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Assessment of chrysanthemum (*Dendranthema grandiflora* Tzvelev) varieties for their suitability for flower production under *Tarai* region of Uttarakhand

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ABSTRACT: Floriculture is a fashion driven industry and introduction of new varieties is very much in fashion for bringing novelty in flower production. Cultivars released by various institutes and universities are to be tested in a specific region for their suitability and adaptability in particular agro-climatic conditions before recommending them for commercial cultivation. Keeping the above facts in mind, an experiment was carried out at Model Floriculture Centre, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, during 2022-23. In the present investigation, 20 chrysanthemum varieties were assessed in Randomized Block Design (RBD) with three replications. The findings on vegetative growth characteristics showed that among twenty varieties, maximum plant height at full bloom stage was seen in Bidhan Agnisikha (52.41 cm) while minimum in variety cultivar Double Red (26.67 cm). Regarding flowering attributes, the number of buds per plant (62.33 each) was found maximum in varieties Bidhan Agnisikha and Bidhan Purna while minimum (18.33) was in variety DFRC-6. The flower diameter was reported maximum in DFRC-3 (8.63 cm) while flowering duration was found maximum in variety Coffee (48.40 days). In terms of yield characteristics, maximum flower yield per plant was found in variety Bidhan Swapna (204.90 gram) and minimum (53.41 g) was in variety DFRC-2. With regard to vase life, the variety Bidhan Swapna exhibited maximum vase life (7.67 days). Among the different varieties, Bidhan Swapna (Decorative type), Bidhan Jayanti (Decorative type), Bidhan Agnisikha (Decorative type) and Bidhan Sweta (Reflexed type) found be the best promising for flower production under *Tarai* region of Uttarakhand.

Keywords: Chrysanthemum varieties, flowering attribute, flower production, *Tarai* region

Among the flowers, chrysanthemum (*Dendranthema grandiflora* Tzvelev) is a commercially grown flower crop that belongs to Asteraceae family, consisting of 200 species, and is known as “Queen of the East” with $2n = 18$ chromosome number. Chrysanthemum belongs to the Northern Hemisphere mainly Europe and Asia with a few in other areas. However, it is said to have originated in China (Crater, 1980).

Chrysanthemum is widely grouped into two categories on the basis of size of flower viz., standard type (large flowered) and spray type (small flowered). Varieties with large flowers are grown mainly in pots for exhibition and cut flower production whereas varieties with small flowers are grown mainly in fields and beds for loose and cut flowers.

It grows in well-drained soil, but thrives best in sandy loam soil rich in organic content. A soil pH of 6.0 to

7.0 is considered ideal for chrysanthemum cultivation; however, soils with pH range of 5.0 to 7.0 can also be found to be suitable (Kumar and Polara, 2017). Chrysanthemum is a cross-pollinated crop and based on photoperiod, it is short day plant and requires a photoperiod of >14 hours for the plants to have good vegetative growth and with the onset of short days, flowering occurs. Based on temperature requirement, chrysanthemum can be classified into Thermo zero, Thermo positive and Thermo negative cultivars, but it is a typical short day plant and cannot normally form flower buds when the day length exceeds 14.5 hours. It is grown under vast range of climatic conditions but the characteristic of the genotype differs with the region, season and other developmental conditions. However, ability to produce year-round flowers depends on an understanding the complex interaction between the plant and

its environment (Kashyap *et al.*, 2024).

The globe is home to many different varieties of the chrysanthemum, a very attractive and lovely flowering plant. It is widely used for making *veni*, garlands and as a form of worship offering to God and Goddesses as a loose flower and for bouquets, flower arrangements, vases, etc. as cut flower. Besides this, some dwarf or varieties with small flowers named as "no pinch no stake" became very popular for their charismatic flowers and for growing in pots. This crop is a versatile floral crop due to the extensive variation displayed by numerous species and bloom shapes. Spray varieties are fit for growing in flower beds, edging, mixed borders, hanging baskets, potted plants, front row gardening and window boxes. These plants are perennial herbs; however some of the species are also annual and sometimes partial woody growing to 50-150 cm tall. Annual species like *C. cinerariifolium* and *C. coccineum* are used to produce pyrethrum, the safest biological insecticide for household commodities.

