9	42.55	6.75	16.40	40.88	40.88	318.50
UHSBGL-10	46.62	10.45	16.25	44.17	44.17	407.60
UHSBGL-11	44.26	9.95	18.75	42.97	42.82	396.00
UHSBGL-12	35.72	6.40	9.95	33.83	36.26	272.70
UHSBGL-13	43.80	9.40	18.60	45.03	45.03	415.10
UHSBGL-14	52.29	17.15	27.75	47.91	48.32	463.35
UHSBGL-15	35.15	4.75	10.06	32.97	33.22	284.40
S.Em±	**1.55**	**0.98**	**1.14**	**1.08**	**1.25**	**20.83**
CD(0.05)	**4.70**	**3.00**	**2.60**	**NS**	**NS**	**63.20**

NS:Non significant
UHSBGL: University of SciencesBagalkot Gaillardia Local

Table.4 Flowering parameters of various

Genotypes	Number of days taken for appearance of first flower bud (days)	Number of days taken for 50 per cent flowering (days)	Duration of flowering (days)	Shelf life (hr)	Individual flower weight (g)	Diameter of disc (cm)
UHSBGL-1	113.50	160.00	71.50	1.65	2.32	2.12
UHSBGL-2	101.50	130.60	90.00	4.76	3.04	1.46
UHSBGL-3	111.55	138.00	110.50	3.33	1.64	2.04
UHSBGL-4	115.50	161.50	61.00	6.57	2.04	1.72
UHSBGL-5	75.50	95.50	116.00	11.35	8.99	*0.00
UHSBGL-6	122.65	145.00	78.50	7.85	5.24	2.95
UHSBGL-7	117.50	137.50	86.50	1.70	2.28	1.84
UHSBGL-8	106.00	126.05	87.00	11.35	2.08	*0.00
UHSBGL-9	95.00	115.00	99.00	6.05	3.66	2.22
UHSBGL-10	108.50	133.50	69.50	11.45	6.31	4.35
UHSBGL-11	95.50	120.50	72.00	7.60	2.33	1.98
UHSBGL-12	83.00	103.25	91.00	8.60	3.07	2.51
UHSBGL-13	98.00	118.00	101.00	10.38	4.24	2.26
UHSBGL-14	59.00	69.05	131.00	14.90	2.95	*0.00
UHSBGL-15	61.50	82.00	121.50	13.85	2.37	*0.00
S.Em±	**4.51**	**5.78**	**4.80**	**0.68**	**0.44**	**0.20**
CD (0.05)	**13.69**	**17.53**	**14.57**	**2.06**	**1.35**	**0.61**

*No disc = Pompon type

Table.5 Yield parameters of various genotypes of gaillardia

Genotypes	Number of flowers per plant	Flower yield (kg/plot)	Flower yield (t/ha)
UHSBGL-1	56.30	1.31	3.29
UHSBGL-2	66.00	0.77	1.87
UHSBGL-3	69.00	1.14	2.86
UHSBGL-4	40.70	0.54	1.35
UHSBGL-5	67.10	1.82	4.56
UHSBGL-6	56.60	1.47	3.67
UHSBGL-7	70.50	1.65	4.13
UHSBGL-8	51.00	0.99	2.47
UHSBGL-9	43.20	0.99	2.49
UHSBGL-10	62.50	1.04	2.61
UHSBGL-11	63.90	1.39	3.47
UHSBGL-12	58.20	1.23	3.09
UHSBGL-13	53.10	1.44	3.56
UHSBGL-14	203.30	2.10	5.26
UHSBGL-15	98.95	1.56	3.90
S.Em±	**8.21**	**1.56**	**0.38**
CD (0.05)	**24.92**	**4.74**	**1.16**

Table.6 Consumer acceptance for loose flower purpose in various genotypes of gaillardia

