Assessment of chrysanthemum (*Chrysanthemum morifolium* Ramat.) germplasm for commercial cultivation under Rayalaseema region of Andhra Pradesh

C. Madhumathi[1], V. Bhargav[1], D. Srinivasa Reddy*[2], P. Lalitha Kameshwari[3], D. Sreedhar[1] and T. Naga Lakshmi[1]

*[1]College of Horticulture, Anantharajupeta, Dr. Y.S.R. Horticultural University, Y.S.R. Kadapa District, A.P.. [2]Citrus Research Station, Tirupati, A.P. [3]ARS, Floriculture, Hyderabad, Telangana. *E-mail: madhulokanadh@gmail.com*

Abstract

Fifty nine chrysanthemum (*Chrysanthemum morifolium* Ramat.) genotypes were evaluated for their performance under southern zone of Andhra Pradesh at HRS Farm, Anantharajupeta, Y.S.R. Kadapa, Andhra Pradesh. Significant differences were observed among the genotypes for all vegetative, flowering and yield traits studied. Genotype Selection-5 (56.50 cm) recorded maximum plant height, and plant spread was maximum in two genotypes Chandini and Violet (51.83 cm). Genotypes Sugandha Yellow and Sugandha White produced maximum (11.67) number of primary branches/plant while least in Yellow Cherub (2.33). Earliest bud appearance was observed in genotype Violet (61.67 days), whereas genotype Meera (113.52 days) was late. The highest number of flowers/spray and spray length was produced by genotype Yellow Star and Selection-2 (41.67 and 44.87 cm), respectively. Flower diameter was maximum in Firtation (10.06 cm), however, number of flowers/plant was highest in HYDC- 7 (287). The weight of single flower and 100 flower weight was maximum in Mother Teresa (4.96 g and 495.50 g). Keeping in view of these characters, genotypes Mother Teresa, Firtation and Chrysanthemum Yellow were found to be highly suitable to grow under Rayalaseema conditions of Andhra Pradesh for loose flower production. Based on hierarchical cluster of the morphological traits, the genotypes were grouped into three. Results of principal component Analysis (PCA) were also in conformity with the results of cluster analysis.

Key word: Chrysanthemum, genotype, morphological traits, cluster analysis and PCA

Introduction

Chrysanthemum (*Dendranthema grandiflorum*) belonging to the family Asteraceae is one of the leading commercial flower, important as a cut flower as well as pot plant. It ranks second after rose in world cut flower trade and fifth as pot plant (Negi *et al*., 2015). It is commonly known as Guldaudi, Autumn Queen or Queen of the East.

Chrysanthemum is cultivated commercially all over India and Andhra Pradesh is a leading state in the production of loose flowers followed by Karnataka. Chrysanthemum owes its popularity due to the range of form and colour of its flowers and their excellent keeping quality. It is grown under wide range of climatic conditions but the performance of the genotype varies with the region, season and other growing conditions (Singh *et al*., 2017). Therefore, an evaluation of different chrysanthemum genotypes in Rayalaseema region of Andhra Pradesh is of great importance so that suitable cultivars can be recommended for commercial cultivation. Keeping the importance of the crop in view, the present investigation was under taken to evaluate different genotypes to select a suitable genotype for crop improvement and productivity.

Materials and methods

The present study was conducted at research block of Horticultural Research Station, Anantharajupeta, Railway Kodur, Kadapa District, Andhra Pradesh during 2014-15 and 2015-16. The experimental site was geographically located at 13° 98' N Latitude, 79° 40'E Longitude and at an elevation of 162 m above mean sea level. The soil of experimental block was red loamy with pH 7.5 and E.C. 0.01 dScm^{-1}.

A total of 59 genotypes were evaluated for vegetative growth, flowering and yield in randomized complete block design with three replications. Twenty five plants per replication were planted at a spacing of 30 x 30 cm under open field conditions. The recommended agronomical practices were adopted to raise the crop. Five random plants were selected for recording various observations *viz*. plant height (cm), plant spread (cm), number of branches per plant, days to first flowering, number of flowers per spray, spray length, flower head diameter (cm), number of flowers per plant, single flower weight (g) and 100 flowers weight (g). The analysis of variance was done by the method suggested by Gomez and Gomez (1984). Cluster analysis and principal component analysis (PCA) of the morphological data were performed using XLSTAT (Addinsoft, 2017).

