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MORPHOLOGICAL CHARACTERIZATION OF CHRYSANTHEMUM (*Chrysanthemum morifolium* Ramat.) GENOTYPES AND THEIR VALUE ADDITION

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ABSTRACT

The study was conducted to evaluate six genotypes of chrysanthemum (*Chrysanthemum morifolium* Ramat.) for cut flower production and different value-added products prepared from the flowers of selected genotypes at the Experimental farm of Department of Floriculture and Landscape Architecture, Dr. Y.S. Parmar University of Horticulture & Forestry, Nauni, Solan, (HP) during 2019-20. Among the genotypes evaluated, 'UHFSChr133' was found to be superior with respect to maximum plant height (69.77 cm), flower size (10.86 cm), number of side shoots per plant (9.21), number of cut stems per plant (9.67), stem length (61.39 cm) and highest B:C ratio (2.38). For different value-added products prepared from cut flowers; highest B:C ratio was obtained for ordinary bouquets (13.94) followed by special bouquets (12.71) of genotype 'UHFSChr133'. However, when the flowers of the same genotype were sold in the form of cut stems, B:C ratio was calculated to be 2.38. Therefore, for profit maximization, genotype 'UHFSChr133' is recommended for cut flower production. From the present studies, it can be inferred that selling of cut flowers after preparation of suitable value-added products i.e., bouquets and flower arrangements can lead to increased returns to the farmer.

Keywords: Ambient, B:C ratio, Chrysanthemum, Profit maximization, Refrigerated, Value-added products

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The chrysanthemum (*Chrysanthemum morifolium* Ramat.) is a plant belonging to the family Asteraceae with brightly coloured ornamental flowers and is among the oldest ornamental crops known to man. It is known by different names all around the world such as 'Queen of the East' and 'Autumn Queen' and in India as 'Guldaudi'. The cut blooms are sold as such or they are made into different value-added products, such as, floral arrangements or bouquets, the loose flowers are used for a number of purposes such as garlands, in religious offerings, for making rangoli, floral decorations, etc. For pot production purposes, dwarf plants are chosen, which are commonly known as pot mums. Chrysanthemum comes into bloom during the months of September to December in Himachal Pradesh when the natural short days are prevailing. However, in the North-Indian plains the blooming period of the plant is from November to January. In Himachal Pradesh, the total area under floriculture is 629.29 hectares out of which about 183.03 hectares is under chrysanthemum production (Anonymous, 2020), which is a major part of the area and production under floriculture crops in the state.

Presently, chrysanthemum growers are selling their produce as cut flowers, loose flowers and as pot plants for which selected recommended cultivars are being utilized. But due to the perishable nature of flowers, the farmers face problems during marketing and moreover, flowers are not uniform and have variations in their shape, size and colour. This leads to fetching of lesser price in the market that may result in the loss to the seller. Hence, if such flowers are sold after preparation of value-added products like bouquets, garlands, flower arrangements, etc., that can be sold at premium prices. This may also reduce the post-harvest losses, fetch higher returns and generate new avenues in the flower market to generate more employment opportunities. During the decorations for marriage or social functions, the value-added products i.e., bouquets and flower arrangements etc. are being procured from Delhi or Chandigarh market, although the flowers for these products might have been grown in Himachal Pradesh. If the farmers also start selling the flower produce by making value-added products like bouquets and flower arrangements; then this will definitely lead to their profit maximization. Keeping this in view, the present study was planned with the objective of identifying suitable cut flower genotype(s) of chrysanthemum to enhance farmer's income by making suitable value-added products.

MATERIALS AND METHODS

The present study was carried out at the Experimental Farm of the Department of Floriculture and Landscape Architecture, Dr Y.S. Parmar University

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of Horticulture & Forestry, Nauni, Solan (H.P.) during 2019-20. The plants were raised through terminal shoot-tip cuttings which were taken from healthy and disease-free mother plants grown under protected conditions. Healthy and disease-free rooted cuttings of 8-10 cm were planted in the raised beds on July 2nd 2019, at a spacing of 30 x 30 cm under open-field conditions. Well-rotten Farmyard Manure @ 5 kg/m^2 was incorporated ad mixed thoroughly into the soil before the planting of rooted cuttings. A basal dose of N:P:K (30:30:30) in the form of Urea, SSP and MOP with a full dose of P and K and half dose of N was also added into the soil before planting. The remaining half was applied 45 days after transplanting of cuttings. The plants were also fertigated at fortnightly intervals with a water-soluble fertilizer @2g/l having N, P and K in the ratio of 19:19:19.