Despite a large number of chrysanthemum varieties are present in the market, novelty in commercial traits like flower colour, shape, size, growth habit, post-harvest life of the flower, etc., are consistently valued and preferred by the consumer. The choice of an appropriate variety is essential for the effective development of chrysanthemum. Many new, ideal-colour cultivars have been produced in the last few years, but among them not all perform effectively in all environments. Generally, performance of genotypes determined by genetic composition, while determination their expression depends on the environmental conditions of the area under which they are grown. The effective results for selecting novel types of chrysanthemum rely on the degree of varietal assessment present in base materials and depending upon their suitability and adaptability to the given climatic conditions, the developed varieties perform best in one or another region. Taking into account the aforementioned details, an experiment was conducted to assess various chrysanthemum varieties for their adaptability and suitability in the *Tarai* region of Uttarakhand.

MATERIALS AND METHODS

The present experiment was conducted at Model Floriculture Centre, G. B. Pant University of Agriculture and Technology, Pantnagar, District Udham Singh Nagar (Uttarakhand) during 2022-23. Pantnagar is located at the foothills of the Himalayas at 29° North latitude and 79.3° East longitude. The altitude of the place is 243.84 m above mean sea level. The climate of Pantnagar is humid subtropical with dry hot summer, cold winter and intense rainy season. The soil of experimental site is having pH 6.8, 248.52 kg/ha available nitrogen, 35.13 kg/ha phosphorus and 270.0 kg/ha potassium. The experiment was laid out in Randomized Block Design and replicated thrice under open field conditions. The investigation included twenty chrysanthemum varieties *viz.*, Akitha, Bidhan Agnisikha, Bidhan Jayanti, Bidhan Lalima, Bidhan Mum, Bidhan Neeta, Bidhan Purna, Bidhan Savita, Bidhan Sweta, Bidhan Swapna, Cherabu, Coffee, DFRC-1, DFRC-2, DFRC-3, DFRC-4, DFRC-6, DFRC-7, Double Red and Himani.

The healthy terminal stem cuttings of 5-7 cm length free from symptoms of diseases or insect/pests were collected from mother block maintained at Model Floriculture Centre, G. B. Pant University of Agriculture and Technology, Pantnagar. Before planting the cuttings in the nursery bed, basal leaves of each cutting were removed, and then cuttings were dipped in fungicidal solution of carbendazim (1 g/L) and Dithane M-45 (2 g/L) for thirty minutes. After dipping in fungicidal solution, cut ends were dipped in NAA solution (500 parts per million) as quick dip (5-10 seconds). Cuttings were then placed in raised nursery beds for rooting in the initial 15 days of July; the cuttings were kept moist through sprinkling of water. For the experimental field preparation vermicompost @ 500.0 g/m² and fertilizers were applied @ 26.40 g/m² nitrogen, 62.50 g/m² phosphorus and 13.34 g/m² potassium, mixed uniformly in soil and all the recommended cultural practices were followed. After 30 days healthy and uniform well rooted cuttings were selected and planted in raised plots or beds of 1 m × 1 m size that were made ac-

cording to the treatments design, each treatment replicated thrice and in each replication nine chrysanthemum rooted cuttings were planted at 30 cm × 30 cm spacing. The operation of pinching was performed after one month i. e., 30 days of planting in the field where pinching was done to induce side shoots. Adequate measures were practiced to prevent lodging by staking the plants. Three competitive plants in each treatment were tagged at random in each replication for recording detailed observation and the observations were recorded for various vegetative and floral traits viz., height of plant (cm), number of primary branches, number of secondary branches, plant spread (E-W) (cm), plant spread (N-S) (cm), days to initiation of first flower bud, number of buds per plant, days taken to flower initiation, days taken to 50% flowering, days taken for full bloom, number of flowers per plant, flower diameter (cm), number of ray florets per flower, vase life (Days), duration of flowering (days), type of bloom, flower colour (as per RHS Colour Chart), single flower weight (g), flower yield per plant (g), yield of flower per square meter (kg) and benefit cost ratio. The observations recorded on vegetative growth, flowering parameters and yield characteristics were subjected to statistical analysis in Randomized Block Design (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Vegetative growth characteristics