Result and discussion

Vegetative traits: Vegetative growth is usually a good index of plant vigour, which may contribute towards greater productivity. It also serves as a guide to determine the suitable genotypes for obtaining maximum yield. Data presented in Table 1 revealed that there was a significant variation in vegetative growth among the genotypes studied. Highest plant height and plant spread

were recorded for genotype Selection- 5 (56.50 cm) which was statistically comparable with Chandini (54.67 cm), Local Yellow (53.60 cm), whereas, lowest was recorded in PAU.B.01 (16.33 cm). The variation in plant height can be attributed to genetic makeup of the particular genotype (Singh *et al.*, 2008). Plant spread was recorded maximum in Chandini and Violet (51.83 cm), while genotype HYDC- 21 (13.07 cm) attained the lowest.

The increase in plant spread was might be due to the production of increased number of branches with more length. Number of branches/plant is an important characters, which signifies canopy shape and architecture of plant. Among the evaluated genotypes, Sugandha Yellow and Sugandha White produced maximum (11.67) number of primary branches/plant while least in Yellow Cherub (2.33).

Table 1. Evaluation of chrysanthemum genotypes for vegetative, flowering and yield traits

Sl. No.	Variety	Plant height (cm)	Plant Spread (cm)	Number of branches/ plant	Days to first flower bud flowering	Number of flowers/ spray	Spray length (cm)	Flower head diameter (cm)	Number of flowers/ plant	Single flower weight (g)	100 flowers weight (g)
1	Voilet	47.50	51.50	5.67	61.67	18.33	33.83	6.07	112.67	2.61	260.50
2	Orange	53.17	46.20	9.00	62.67	14.00	28.17	5.85	109.00	2.05	204.50
3	Suganda Yellow	36.00	33.83	11.67	63.75	6.67	20.17	5.04	80.00	1.85	185.00
4	Suganda White	37.83	44.17	11.67	64.41	13.00	29.50	5.78	127.33	2.39	239.00
5	Basanti	31.83	22.50	5.67	74.27	22.67	21.17	4.57	119.00	1.34	134.00
6	HYDC - 7	37.50	33.93	6.67	76.14	25.67	27.83	3.92	287.00	0.98	97.50
7	Regar Empheror	38.00	31.27	4.33	82.17	13.33	23.83	7.27	74.33	2.53	252.50
8	Aparajitha	33.27	40.50	5.00	82.63	13.67	29.23	3.36	61.00	0.69	68.50
9	HYDC - 19	30.83	33.50	6.33	90.43	20.67	21.83	3.88	174.67	1.71	171.00
10	HYDC - 5	32.50	16.83	4.33	89.99	5.00	14.87	4.99	26.00	1.48	147.50
11	Pink	28.50	38.50	4.33	91.20	27.67	32.83	4.35	154.00	1.04	103.50
12	Paper White	49.50	44.50	6.00	86.73	18.00	24.53	5.28	112.00	1.78	178.00
13	Poornima Yellow	49.17	47.83	5.67	85.07	22.67	31.43	5.91	114.33	2.12	211.50
14	Chandini	54.67	51.83	4.67	91.26	22.67	38.87	3.97	154.33	1.29	129.00
15	HYDC - 11	36.50	41.17	4.67	102.63	15.33	26.83	6.03	82.00	3.19	319.00
16	Firtation	49.17	25.83	5.00	102.85	13.33	28.27	10.06	62.67	4.90	490.00
17	HYDC - 4	28.17	22.50	4.33	86.73	7.67	18.30	6.36	41.67	2.17	216.50
18	Salora	34.17	43.83	5.00	100.73	38.00	30.93	5.31	120.00	2.62	261.50
19	Selection - 1	52.50	21.17	6.33	85.74	5.67	39.50	4.64	41.67	1.38	137.50
20	Selection - 2	49.50	18.50	4.67	85.21	7.33	44.87	3.30	38.33	1.28	128.00
21	Selection - 3	33.00	16.33	5.00	87.25	11.67	30.50	2.58	73.67	0.43	42.50
22	Selection - 4	46.83	17.83	5.67	87.84	12.00	36.33	3.72	59.67	1.60	159.50
23	Selection - 5	56.50	15.83	3.33	92.83	9.33	44.17	3.23	26.33	2.14	214.00
24	Selection - 6	45.17	18.67	6.00	90.53	7.00	38.33	2.20	56.00	0.86	86.00
25	PAU.B.107	37.40	40.20	5.67	95.99	16.33	28.50	6.34	91.33	3.65	365.00
26	Terry	25.67	33.00	3.33	98.00	16.00	24.20	4.48	70.33	1.15	115.00
27	Arka Ravi	29.17	23.67	3.67	98.67	7.00	26.50	6.42	44.00	3.23	323.00
28	Yellow Star	31.83	44.17	4.67	104.43	41.67	26.88	6.49	188.67	2.14	214.00
29	PAU.B.01	16.33	21.33	4.33	101.00	33.67	10.33	3.77	93.00	3.91	390.50
30	HYDC - 18	36.17	18.00	2.67	97.52	15.33	29.33	7.19	41.00	2.74	274.00
31	Plant & Seed Choice	30.17	26.50	3.33	101.17	16.00	26.17	3.57	88.67	1.28	128.00
32	Winter Queen	36.67	32.17	4.00	103.19	30.00	22.00	7.00	101.00	1.32	132.00
33	Cucubion	19.83	20.83	3.00	97.76	19.33	11.17	4.30	72.67	0.81	81.00
34	Local Button	32.00	45.17	10.67	97.17	34.67	24.17	2.59	249.67	0.78	77.50
35	Punjab Anuradha	33.83	26.83	5.00	101.26	34.67	30.17	5.30	167.00	1.77	176.50
36	Dee	18.17	26.17	3.67	101.50	29.67	17.50	4.00	129.00	0.63	63.00
37	Farr	34.17	27.60	4.00	99.23	18.67	27.00	7.00	82.67	3.86	385.50