Experiment details

This experiment was conducted on 6 genotypes ('Ajay', 'Solan Shringar', 'UHFSChr125', 'UHFSChr126', 'UHFSChr132', and 'UHFSChr133'). Data on growth such as plant height, days taken for flowering, duration of flowering and number of side shoots per plant and flowering parameters such as flower size, stem length, number of flowers per stem, number of cut stems per plant and vase life was recorded. Routine intercultural operations required for raising healthy cut flower crop such as pinching, disbudding, weeding etc. were followed.

Different value-added products were prepared from cut flowers harvested from different genotypes. These value-added products were studied for their acceptability (as fresh and stored under different conditions) and market value. In this experiment, five different types of value-added products were prepared which were:

i. Cut stems
ii. Ordinary bouquets
iii. Special bouquets
iv. Ordinary flower arrangements
v. Special flower arrangements

The shelf-life of these value-added products was evaluated under ambient (18-25°C and 55-65% RH) and refrigerated conditions (4±1°C and 65-70% RH). Analysis of variance was done as per the model suggested by Panse and Sukhatme (2000). The data recorded was analyzed using MS Excel and OPSTAT (Sheoran *et al.,* 1998).

RESULTS AND DISCUSSION

Data pertaining to different growth and flowering characters of genotypes is furnished in Table 1. Scrutiny of the data revealed that there was a significant variation among the genotypes evaluated for different characters. Among the genotypes evaluated for cut flower production, the tallest plants were produced by 'UHFSChr133' (69.77 cm) whereas, the shortest plants were produced by 'Ajay' (58.54 cm). The variation in plant height is mainly due to the genetic make-up of individual genotype (Kumar *et al*., 2014).

A cursory glance of the data also revealed that earliest flowering (125.52 days) was recorded in the genotype 'UHFSChr125' whereas, maximum days taken for flowering (136.27 days) were recorded in cv. 'UHFChr 133'. The longest flowering duration (37.60 days) was recorded in the genotype 'UHFSChr132' whereas, the shortest duration was recorded in cv.

Table 1. Different growth and flowering attributes for cut flower production

Sr. No.	Genotype(s)	Plant height (cm)	Days taken for flowering	Duration of flowering	Flower size (cm)	No. of side shoots per plant	No. of flowers per stem	No. of cut stems per plant	Stem length (cm)	Vase life (days)	Flower colour (RHS Colour Chart)
1	'Ajay'	58.54	132.38	34.24	4.28	3.08	35.14	4.35	50.21	9.50	Yellow Group (3A)
2	'Solan Shringar'	64.43	135.52	36.48	7.54	3.94	31.33	5.40	56.33	10.60	White Group (155B)
3	'UHFSChr125'	59.88	125.52	25.21	4.32	5.15	31.01	6.23	48.63	10.50	Red Purple Group (64A)
4	'UHFSChr126'	67.83	133.13	36.31	6.67	5.67	19.20	6.40	57.76	7.84	Red Purple Group (70B)
5	'UHFSChr132'	69.18	135.42	37.60	5.32	3.67	37.30	4.48	59.24	11.60	Purple Group (75A)
6	'UHFSChr133'	69.77	136.27	34.48	10.86	9.21	18.65	9.67	61.39	10.42	Red Purple Group (65A)
$CD_{0.05}$		1.08	0.31	0.41	0.12	0.35	0.25	0.41	1.12	0.41	

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Table 2. Storage life of ordinary bouquets and ordinary flower arrangements

Sr. No.	Genotypes used (V)	Storage life of ordinary bouquets (days)		Mean	Storage life of ordinary flower arrangements (days)		Mean
		Under Ambient Conditions	Under Refrigerated Conditions		Under Ambient Conditions	Under Refrigerated Conditions	
1	Ajay (V_1)	4.33	6.67	5.50	9.33	13.33	11.33
2	Solan Shringar (V_2)	6.33	8.33	7.33	11.00	14.67	12.83
3	UHFSChr125 (V_3)	1.00	2.33	1.67	9.33	15.00	12.17
4	UHFSChr126 (V_4)	1.33	2.00	1.67	7.67	11.67	9.67
5	UHFSChr132 (V_5)	4.67	6.67	5.67	11.67	15.67	13.67
6	UHFSChr133 (V_6)	1.00	2.00	1.50	9.67	15.67	12.67
Mean		3.11	4.67		9.78	14.33	