The result reveals that significant differences existed between the varieties for all the assessed characters. The maximum plant height at 30, 60 days after planting (20.50 and 39.52 cm, respectively) and at full bloom (52.41cm) was recorded in variety Bidhan Agnisikha while minimum plant height at 30 days after planting (10.57 cm), at 60 days of planting (18.33 cm) and at full bloom (26.67 cm) was observed in Double Red; The plant height is a very important growth related morphological character of plants for screening of chrysanthemum varieties. Increase in plant height is associated with accelerated meristematic activity, likely as a result of quick cell division and lengthening during the tender growth stage. This association may be attributable

to genetics as well as climate-related factors like light, temperature, nutrition, soil quality, etc. (Suvija *et al.*, 2016). The results were similar with the findings in plant height between genotypes by Thiripurasundari *et al.* (2021) in chrysanthemum.

Maximum plant spread was recorded by variety Bidhan Mum in North-South and East-West directions (38.00 and 36.73 cm, respectively) while minimum (19.00 and 16 cm, respectively) was in variety Double Red. Plant spread in various directions reveals the plant development and vigour. It might also have an impact on plant productivity, because it is determined by genetics as the differences in spread of plant is a varietal attribute. Similar differences in spread of plant were also observed by Yumkhaibam *et al.* (2023a) in chrysanthemum.

The maximum number (4.00) of primary branches per plant were found in variety Bidhan Lalima while minimum (1.00) in Double Red and maximum number (8.00 each) of secondary branches per plant were found in Bidhan Mum and DFRC-1 respectively, while minimum (4.00) in Double Red. The difference in number of branches per plant might be because of varied growth rates and their genetic potential resulting in variation in phenotypic expression. It may also be attributed to the soil and climatic conditions prevailing in the area (Bajaraya *et al.*, 2018). The results are consistent with the differences in number of branches per plant observed by Henny *et al.* (2021) and Singh *et al.* (2022) in chrysanthemum.

Floral characteristics

The days taken to flower bud initiation were recorded minimum (64.33 days) in variety Akitha and maximum (77.00 days) in variety Himani. The genetic makeup of each variety, in addition to how it interacts with the appropriate microclimate (light, temperature and humidity) directly affects how flower buds form. The results are consistent with observations of Shravani *et al.* (2023) in chrysanthemum.

Maximum number of buds per plant (62.33 each) were recorded in variety Bidhan Agnisikha and

Table 1: Vegetative growth characteristics in different varieties of chrysanthemum