Table 1. Evaluation of chrysanthemum genotypes for vegetative, flowering and yield traits

Sl. No.	Variety	Plant height (cm)	Plant Spread (cm)	Number of branches/ plant	Days to first flower bud flowering	Number of flowers/ spray	Spray length (cm)	Flower head diameter (cm)	Number of flowers/ plant	Single flower weight (g)	100 flowers weight (g)
38	HYDC - 21	39.17	13.07	3.67	93.23	7.67	24.93	6.44	21.00	3.35	334.50
39	White	30.17	40.67	3.67	96.10	16.00	24.33	6.08	102.67	3.23	322.50
40	Full Red	35.20	20.67	4.67	102.99	6.67	24.60	3.63	37.33	2.80	279.50
41	Chrysanthemum Gold	42.83	42.83	5.67	98.75	18.00	21.83	5.06	88.00	3.19	319.00
42	Chrysanthemum Yellow	34.67	31.00	4.00	104.23	11.00	27.67	7.37	97.33	4.05	404.50
43	Red & White	45.40	18.67	3.33	95.25	11.00	27.40	5.82	34.00	2.81	281.00
44	Paper yellow	46.50	33.83	3.33	99.75	17.67	25.73	5.88	119.33	2.94	294.00
45	Poornima White	47.67	30.50	4.00	96.93	5.33	23.00	5.99	83.33	3.57	356.50
46	HYDC - 17	42.50	44.17	4.33	102.25	8.67	24.50	6.08	202.33	2.89	288.50
47	Mohraj	33.87	30.33	2.67	104.17	5.00	21.60	4.72	62.00	1.91	191.00
48	Yellow Cherub	31.50	20.50	2.33	97.25	4.67	20.17	5.09	30.33	1.53	153.00
49	Rekha	26.27	39.87	5.00	90.09	10.67	18.67	3.67	186.33	0.90	90.00
50	Red stone	44.57	49.20	4.67	105.29	8.67	29.87	5.35	175.67	2.63	262.50
51	Poonam	38.17	34.33	3.33	101.25	10.00	17.50	6.39	142.00	2.87	286.50
52	Mother Teresa	33.83	45.50	4.33	102.75	7.00	18.50	7.85	136.00	4.96	495.50
53	M10	33.80	35.63	4.33	92.67	11.67	19.40	4.57	176.00	2.27	226.50
54	Big Red	32.17	46.83	4.33	106.83	7.00	19.83	6.46	207.67	1.87	187.00
55	Pankaj	36.40	33.97	4.67	107.16	6.33	26.73	5.45	171.33	2.37	236.50
56	Neelima	51.83	20.10	4.67	102.56	5.00	22.63	5.57	51.00	2.39	239.00
57	Meera	40.17	47.50	4.00	113.52	15.00	20.50	3.77	164.00	0.72	71.50
58	Local Yellow	53.60	33.73	4.67	92.75	6.67	13.60	6.12	81.33	3.60	359.50
59	Freedom	28.13	44.53	4.33	108.74	8.33	21.27	4.71	124.33	2.63	262.50
	C.D.	7.22	4.76	1.42	2.60	3.43	3.44	3.85	15.12	0.13	13.19
	SE(m)	2.57	1.70	0.51	0.92	1.22	1.23	1.37	5.39	0.05	4.65
	C.V.	11.86	8.99	17.95	1.38	14.04	8.27	4.54	8.89	2.94	2.94

