J. Hortl. Sci.
Vol. 7(1):51-55, 2012

Morphological and biochemical characterization of chrysanthemum

B.K. Banerji, Atul Batra and A.K. Dwivedi
Floriculture Section, National Botanical Research Institute
Rana Pratap Marg, Lucknow-226001, India
E-mail : banerjibk@yahoo.co.in

ABSTRACT

Ten large flowered chrysanthemum cultivars, viz., 'Beat Rice May', 'Beauty', 'Casa Grande', 'Jet Snow', 'John Weber', 'Miss Maud Jeffries', 'Penny Lane', 'Shanker Dayal', 'Snow Ball' and 'S.S. Arnold' from National Botanical Research Institute (NBRI), Lucknow, were evaluated for morphological and biochemical characterization. Morphological data were recorded on vegetative and floral characters. Biochemical characterization included analysis of anthocyanins, carotenoides, chlorophyll content (chlorophyll a, b and total) and flavonoids. Results on morphological and biochemical parameters clearly indicated distinctness among cultivars with reference to differences in morphological characters and chemical composition of pigments.

Key words: Chrysanthemum, morphology, anthocyanin, carotenoids, flavonoids

INTRODUCTION

National Botanical Research Institute, Lucknow, is a pioneer in chrysanthemum collection. Banerji and Dwivedi (2008) reported new chrysanthemum cultivars at the Institute evolved during the last decade. Chrysanthemum (*C. morifolium* Ramat.) is an ornamental plant belonging to Asteraceae family. Origin of Chrysanthemum is traced to China. From China, chrysanthemum spread through out the world. The name *Chrysanthemum morifolium* has been changed to *Dendranthema grandifolium* Tzvelev (Heywood and Humphries, 1977; Anderson, 1987). Spontaneous mutation has played an important role in evolution of many present day garden chrysanthemums and 30% of the garden chrysanthemums here evolved as bud sports (Wasscher, 1956) and the rest by induced mutation, hybridization and seedling selection. Large-flowered chrysanthemum cultivars are used as potted plant. In the present study, ten large-flowered chrysanthemum cultivars were selected and characterized. Which included vegetative and floral characters. Morphological and biochemical characterization is an important parameter for DUS (Distinct, Uniform and Stable) testing and is equally important for registration of new cultivar under the Protection of Plant Variety and Farmer's Rights (PPVRF), New Delhi. Such information is very useful and can be exploited by breeders, growers and nurserymen in the future.

MATERIAL AND METHODS

Ten large-flowered chrysanthemum cultivars, viz., 'Beat Rice May' (reflexed), 'Beauty' (incurving), 'Casa Grande', (irregular), 'Jet Snow' (incurving), 'John Weber' (reflexed), 'Miss Maud Jeffries' (reflexed), 'Penny Lane' (reflexed), 'Shanker Dayal' (incurved), 'Snow Ball' (incurved) and 'S.S. Arnold' (incurved) were selected for morphological and biochemical characterization. Data were recorded on plant height, number of branchs, stem diameter, plant spread (East-West and North–South), leaf number, leaf size (length, width and petiole length), leaf colour, chlorophyll content (chlorophyll a, b and total) at the time of flowering. Chlorophyll estimation (Chlorophyll a, b and total) was carried out in mature leaf as per Arnon (1949). Estimation of anthocyanin, carotenoids and flavonoids was done as per Williams *et al* (1981), Wettstein (1957) and Ivankosalec *et al* (2005), respectively.

Characterization of flowering was done using parameters like, days to bud initiation, days to first colour appearance, days to full bloom, number of flower- heads per plant, flower colour, flower-head size (across), flower head-weight, flower-head height, number of ray florets per head and size of ray floret (length and width). For biochemical analysis, ray florets were collected from which anthocyanins, carotenoids and flavonoids were estimated. Colour of foliage and flowers was matchedto Royal Horticultural Colour Chart (Anonymous, 1966) (Table 1).