$CD_{0.05}$ for:

Genotypes	=	0.57	Genotypes	=	0.72
Storage Conditions	=	0.33	Storage Conditions	=	0.42
Genotypes x Storage Conditions	=	0.80	Genotypes x Storage Conditions	=	1.02

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'UHFChr 125' (25.21 days). Number of days taken for first flowering and duration of flowering are important characters which signify earliness or late flowering and the availability of the flower in the markets. The variation among different cultivars for early or late blooming habit seems to be genetically controlled and similar findings were reported by Negi *et al*. (2015) and Srilatha *et al.* (2015) in chrysanthemum. Also, the variation in flowering duration among the cultivars is attributed to genotype of the plant, environmental influence and other management factors (Prabhu *et al*., 2018).

Significant variations in the size of flower were noticed among different genotypes of chrysanthemum grown under open field conditions. Among different genotypes evaluated, the largest flower was recorded in genotype 'UHFSChr133' (10.86 cm) whereas, cv. 'Ajay' recorded the flowers of smallest size (4.28 cm). The variation in flower size might be due to the differences in the genetic makeup of cultivars and due to the genotypic differences in phenotypic expression of flower diameter. Although flower size is a varietal character, it may be influenced in some extent by the total number of flowers borne per plant, soil moisture and source sink relation (Singh *et al.,* 2017).

Perusal of data revealed that among different genotypes, maximum number of side shoots per plant was recorded for genotype 'UHFSChr133' (9.21) whereas, the least number of side shoots per plant were recorded in cv. 'Ajay' (3.08). Difference in number of branches among the cultivars could be due to influence of genetic make-up of chrysanthemum cultivars (Kumar *et al*., 2015). A scrutiny of data in Table 1 reveals that among different genotypes evaluated, genotype 'UHFSChr132' registered highest number of flowers per stem (37.30) and 'UHFChr133' recorded the least number of flowers per stem (18.65). A wide range of variability for number of flowers per stem is mainly due to genetic nature of the plant (Kumar *et al*., 2015). The results are in conformity with the findings of Poonam and Kumar (2007) in chrysanthemum. Maximum number of cut stems (9.67) and stem length (61.39 cm) was recorded in 'UHFSChr133'. Whereas, the minimum value for the same parameters were recorded in the cvs. 'Ajay' (4.35) and 'UHFChr125' (48.63 cm) respectively. The number of stems per plant varies from genotype to genotype (Negi *et al*., 2018). It may be due to inherent genetic factors as reported by Negi *et al*., (2015) and Behera *et al*. (2002) in chrysanthemum. Length of flower stalk is an important characteristic for suitability of flower as cut flower (Singh *et al.,* 2019). It was observed that the cultivars with higher plant height produced the longer flower stalk as compared to cultivars with smaller plant heights (Uddin *et al.,* 2015).

The data recorded on vase life of cut chrysanthemum flowers revealed that maximum vase life was recorded for genotype 'UHFSChr132' (11.60 days) whereas, the flowers of genotype 'UHFChr126' had the least vase life (7.84 days). Variations in vase life may be due to the different accumulation of carbohydrates due to varied leaf production and sensitivity of cultivars to ethylene.

In turn variations in these aspects might be due to genetical makeup of genotypes (Singh *et al*., 2017). Among the six genotypes evaluated for cut flower production, genotype 'UHFSChr133' performed best in terms of growth and flowering parameters.

Data pertaining to value-added products made from different chrysanthemum genotypes evaluated is furnished in Table 2 (2 and 3) and 4. The data recorded on storage life under ambient and refrigerated storage conditions of value-added products prepared from different genotypes of chrysanthemum evaluated for cut flower production is presented in Table 2 (2 and 3). There was a significant increase in shelf-life of flowers stored under refrigerated conditions over shelf-life under ambient conditions. Between the two storage conditions opted for storage of ordinary bouquets and flower arrangements, increased storage life i.e., 4.67 days and 14.33 days were recorded under refrigerated storage conditions. In contrast, ambient storage conditions showed minimum shelf life i.e., 3.11 days and 9.78 days. Among different genotypes evaluated for making value-added products from cut flowers, maximum storage life was recorded in the ordinary bouquet prepared from cv. 'Solan Shringar' (7.33 days) and flower arrangements prepared from genotype 'UHFSChr132' (13.67 days). The interaction between genotypes and storage conditions revealed that maximum storage life was recorded in ordinary bouquet of cv. 'Solan Shringar' (8.33 days) and in flower arrangement of genotypes 'UHFSChr132' and 'UHFSChr133' (15.67 days) under refrigerated storage conditions (Table 2).