Treatments		Plant height (cm)			Plant spread (cm)			Number of branches per plant	
		30 DAP	60 DAP	At full bloom	N-S	E-W	Mean	Primary branches	Secondary branches
T ₁	Akitha	14.00	21.00	33.31	25.33	22.00	23.67	1.67	6.33
T ₂	Bidhan Agnisikha	20.50	39.52	52.41	32.21	30.00	31.11	2.67	7.00
T ₃	Bidhan Jayanti	16.50	23.67	48.67	33.00	31.00	32.00	2.00	6.00
T ₄	Bidhan Lalima	19.50	34.33	49.33	36.20	34.00	35.10	4.00	7.67
T ₅	Bidhan Mum	16.00	32.67	43.33	38.00	36.73	37.37	3.67	8.00
T ₆	Bidhan Neeta	15.33	23.67	37.67	19.00	17.00	18.00	3.00	7.33
T ₇	Bidhan Purna	20.47	30.33	40.92	36.00	33.77	34.88	1.67	6.33
T ₈	Bidhan Savita	20.33	31.33	44.97	31.17	30.40	30.79	2.33	7.67
T ₉	Bidhan Sweta	15.07	24.59	39.67	21.19	20.00	20.60	3.00	6.67
T ₁₀	Bidhan Swapna	20.17	28.67	38.25	35.00	33.47	34.24	1.67	6.33
T ₁₁	Cherabu	12.00	20.33	30.74	21.00	18.16	19.58	1.67	4.67
T ₁₂	Coffee	10.67	19.00	28.41	20.90	19.33	20.12	1.67	6.00
T ₁₃	DFRC-1	13.33	23.00	40.17	19.18	18.33	18.76	2.00	8.00
T ₁₄	DFRC-2	19.00	30.00	44.13	24.50	22.24	23.37	1.33	5.67
T ₁₅	DFRC-3	18.57	28.86	41.00	30.58	28.21	29.40	2.67	7.00
T ₁₆	DFRC-4	17.00	25.67	36.82	21.41	18.80	20.10	2.00	6.67
T ₁₇	DFRC-6	18.97	28.53	40.10	29.20	27.15	28.17	1.67	6.33
T ₁₈	DFRC-7	19.20	32.33	43.92	32.18	30.00	31.09	1.33	5.00
T ₁₉	Double Red	10.57	18.33	26.67	19.00	16.00	17.50	1.00	4.00
T ₂₀	Himani	19.33	29.45	38.33	20.17	18.17	19.17	2.00	7.33
SE (m)±		0.502	1.032	1.29	0.63	0.756		0.443	0.725
C. D. at 5%		1.442	2.966	3.70	1.811	2.172		1.274	2.083

Table 2: Floral characteristics in different varieties of chrysanthemum

Treatments		Days taken to flower bud initiation	Number of buds per plant	Days taken to initiation of flowering	Days taken to 50% flowering	Days taken for full bloom	Number of flowers per plant	Flower diameter (cm)	Number of ray florets per flower
T ₁	Akitha	64.33	30.33	77.66	92.67	107.00	29.00	6.87	304.33
T ₂	Bidhan Agnisikha	70.00	62.33	81.67	94.00	109.00	61.67	5.90	222.33
T ₃	Bidhan Jayanti	64.67	62.00	78.66	91.00	106.00	60.00	7.30	402.66
T ₄	Bidhan Lalima	71.00	50.67	83.00	95.00	110.33	50.33	6.07	200.67
T ₅	Bidhan Mum	66.33	60.33	81.00	93.67	108.00	60.00	5.90	223.33
T ₆	Bidhan Neeta	68.00	58.00	82.33	94.33	109.33	57.00	4.53	253.00
T ₇	Bidhan Purna	71.00	62.33	81.66	94.00	109.00	61.67	7.03	63.33
T ₈	Bidhan Savita	67.33	53.66	81.33	95.33	110.00	52.00	5.93	128.33
T ₉	Bidhan Sweta	66.67	52.67	79.67	91.66	106.66	51.33	5.40	181.67
T ₁₀	Bidhan Swapna	65.33	39.00	79.33	93.33	108.33	38.67	6.33	270.33
T ₁₁	Cherabu	72.33	25.00	82.33	93.67	108.67	24.33	3.90	154.67
T ₁₂	Coffee	66.67	31.66	81.33	92.00	107.00	30.33	6.43	314.33
T ₁₃	DFRC-1	70.33	36.33	82.00	93.00	108.00	34.67	6.00	209.33
T ₁₄	DFRC-2	71.33	26.67	83.33	92.66	107.33	25.33	5.77	103.67
T ₁₅	DFRC-3	73.00	58.66	86.00	96.00	111.00	58.00	8.63	60.33
T ₁₆	DFRC-4	70.00	37.00	82.33	94.33	109.33	36.33	4.90	138.00
T ₁₇	DFRC-6	72.33	18.33	84.33	93.67	108.00	17.00	6.97	289.33
T ₁₈	DFRC-7	72.00	52.66	82.00	94.00	109.00	51.67	6.00	173.67
T ₁₉	Double Red	73.67	18.67	85.67	96.66	110.66	18.33	3.83	140.33
T ₂₀	Himani	77.00	20.00	89.00	98.00	113.00	19.67	3.93	130.33
SE (m)±		1.019	1.195	0.983	0.807	0.681	1.048	0.063	1.280
C. D. at 5%		2.929	3.433	2.824	2.319	1.958	3.012	0.182	3.680