Flowering traits: From Table 1, it is apparent that, significantly less number of days for the first flower bud appearance was taken by Violet (61.67 days) and it was on par with Orange (62.67 days) and Sugandha Yellow (63.75 days) genotypes. While the maximum number of days for first flower bud appearance was taken by Meera (113.52 days). Number of days taken for flower bud appearance is an important character that signifies early or late flowering varieties which determines the flower availability in the market. The variation in time to flowering might be due to the genetic makeup or the influence of genotype and environment. The variation in time for flower bud appearance of different chrysanthemum genotypes was also reported by Rao and Pratap (2006) and Singh *et al*. (2008) under different locations.

Significant variation was noticed in number of flowers per spray among the genotypes (Table 1). The maximum number of flowers per spray was recorded in Yellow star (41.67) followed by Salora (38.00), while the minimum number of flowers per spray was recorded in Yellow Cherub (4.67). The maximum length of the spray was recorded in Selection-2 (44.87 cm) and found to be at par with Selection-5 (44.17 cm), however, minimum was recorded in PAU.B.01 (10.33 cm). The variation in number of flowers per spray and spray length among the accessions was

attributed to genotype of the plant, environmental influence and other cultural factors. Similar results for variation in number of flowers/spray among the genotypes have also been reported (Punetha *et al.*, 2011).