Table 1. Names of chrysanthemum cultivars, type of flower and flower-heads and colour of foliage

Name of cultivar	Flower type	Foliage		Flower-head	
		Colour	Code	Colour	Code
Beat Rice May	Reflexed	Green	Green Group 147A fan 3	White	Yellow-White Group 158C fan 4
Beauty	Incurving	Green	Green Group 139A fan 3	White	Yellow-White Group 158D fan4
Casa Grande	Irregular	Green	Green Group 139A fan 3	White	White Group 155C fan 4
Jet Snow	Incurving	Green	Green Group 139A fan 3	White	White Group 155C fan 4
John Weber	Reflexed	Green	Yellow-Green Group 147A fan 3	White	White Group 155A fan 4
Miss Maud Jeffries	Reflexed	Green	Green Group 137A fan 3	White	White Group 155C fan 4
Penny Lane	Reflexed	Green	Green Group 139A fan 3	White	White Group 155D fan 4
Shankar Dayal	Incurved	Green	Green Group 137A fan 3	White	White Group 155Dfan 4
Snow Ball	Incurved	Green	Green Group 139A fan 3	White	White Group 155C fan 4
S.S. Arnold	Incurved	Green	Green Group 139A fan 3	White	White Group 155B fan 4

RESULTS AND DISCUSSION

Maximum plant height (120.3cm) was recorded in 'Jet Snow' and minimum (50.4cm) in 'Shankar Dayal' while, the remaining cultivars grew in height between these two values (Table 2). Stem diameter of seven cultivars, viz., 'Beat Rice May', 'Beauty', 'Casa Grande', 'Jet Snow', 'Shankar Dayal, 'Snow Ball' and 'S.S. Arnold' ranged between 0.6 and 0.7cm while that in 'John Weber', 'Miss Maud Jeffries' and 'Penny Lane' range from 0.7 to 0.76cm. Stem colour was green in all cultivars. Plant spread in North-South direction ranged from 21.9-32.31cm and in the East – West direction from 24.20 to 32.92cm. Chrysanthemum cultivars show a wide variation in leaf number. Minimum number of leaves (22.60) was produced in 'Penny Lane' and maximum (45.89) 'Beat Rice May' (Table 2). The remaining cultivars had leaf number ranging from of 24 to 36. Largest leaf size (length, width and petiole length) was observed in cultivar 'Jet Snow' and in 'John Weber'. Rest of the cultivars, i.e., 'Beat Rice May', 'Beauty', 'Casa Grande', 'Miss Maud Jeffries', 'Penny Lane', 'Shanker Dayal', 'Snow Ball' and 'S.S. Arnold' fell in between and recorded almost similar size of leafe (Table 2).

Earliest bud initiation was seen at 49.40 days of planting in 'Beat Rice May'. Cultivar 'Miss Maud Jeffries' took 82.6 days, while the rest of the cultivars took 49.4 to 82.6 days for bud initiation. Earliest color appearance in the flower-head was observed in 'Penny Lane' which took 61.9 days, while, cultivars 'Miss Maud Jeffries' and 'Shankar Dayal' exhibited first color appearance at 90.2 days of planting. The rest of the cultivars had these values in between. Earliest full-bloom of flower-head was recorded at 69.4 days of planting in cultivar 'Beauty', while, cultivar 'Jet Snow' took 99.4 days to full-bloom. The remaining eight cultivars, i.e., 'Beat Rice May', 'Casa Grande', 'John Weber', 'Miss Maud Jeffries', 'Penny Lane', 'Shanker Dayal', 'Snow Ball' and 'S.S.Arnold' bloom in between 69 and 99 days (Table 2). The smallest flower (11.5cm) was recorded in cultivar 'Beat Rice May', while, the largest flower (18.5 cm) was recorded in cultivar 'Casa Grande'; the remaining eight cultivars recorded flower-size in between these values. The lowest flower-head height. (7.0cm) was seen in cultivar 'Shankar Dayal' and maximum flower-height of 11.9cm was observed in 'Casa Grandi'. The remaining eight cultivars had a flower-head size that ranged from 7.0 to 10.0cm (Table 2). Cultivar 'Jet Snow' had the heaviest flower-head weight (>48.0g) while, the lightest flower head was approximately (16.0g) in 'Beauty'. All the cultivars of chrysanthemum included in the present investigation had flower-heads with hundred per cent ray florets. Cultivar 'Jet Snow' produced 139 ray florets per flower-head - the least number of ray florets/head among the ten cultivars studied. Cultivar 'Miss Maud Jeffries' had 415 ray florets per head, the maximum number among the ten cultivars. The range of number of ray florets/ flower-head was 148 to 367.