Table 3: Floral and post harvest characteristics in different varieties of chrysanthemum

	Treatments	Vase life (Days)	Incidence of pests*	Incidence of diseases* (days)	Flowering duration	Type of bloom	Flower colour (as per RHS Colour Chart)
T ₁	Akitha	6.00	2	2	35.00	Decorative	167A (Grayed Orange)
T ₂	Bidhan Agnisikha	6.33	2	1	38.51	Decorative	69A (Red Orange)
T ₃	Bidhan Jayanti	6.00	1	3	39.18	Decorative	12A (Yellow)
T ₄	Bidhan Lalima	7.33	2	2	41.70	Semi quilled (Spoon)	46A (Red)
T ₅	Bidhan Mum	5.33	0	1	46.69	Decorative	9A (Yellow)
T ₆	Bidhan Neeta	5.67	1	3	42.10	Decorative	155A (White)
T ₇	Bidhan Purna	5.33	3	3	38.72	Korean (Single)	5A (Yellow)
T ₈	Bidhan Savita	6.33	1	1	35.37	Decorative	34A (Orange-Red)
T ₉	Bidhan Sweta	5.33	3	0	47.47	Reflexed	155C (White)
T ₁₀	Bidhan Swapna	7.67	2	0	42.32	Decorative	74D (Red Purple)
T ₁₁	Cherabu	4.67	3	3	43.75	Korean (Single)	171A (Orange)
T ₁₂	Coffee	6.67	1	1	48.40	Korean (double)	25A (Orange-Red)
T ₁₃	DFRC-1	4.33	3	1	42.59	Decorative	64D (Light Pink)
T ₁₄	DFRC-2	5.00	4	5	38.36	Korean (Single)	155C (White)
T ₁₅	DFRC-3	4.33	1	0	34.48	Korean (Single)	14B (Dark Yellow)
T ₁₆	DFRC-4	5.33	0	0	35.48	Korean (double)	14C (Yellow-Orange)
T ₁₇	DFRC-6	6.33	2	1	35.49	Decorative	155D (White)
T ₁₈	DFRC-7	5.67	1	3	34.45	Korean (double)	63D (Red Purple)
T ₁₉	Double Red	4.33	1	0	33.40	Decorative	34C (Orange-Red)
T ₂₀	Himani	5.67	2	5	34.70	Decorative	65C (Red Purple)
	SE (m)±	0.39	0.178	0.227	0.310		
	C. D. at 5%	1.12	0.511	0.654	0.890		

* Pests incidence - on the basis of index given by Pulido-Blanco *et al.* (2020); * Disease incidence - on the basis of visual scale of (1-7) developed by Alegbejo (1997)