Flower diameter is very important trait for deciding the quality of flowers. Largest flower was recorded in genotype Firtation (10.06 cm), and found to be at par with Mother Teresa (7.85 cm) and Chrysanthemum Yellow (7.37 cm); while smallest (2.20 cm) was recorded in Selection-6. Variation in flower diameter might be due to the genetic makeup of the genotypes and their interaction with prevailing environment conditions. Present findings are in concordance with the findings of Singh *et al*. (2017) and Negi *et al*. (2015). Significantly maximum number of flowers/plant was produced by genotype HYDC- 7 (287), followed by Local Button (249.67), whereas HYDC- 21 (21.00) produced minimum flowers /plant. Similar variation with regard to number of flower/plant was reported by Singh *et al*. (2017) and Srilatha *et al*. (2015). Heaviest flower at the time of harvest was produced in Mother Teresa (4.96 g), which was at par with Firtation (4.90 g); while Selection- 3 produced lightest flower (0.43 g). Hundred floweres each of Mother Teresa and Flirtation weighed 495.50 g and it and 490.00 g, respectively. Similar variations among the different
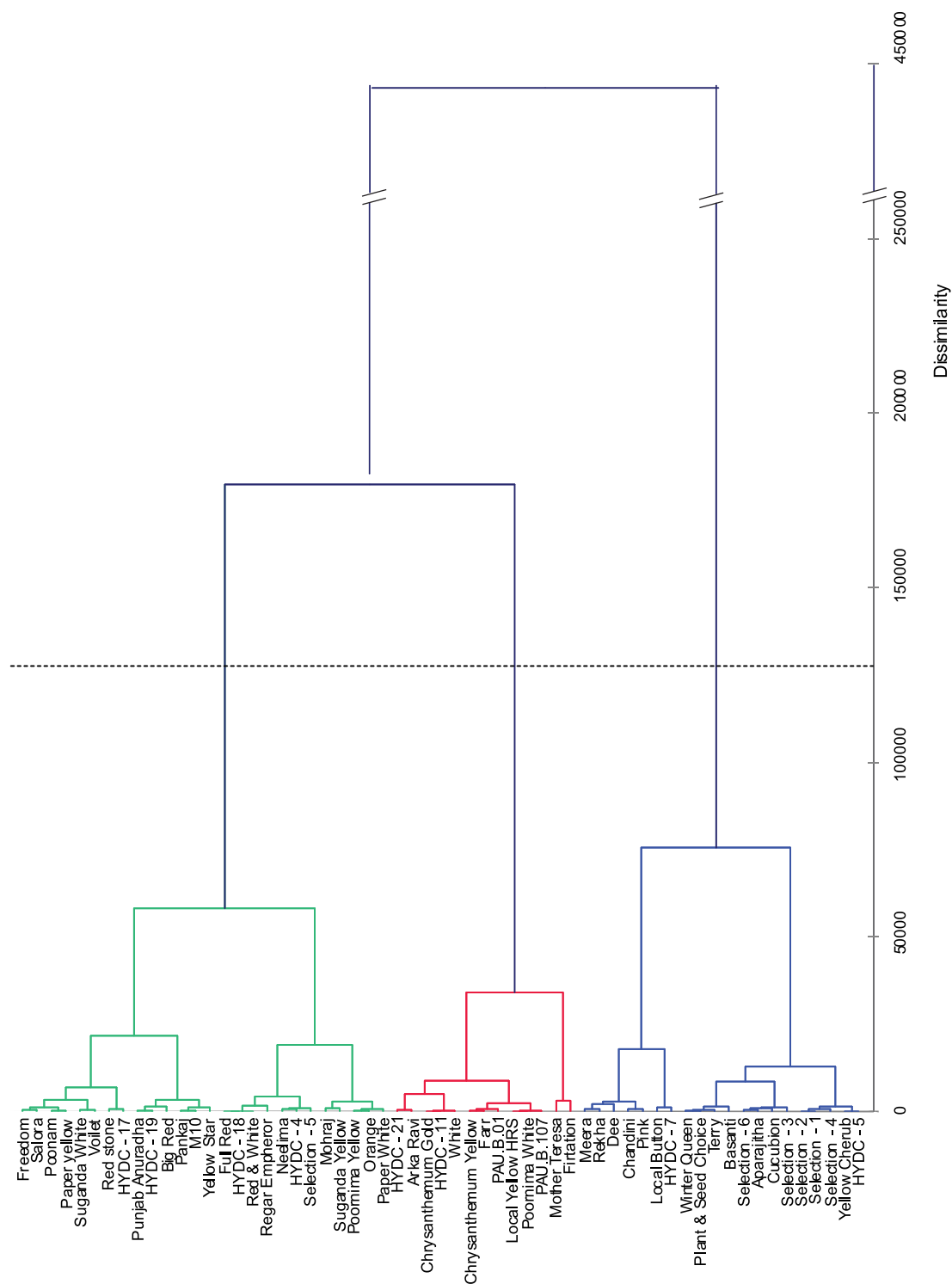
Fig. 1. Cluster analysis of different chrysanthemum genotypes based on diversity in morphological traits

chrysanthemum genotypes have also been observed by Punetha *et al.* (2011) and Laxmi *et al.* (2008).