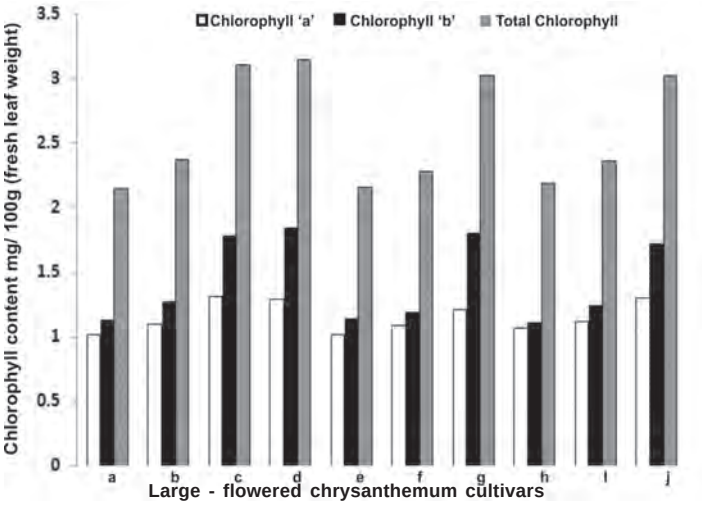
Qualitative analysis of chlorophylls 'a', 'b' and total chlorophtll clearly indicated that each cultivar had specific chlorophyll composition, that was distinct among cultivars (Fig. 1).

Pigment analysis in ten cultivars revealed that anthocyanin to be present in three cultivars, viz., Beauty (0.093), John Weber (0.081) and S.S.Arnold (0.039), while, carotenoids and flavonoids were need to be present in all the cultivars studied. However, range of these varied from cultivar to cultivar thereby imparting different levels of color intensity (Fig. 2).

Morphological and biochemical characterization of cultivars has also been carried out in various ornamental crops, viz., bougainvillea (Banerji *et al,* 2009 and Tewari *et al,* 2009), mini chrysanthemum (Banerji *et al,* 2011a,), annual chrysanthemum (Banerji *et al,* 2011b,),

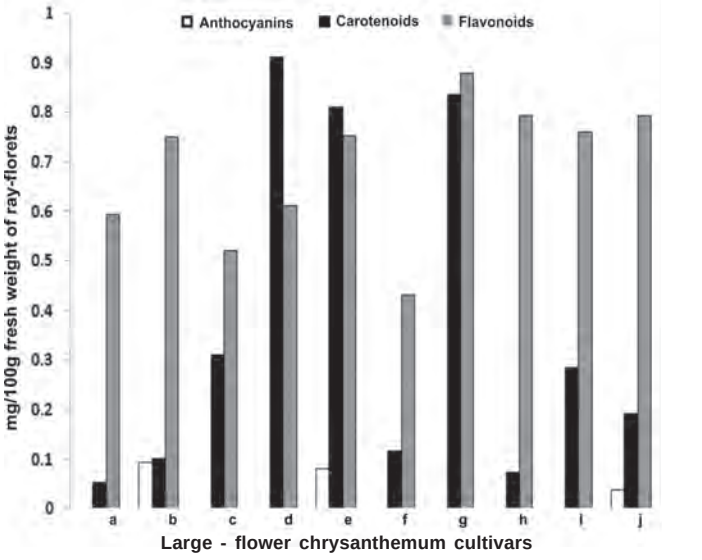
Table 2. Vegetative and floral characters of ten large-flowered chrysanthemum cultivars