Table 4: Yield characteristics in different varieties of chrysanthemum

	Treatments	Single flower weight (g)	Flower yield per plant (g)	Flower yield per square meter (kg)	Flower yield per hectare (ton)	Benefit cost ratio
T ₁	Akitha	4.14	119.96	1.10	10.98	1.74
T ₂	Bidhan Agnisikha	2.95	182.08	1.64	16.39	3.10
T ₃	Bidhan Jayanti	3.29	197.33	1.78	17.76	3.44
T ₄	Bidhan Lalima	1.61	80.95	0.73	7.29	0.82
T ₅	Bidhan Mum	2.13	128.03	1.15	11.52	1.88
T ₆	Bidhan Neeta	2.42	138.06	1.24	12.43	2.11
T ₇	Bidhan Purna	2.40	148.18	1.33	13.34	2.33
T ₈	Bidhan Savita	2.97	154.51	1.39	13.91	2.48
T ₉	Bidhan Sweta	3.49	179.03	1.61	16.11	3.03
T ₁₀	Bidhan Swapna	5.30	204.90	1.84	18.44	3.61
T ₁₁	Cherabu	2.53	61.63	0.55	5.55	0.39
T ₁₂	Coffee	3.28	99.67	0.82	8.16	1.04
T ₁₃	DFRC-1	3.21	111.28	1.00	10.02	1.50
T ₁₄	DFRC-2	2.11	53.41	0.48	4.81	0.20
T ₁₅	DFRC-3	1.48	86.12	0.78	7.75	0.94
T ₁₆	DFRC-4	2.18	78.99	0.71	7.11	0.78
T ₁₇	DFRC-6	4.28	72.63	0.65	6.54	0.63
T ₁₈	DFRC-7	3.03	156.40	1.41	14.08	2.52
T ₁₉	Double Red	3.62	66.47	0.60	5.98	0.50
T ₂₀	Himani	3.48	68.61	0.62	6.18	0.54
	SE (m)±	0.175	0.258	0.002		
	C. D. at 5%	0.503	0.742	0.006		