Cluster analysis and Principal Component Analysis (PCA): Agglomerative hierarchical clustering (AHC) of the data (all the characters) based on dissimilarity among the genotypes showed the relative position of genotypes in each group (Fig 1). Fifty nine chrysanthemum genotypes were broadly grouped into three clusters representing dissimilarity among chrysanthemum genotypes based on Wards method of cluster analysis by using Euclidean distance. Group 1 consists of 20 genotypes, group two consists of 22 and group 3 consists of 17. Crossing between highly genetic divergent genotypes could yield better results (Singh *et al.,* 2016). Therefore, genotypes may be chosen for crossing for further improvement on the basis of genetic divergence as depicted in the dendrogram. In the present study Mother Teresa and Selection- 3 were most divergent genotypes based on genetic distance as depicted in the dendrogram. Therefore, crossing among the most divergent genotypes can achieve further improvement in the flower quality and yield by getting desirable transgressive segregants (Bhargav *et al*., 2018).
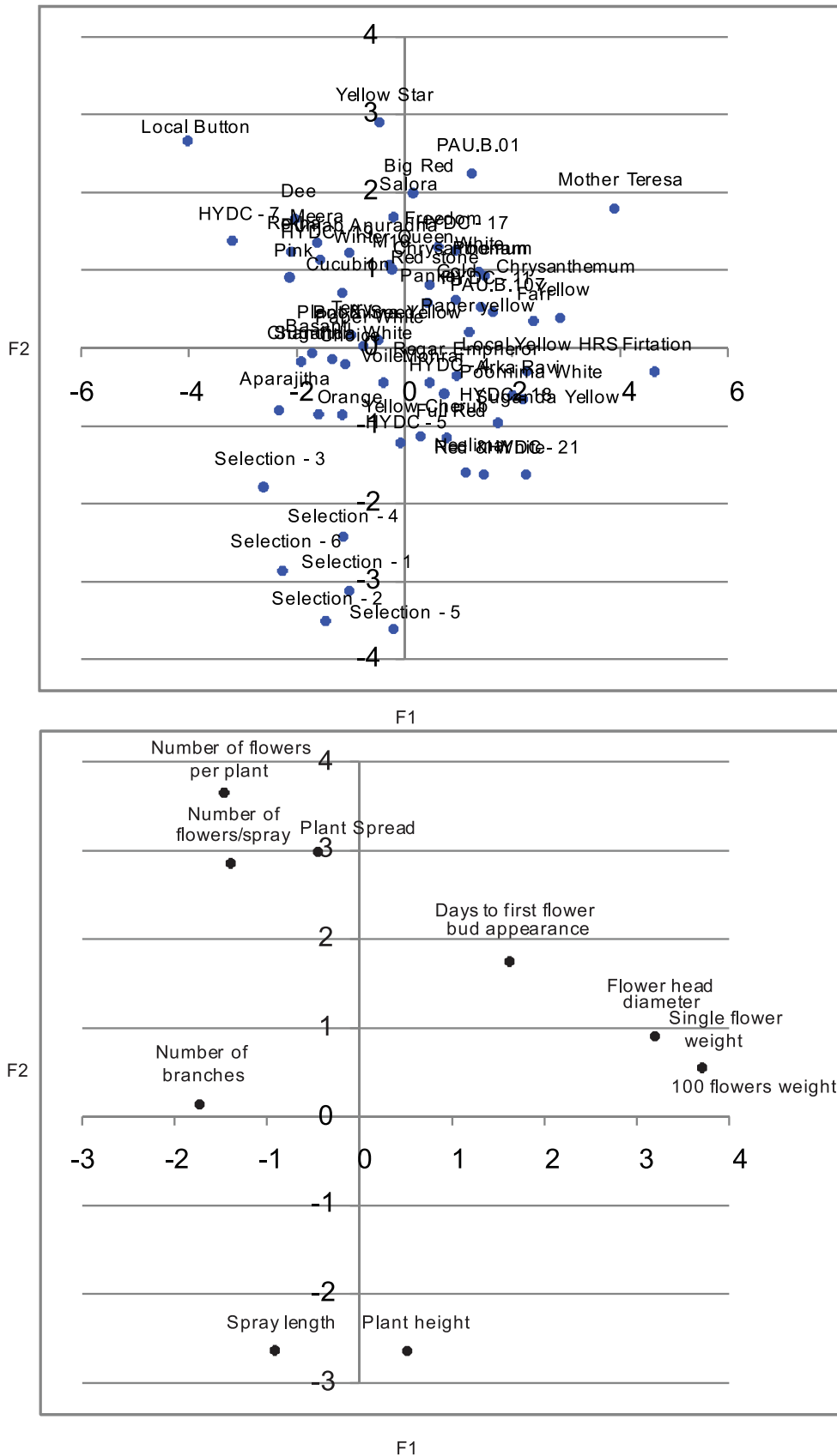
Fig. 2. Ordination of Principal components for genotypes and morphological traits