	Beat Rice May	Beauty	Casa Grande	Jet Snow	John Weber	Miss Maud Jeffries	Penny Lane	Shankar Dayal	Snow Ball	S.S Arnold
Vegetative character										
Plant height (cm) ± SE	71.50 ± 3.87	60.4 ± 4.41	94.8 ± 4.63	120.3 ± 5.10	88.6 ± 5.32	81.0 ± 5.62	62.3 ± 2.98	50.4 ± 4.31	60.00 ± 5.64	62.6 ± 4.65
Plant Spread N-S(cm) ± SE	24.91 ± 1.89	28.32 ± 2.11	27.01 ± 2.92	30.23 ± 2.01	21.90 ± 2.11	26.0 ± 2.99	27.72 ± 3.10	25.99 ± 2.89	23.40 ± 3.11	32.31 ± 2.91
E-W(cm) ± SE	26.00 ± 3.01	32.92 ± 3.11	31.99 ± 3.00	29.61 ± 2.19	24.20 ± 2.61	28.32 ± 2.56	32.91 ± 2.51	31.97 ± 3.01	27.71 ± 2.19	28.31 ± 2.51
Stem diameter (cm) ± SE	0.65 ± 0.61	0.66 ± 0.13	0.69 ± 0.08	0.60 ± 0.05	0.74 ± 0.02	0.76 ± 0.08	0.70 ± 1.33	0.61 ± 0.06	0.60 ± 0.51	0.67 ± 0.45
Leaf number ± SE	45.89 ± 2.65	33.98 ± 1.66	36.12 ± 2.99	24.10 ± 2.86	31.63 ± 2.54	32.60 ± 2.59	22.60 ± 3.94	25.00 ± 2.49	27.81 ± 3.41	34.40 ± 2.77
Leaf size (cm) ± SE										
Length	8.75 ± 0.88	10.80 ± 0.75	9.33 ± 0.13	11.10 ± 0.39	7.66 ± 0.54	10.10 ± 0.26	9.33 ± 0.27	9.81 ± 0.36	9.00 ± 0.32	10.80 ± 0.75
Width	5.50 ± 0.70	7.50 ± 0.70	5.16 ± 0.36	8.50 ± 0.40	5.50 ± 0.62	5.50 ± 0.57	6.66 ± 0.13	6.71 ± 0.16	5.50 ± 0.13	5.50 ± 0.62
Petiole length	2.00 ± 0.35	2.66 ± 0.36	2.33 ± 0.27	2.66 ± 0.33	1.33 ± 0.27	2.83 ± 0.23	3.00 ± 0.02	2.16 ± 0.12	2.12 ± 0.02	2.01 ± 0.23
Floral character										
Days to bud initiation ± SE	49.40 ± 2.38	56.20 ± 2.77	69.10 ± 3.23	76.30 ± 4.21	67.80 ± 3.56	82.60 ± 4.40	59.80 ± 2.67	76.70 ± 3.99	69.80 ± 3.82	64.70 ± 4.67
Days to first color appearance ± SE	68.90 ± 2.89	66.70 ± 5.21	78.90 ± 3.80	81.00 ± 2.67	72.90 ± 3.45	90.20 ± 2.79	61.90 ± 3.22	82.40 ± 1.88	79.30 ± 2.67	69.10 ± 3.10
Days to full bloom ± SE	77.00 ± 3.43	69.40 ± 2.56	89.70 ± 2.67	99.40 ± 3.87	75.90 ± 4.12	96.00 ± 3.10	73.90 ± 4.71	90.20 ± 2.90	84.80 ± 4.01	93.60 ± 4.66
Flower head size (cm) ± SE										
Across	11.50 ± 0.35	12.60 ± 1.18	18.50 ± 1.32	14.50 ± 1.06	15.40 ± 0.32	12.20 ± 1.06	12.50 ± 1.06	14.50 ± 0.37	13.50 ± 0.34	11.70 ± 0.41
Height	8.20 ± 0.21	8.40 ± 0.10	11.90 ± 0.47	9.80 ± 0.11	10.10 ± 0.21	8.10 ± 0.32	8.70 ± 0.18	6.80 ± 0.45	7.50 ± 0.04	7.10 ± 0.88
Flower head weight (g) ± SE	41.00 ± 0.70	15.90 ± 1.46	28.00 ± 1.13	48.50 ± 1.06	25.00 ± 2.12	44.70 ± 2.29	18.50 ± 2.47	29.70 ± 1.41	42.75 ± 2.67	17.90 ± 1.04
Number of Ray florets ±SE	261.00 ± 7.07	171.00 ± 5.82	231.00 ± 6.32	139.00 ± 6.56	148.00 ± 3.47	415.00 ±11.30	160.00 ± 6.71	367.00 ±10.6	190.00 ±10.3	154.00 ± 5.47
Ray floret size (cm) ± SE										
Length	6.00 ± 0.04	2.21 ± 0.13	5.32 ± 0.13	5.67 ± 0.20	5.27 ± 0.30	7.52 ± 0.10	2.31 ± 0.21	5.75 ± 0.19	6.67 ± 0.71	6.72 ± 0.11
Width	0.68 ± 0.02	0.41 ± 0.04	0.93 ± 0.03	0.67 ± 0.05	0.50 ± 0.06	0.48 ± 0.02	0.32 ± 0.03	0.91 ± 0.07	0.72 ± 0.10	0.82 ± 0.07



a: Beat Rice May, b: Beauty, c: Casa Grande, d: Jet Snow, e: John Weber, f: Miss Maud Jeffries, g: Penny Lane, h: Shankar Dayal, i: Snow Ball, j: SS Arnold

Fig 1. Chlorophyll content of ten large-flowered chrysanthemum cultivars



a: Beat Rice May, b: Beauty, c: Casa Grande, d: Jet Snow, e: John Weber, f: Miss Maud Jeffries, g: Penny Lane, h: Shankar Dayal, i: Snow Ball, j: SS Arnold

Fig 2. Biochemical analysis of pigments of ten large-flowered chrysanthemum cultivars

Catharanthus (Dwivedi *et al*, 2011), gladiolus (Dwivedi and Banerji, 2008), hibiscus (Singh *et al*, 2009), marigold (Singh *et al*, 2008) and rose (Datta and Singh, 2004). The present information will be useful to breeders for planning trait-specific breeding programmes in chrysanthemum.