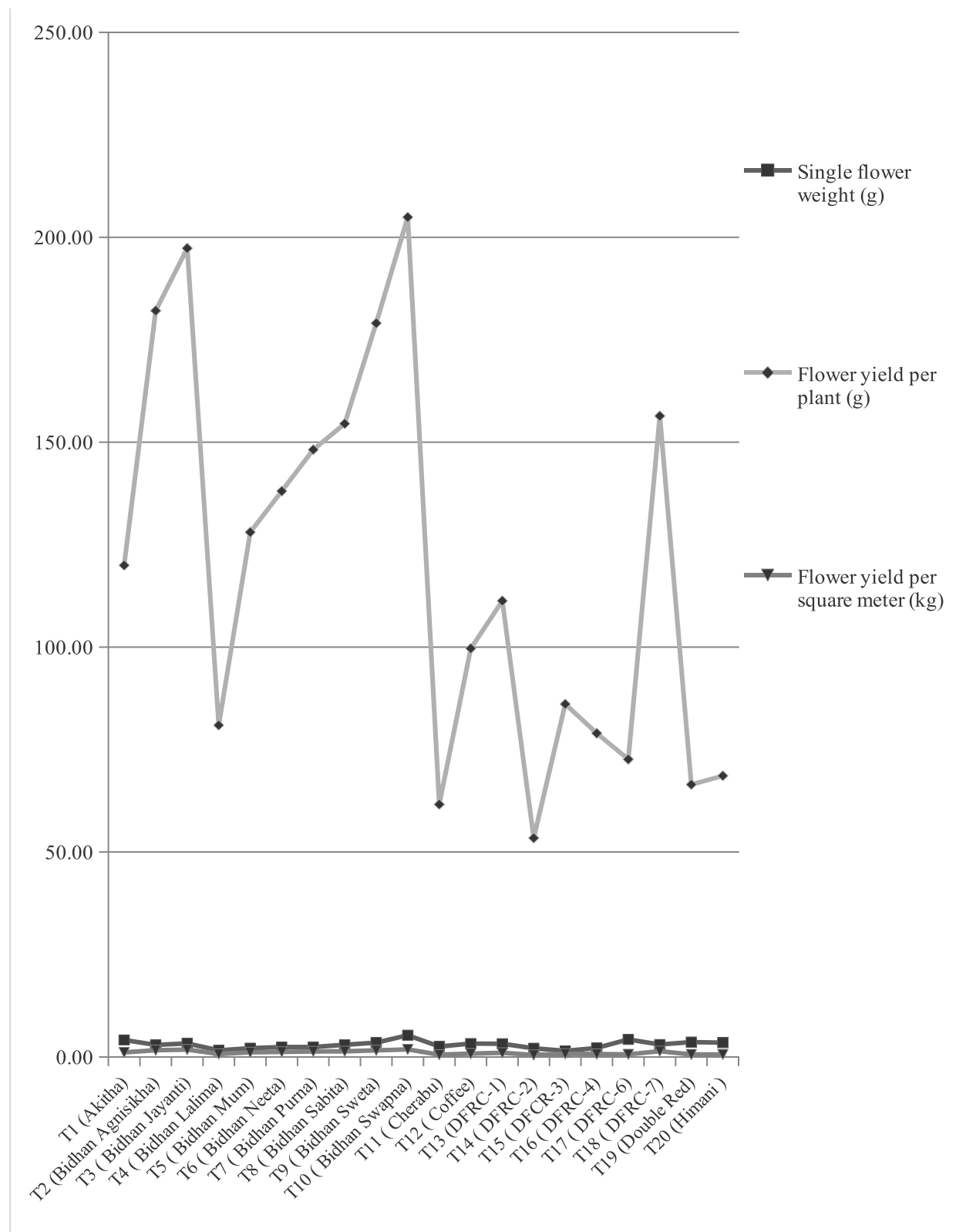


Fig.1: Yield characteristics in different varieties of chrysanthemum



Plate 1: Different varieties of chrysanthemum (*Dendranthema grandiflora* Tzvelev) used in the experiment

Bidhan Purna, respectively, while minimum in DFRC-6 (18.33). Change in the number of buds per plant could have resulted from both environmental factors and differences in the genetic make-up of the plants. Findings are consistent with past observations of Jamaluddin *et al.* (2015) in chrysanthemum.

The minimum days taken to initiation of flowering (77.66 days) were recorded in variety Akitha while maximum days (89.00 days) were recorded in variety Himani. Early or delay in flowering might be determined due to genetic composition of the varieties (Negi *et al.*, 2020). Similar outcomes were also seen by Siddiqua *et al.* (2017) in chrysanthemum.

The days taken to 50% flowering (91.00 days) and days taken to full bloom (106.00 days) were observed minimum in variety Bidhan Jayanti and maximum days taken to 50% flowering (98.00) and days taken to full bloom (113.00 days) were found in variety Himani. The genetic composition of the cultivars was credited for the variations in the number of days needed for full blossoming (Negi *et al.*, 2020). Similar differences in various cultivars of chrysanthemum were also recorded by Prasanth *et al.* (2020).

Number of flowers per plant (61.67 each) were observed maximum in variety Bidhan Agnisikha and Bidhan Purna while minimum (17.00) in variety DFRC-6. Increase in morphological characters like plant height, number of leaves and the area of the leaves may have contributed to producing more photosynthates, which helps the plant to accumulate more dry matter and lead the plants to produce more flowers. Consistent outcomes were seen by Patil *et al.* (2017) in chrysanthemum.

The maximum (8.63 cm) flower diameter was recorded in variety DFRC-3 and minimum (3.83 cm) in Double Red. The genetic characteristics of the various varieties and environmental conditions may be reason for the variance in flower diameter between the varieties (Henny *et al.*, 2021). These outcomes of present findings are corroborated with the findings of Vandana *et al.* (2024).

The numbers of ray florets per flower were observed

maximum (402.66) in variety Bidhan Jayanti and minimum (60.33) in variety DFRC-3. Increased flower size with a correspondingly higher floral weight was the main reason of the difference in the number of ray florets per flower head among the varieties. The distinct varietal intrinsic genetic constitution of each variety may also contribute to the variance in the number of ray florets among various varieties. Similar differences were also seen in chrysanthemum variety Thai Chen Queen by Patil *et al.* (2017).