To determine the most significant characteristics of the data set, the same set (59 genotypes × 10 morphological traits) that was used for cluster analysis was subjected to PCA. The analysis also helped to understand the contribution of the traits for grouping the genotypes. The first two components accounted for most of the variation. The first principal component (F1) explained 30.10 % of the total variation and was positively correlated to Single flower weight, 100 flower weight and flower head diameter but highly negatively correlated to number of branches. F2 explained 20.64 % of total variation and was positively correlated to number of

flowers per plant and number of flowers/spray and negatively to plant height and spray length. Because F1 and F2 accounted for a major share of the morphological traits to group the genotypes (Fig. 2) to determine the distances between the genotypes based on the Morphological diversity, a result consistent with that of the cluster analysis.

On the basis of data for vegetative, flowering, yield traits it can be concluded that out of 59 genotypes evaluated Mother Teresa, Firtation and Chrysanthemum Yellow were found promising for growing as loose flowers under Rayalaseema agro-climatic conditions of Andhra Pradesh. Further the agglomerative hierarchical clustering and PCA, group the genotype based on dissimilarity. Carrying out hybridization programme between the divergent genotypes may help in getting the progeny with desirable traits.

References

Addinsoft, 2018. XLSTAT 2018: Data analysis and statistical solution for Microsoft. Excel Paris, France.

Bhargav, V., Rajiv Kumar, K.S. Shivashankara, T. Manjunatha Rao, M.V. Dhananjaya, Anuradha Sane, T. Usha Bharathi, R. Venugopalan and T.K. Roy, 2018. Diversity of flavonoids profile in China aster [*Callistephus chinensis* (L.) Nees] genotypes. *Ind. Crops Prod.,* 111: 513-519.

Gomez, L.A. and A.A.Gomez, 1984. *Statistical Procedure for Agricultural Research*. J. Wiley and Sons, Singapore p. 680.

Laxmi, P., M. Pratap and S.A. Reddy, 2008. Evaluation of yellow coloured chrysanthemum (*Dendrathema grandiflora* L.) cultivars for growth, flowering and yield. *Orissa J. Hort.,* 36(1): 116-119.

Negi, R., K. Jarial, Sunil Kumar and S.R. Dhiman, 2015. Evaluation of different cultivars of chrysanthemum suitable for low hill conditions of Himachal Pradesh. *J. Hill Agr.,* **6**(2): 144-146.

Punetha, P., V.K. Rao and S.K. Sharma, 2011. Evaluation of different chrysanthemum (*Chrysanthemum morifolium*) genotypes under mid hill conditions of Garhwal Himalaya. *Indian J. Agr. Sci.,* 81(9): 830-833.

Rao, A.M. and M. Pratap, 2006. Evaluation of varieties and variability studies in chrysanthemum (*Dendrathema grandifolia* Tzvelev.). *J. Ornamental Hort.,* 9(2): 221-223.

Singh, S., R. Kumar and Poonam, 2008. Evaluation of chrysanthemum (*Dendrathema grandiflora* Tzvelev.) open pollinated seedling from vegetative and floral characters. *J. Ornamental Hort.,* 11(4): 271-274.

Singh, A.K., D.K. Singh, A.K. Singh and R. Kumar, 2017. Evaluation of different Chrysanthemum (*Chrysanthemum morifolium*) genotypes under shadenet House in Northwest himalaya. *Intl. J. Pure Appl. Biosci.,* 5(1): 980-985

Singh, D., R.K. Arya, N. Chandra, R. Niwas and P. Salisbry, 2016. Genetic diversity studies in relation to seed yield and its component traits in Indian mustard (*Brassica juncea* L. Czern & Coss). *J. Oilseed Brassica,* 1(1): 19-22.

Srilatha, V., K. Sunil Kumar and Y. Deepthi Kiran, 2015. Evaluation of chrysanthemum (*Dendranthema grandiflora* Tzvelev) varieties in southern zone of Andhra Pradesh. *Agr. Sci. Digest,* 35(2): 155-157.