Genotypes	Flower colour	Flower shape	Flower size	Overall acceptability
UHSBGL-1	2.97	3.34	2.42	3.39
UHSBGL-2	2.55	2.30	1.79	1.38
UHSBGL-3	2.95	3.45	3.37	3.25
UHSBGL-4	3.92	3.95	4.16	3.35
UHSBGL-5	4.20	4.37	4.57	4.35
UHSBGL-6	1.54	2.35	3.48	1.80
UHSBGL-7	1.85	2.52	4.22	1.70
UHSBGL-8	3.15	3.42	2.63	2.35
UHSBGL-9	2.46	3.23	3.35	3.00
UHSBGL-10	4.20	4.33	2.85	4.35
UHSBGL-11	4.38	3.94	4.02	4.20
UHSBGL-12	2.27	2.50	4.28	1.55
UHSBGL-13	2.36	3.01	4.47	3.75
UHSBGL-14	4.70	3.90	4.45	4.75
UHSBGL-15	4.15	3.44	3.53	3.39
S.Em±	**0.31**	**0.25**	**0.39**	**0.15**
CD (0.05)	**0.94**	**0.78**	**1.18**	**0.43**

Table.7 Consumer acceptance for landscape purpose in various genotypes of gaillardia

Genotypes	Uniformity	Flowering	Landscape impact
UHSBGL-1	1.28	1.93	1.82
UHSBGL-2	1.46	1.40	1.69
UHSBGL-3	2.10	1.46	1.90
UHSBGL-4	1.06	0.76	0.94
UHSBGL-5	2.20	2.85	1.96
UHSBGL-6	0.71	0.88	0.92
UHSBGL-7	2.48	2.34	2.46
UHSBGL-8	1.35	1.67	1.74
UHSBGL-9	2.10	1.37	1.49
UHSBGL-10	1.87	0.99	2.46
UHSBGL-11	2.23	2.04	2.25
UHSBGL-12	0.87	1.97	1.38
UHSBGL-13	1.52	2.33	2.31
UHSBGL-14	2.95	2.99	2.95
UHSBGL-15	2.30	2.65	2.79
S.Em±	**0.2**	**0.20**	**0.13**
CD (0.05)	**0.64**	**0.63**	**0.40**

The highest flower yield per hectare was recorded in the genotype UHSBGL-14, followed by UHSBGL-5 and (Table 5) whereas, the genotype UHSBGL-4 recorded lowest flower yield. It is clearly visible that existence of relationship between number of flower production per plant and number of branches per plant increase the flower yield per plot. These results are in conformity with the results reported by Bhaskarwar *et al.*, (2016), Girange *et al.*, (2016), Tamut (2013) in gaillardia; Naik *et al.*, (2005), Raghuvanshi and Sharma, (2011) in marigold and by Ajeetkumar *et al.*, (2015) in dahlia.

Consumer analysis for loose flower purpose

The consumer preference for loose flower purpose, (Table 6) the genotype UHSBGL-14 was more attractive followed by UHSBGL-11 and UHSBGL-10 with respect to flower colour. The flower shape was better in UHSBGL-5 followed by UHSBGL-10, and UHSBGL-14. Flower size was more in UHSBGL-5 followed by UHSBGL-13 and UHSBGL-14. These results are in conformity with the reports of Beeralingappa *et al.*, (2016). Overall appearance was excellent in UHSBGL-14 and UHSBGL-5 followed by UHSBGL-10 and UHSBGL-11. And the genotype UHSBGL-14 and UHSBGL-5 were mostly preferred by the consumers with respect to flower colour, size, shape and overall acceptability

Consumer analysis garden display purpose

The preference for landscape flower purpose, (Table 7) the genotype UHSBGL-14 and UHSBGL-15 showed more uniformity in plant growth, flowering when compared to other genotypes. And whereas UHSBGL-14 and UHSBGL-15 were found to be very attractive with respect to landscape impact when compared to other genotypes. These results are in conformity with the reports of Harbugh *et al.*, (2002) and Scholellhorn *et al.*, (2005) in gaillardia.

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