The severity of pests, especially aphids (*Myzus persicae*) was seen in varieties Bidhan Purna, Bidhan Neeta, Cherabu, DFRC-1 and DFRC-2, while high symptoms of disease in leaves of varieties DFRC-2 and Himani were seen. The climate and environment prevailing in the area or region along with the susceptibility of varieties may be the reasons for incidence of pests and diseases in plants. Pests' incidence was analyzed on the basis of index given by Pulido-Blanco *et al.* (2020) and disease incidence was analyzed on the basis of visual scale of 1-7 developed by Alegbejo (1997).

Maximum duration of flowering was recorded in variety Coffee (48.40 days) while minimum (33.40 days) in variety Double Red. The genotype of the plant, environmental effects and other management variables were the causes of the variance in the flowering duration between varieties. Results indicating variations in the flowering duration between cultivars under different environmental circumstances have also been reported by Yumkhaibam *et al.* (2023b) in chrysanthemum.

Types of bloom were found in broad range of diversity among chrysanthemum flower 2types, including single Korean, double Korean, decorative, semi quilled (Spoon), reflexed, etc. The genetic component alone is wholly responsible for flower shape and form. The difference in flower form was identical as noticed by Madhu Bala (2015) in chrysanthemum.

Flower colours that were seen among the different assessed varieties were white, yellow, red, orange,

purple, pink and violet. Chrysanthemum varieties differed in flower colours due to their genetic make-up and the colouring pigments that were available in a particular genotype. Anthocyanin pigments are main cause for red colour, while chalcones and aurones for yellow colour. Similarly, flavonols and carotenoid pigments resulted in white colour, while cyanidin pigments are attributed for purple colour. The outcomes of present investigation are consistent with the results of Thakur *et al.* (2018) and Singh *et al.* (2019) in chrysanthemum.

Post harvest and yield characteristics

Vase life in tap water was observed maximum (7.67 days) in the variety Bidhan Swapna while minimum (4.33 days each) was recorded in the varieties DFRC-1, DFRC-3 and Double Red. Similar variations in vase life were observed by Henny *et al.* (2021) in different chrysanthemum genotypes.

Maximum weight of single flower was recorded in Bidhan Swapna (5.30 g) while the minimum was in DFRC-3 (1.48 g). Good plant height and vigour of the plant results in increased flower weight. Increased levels of water and carbohydrates may also contribute to the variations in weight of flowers as the freshness, petal orientation of flowers and turgidity, are all significantly influenced by water. Similar findings regarding flowerweight were also observed by Prakash and Fatmi (2022).

Flower yield per plant (204.90 g) and yield of flower per square meter (1.84 kg) were found maximum in variety Bidhan Swapna while minimum yield of flowers per plant (53.41g) and yield of flowers per square meter (0.48 kg), were seen in variety DFRC-2. Flower yield depends on the vigour of the plants and also on number of flowers and individual flower weight. The difference in the flower yield may also be the result of varietal character, habitat type and genetic composition of the varieties. Higher yield might be result of increase in morphological characters like height of plant, number of leaves, leaf area, plant spread and number of branches which could have contributed in generation of more photosynthates resulting in production of more number of

flowers per plant. Similar variations in the yield of flower per plant among various varieties were also observed by Singh *et al.* (2017) in chrysanthemum. In variety Bidhan Swapna maximum (3.61) benefit cost ratio was found while minimum (0.20) was in variety DFRC-2. The results of present investigation corroborate with the findings of Kumar *et al.* (2021) in chrysanthemum.

CONCLUSION

Significant differences were recorded among the varieties. Based on vegetative growth, floral characteristics, post harvest attributes and benefit-cost ratios i. e., yield characteristics, the varieties viz., Bidhan Swapna (Decorative type), Bidhan Jayanti (Decorative type), Bidhan Agnisikha (Decorative type) and Bidhan Sweta (Reflexed type), etc. were found promising for flower production and can be recommended for commercial cultivation under Tarai region of Uttarakhand.

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