ACKNOWLEDGEMENT

The authors are grateful to Dr. C.S.Nautiyal, Director, National Botanical Research Institute(CSIR), Lucknow, for providing facilities.

REFERENCES

Anderson, N.O. 1987. Reclassification of the genus *Chrysanthemum* L. *Hort.Sci.*, **22**:313

Anonymous. 1966. Royal Horticulture Society colour chart in association with the flower council of Holland. The Royal Horticultural Society, London

Arnon, D.I. 1949. Copper enzymes in isolated chloroplast polyphenil oxidase in *Beta vulgaris. Pl. Physiol.*, **24**:1-15

Banerji, B.K. and Dwivedi, A.K. 2008. New chrysanthemum cultivars released at National Botanical Research Institute, Lucknow. YWC Association of Delhi, *60th Chrysanthemum Show Bulletin*, 06 December, 2008 pp 30-32

Banerji, B.K., Singh, V.N., Saxena, M., Verma, A.K. and Dwivedi, A.K. 2008. Characterization of Chlorophyll variegated Bougainvillea for utilization in Landscaping. In proceeding of Homi Bhabha Centenary DAF-BRNS National Symposium of landscaping for sustanable Environment Nov. 20-21, 2008. Held at BARC, Mumbai. Abstract No. pp-23, Page No. 170-171

Banerji, B.K., Preeti Srivastava, Misra, P., Dwivedi, A.K. and Batra, A. 2011a. 1. Research Round-UP: Characterization of mini chrysanthemum. NBRI News lett. June 2011, **38**:25-29

Banerji, B.K., Dwivedi, A.K. and A. Batra. 2011b. Morphological characterization of Annual Chrysanthemum – A Review, *Floriculture Today*, **16**:30-33

Datta, S.K. and Singh, M.S. 2004. Characterization of Roses- Six more hybrid tea cultivars. *The Indian Rose Annual*, **20**:102-110

Dwivedi, A.K. and Banerji, B.K. 2008. Morphological Characterization of Gladiolus for hybridization. **In:** 'National Symposium on Recent advances in Floriculture, 4-6 March, N.A.U. Navsari, Gujarat Abstract No.P1-31: 28

Dwivedi, A.K., Verma, A.K. and Banerji, B.K. 2011. Morphological and Anatomical studies on Catharanthus roseus. *Prog Res.*, **6**:51-55

Heywood, V.H. and Humphries, C.J. 1977. Anthemideae-Systemic review. P 851-898. In V.H.Heywood, J.B. Harborne and B.L. Turner (eds). The Biology and Chemistry of Compositae. Academic-New York

Ivankosalec, S., Marina, B. and Sanda, V. 2005. Flavonoids analysis and antimicrobial activity of commercially available Propolis products. *Acta Pharma*, **55**:423-430

Singh, V.N., Saxena, M., Banerji, B.K. and Dwivedi, A.K. 2009. Characterization of eight single whorl genotype of Hibiscus. In: National Conference on Floriculture for livelihood and profitability. Session -1. Genetic diversity and crop improvement in ornamental crops**.** **33**: 29

Singh, V.N., Saxena, M., Verma, A.K., Dwivedi, A.K. and Banerji, B.K. 2008. Characterization of French marigold genotype (*Tagetes patula* L.) under Lucknow Condition. Paper presented in 4th National Symposium on Scenario of Agriculture in changing climatic condition. Helt at SVBP University of Agriculture and Tchnology, Meerut, U.P. 18-19 October, 2008. Abstract No. 2. 78, Page No. 222.

Tewari, T., Banerji, B.K., Dwivedi, A.K., Singh, V. N., Saxena, M. and Verma, A.K. 2009. Characterization of fifteen cultivars of Bougainvillea and their use in Landscape gardening. Abstract number PP-**22**: 169

Wasscher, J. 1956. The importance of sports in some florist's flowers. *Euphytica*, **5**: 163-170

Wettstein, D. 1957. Chlorophyll letale und der submikroskopische Formwechsel der Plastiden. *Expl. Cell Res.*, **12:** 427–434 [non-English]

Williams, C., Horborne, J. and Mayo, S.J. 1981. Anthocyanin pigments and leaf flavonoids in the family Araceae. *Phytochem.*, **20**:217-234

(MS Received 20 October 2011, Revised 18 February 2012)