Perusal of data presented in Table 4 clearly revealed that for 6 different types of special bouquets prepared from genotypes evaluated for cut flower production stored at two different storage conditions, refrigerated storage conditions registered more storage life (4.17 days) as compared to ambient storage conditions (2.61 days). Among different genotypes combinations made for preparing special bouquets, maximum storage life was observed for 'Solan Shringar' + 'UHFSChr132' (V_2+V_5) (6.67 days). The interaction between genotypes and storage conditions revealed that maximum storage life was recorded in special bouquet of genotypes 'Solan Shringar + UHFSChr132' (V_2+V_5) (7.33 days) stored under refrigerated storage conditions. A cursory glance of data in Table 2.2 showed that storage life of special

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Table 3. Storage life of special bouquets and special flower arrangements

Sr. No.	Genotypes used (V)	Storage life of special bouquets (days)		Mean	Genotypes used (V)	Storage life of special flower arrangements (days)		Mean
		Under Ambient Conditions	Under Refrigerated Conditions			Under Ambient Conditions	Under Refrigerated Conditions	
1	Ajay + Solan Shringar (V_1+V_2)	4.33	6.67	5.50	Ajay + Solan Shringar (V_1+V_2)	9.33	13.67	11.50
2	Ajay + UHFSChr125 (V_1 + V_3)	1.67	2.33	2.00	Ajay + UHFSChr126 (V_1+V_4)	8.00	11.33	9.67
3	Ajay + UHFSChr126 (V_1 +V_4)	1.00	2.67	1.67	Ajay + UHFSChr132 (V_1+V_5)	9.67	14.00	11.83
4	Solan Shringar + UHFSChr125 (V_2 + V_3)	1.67	3.00	2.33	Solan Shringar + UHFSChr125 (V_2+V_3)	9.33	14.33	11.83
5	Solan Shringar + UHFSChr132 (V_2 + V_5)	6.00	7.33	6.67	Solan Shringar + UHFSChr132 (V_2+V_5)	11.33	14.67	13.00
6	UHFSChr125+ UHFSChr133 (V_3 +V_6)	1.00	3.00	2.00	Solan Shringar + UHFSChr133 (V_2+V_6)	10.33	15.33	12.83
Mean		2.61	4.17			9.67	13.90	

$CD_{0.05}$ for:			$CD_{0.05}$ for:		
Genotypes	=	0.53	Genotypes	=	0.63
Storage Conditions	=	0.31	Storage Conditions	=	0.37
Genotypes x Storage Conditions	=	0.75	Genotypes x Storage Conditions	=	0.89

3. BENEFIT COST RATIO

Table 4. Cost Benefit analysis of different chrysanthemum genotypes grown for cut flowers and making their value-added products

Calculated for an area of 800m²

A1.	FIXED COST (Rs.)			
	Particulars	**Quantity Required**	**Price/unit (Rs.)**	**Total Price (Rs.)**
1.	Rental value of land	800 m² for 250 days	5000/bigha	5000
2.	Rooted cuttings	5400	4.00	21600
B1.	**VARIABLE COST (Rs.)**			
1.	Labour for raising of crop from land preparation to harvesting and packaging	85 man days	300	25500
2.	FYM	3000 kg	185/100 kg	5550
3.	NPK (Urea, SSP, MOP)	Urea: 39,132 g SSP: 1,12,500 g MOP: 30,000 g	Urea: Rs 276/50 kg SSP: Rs 495/50 kg MOP: Rs 840/50 kg	215.226 11,13.75 504
4.	NPK (19:19:19)		160/kg	180
5.	Mancozeb (@ Rs.)	500 gm	180/500 gm	180
6.	Carbendazim	420 g	650/kg	273
7.	Imidacloprid	120 ml	1500/l	180
	TOTAL			61292

	Genotypes Particulars	**Ajay**	**Solan Shringar**	**UHFSChr125**	**UHFChr126**	**UHFSChr132**	**UHFSChr133**
C1	**COST FOR CUT FLOWERS (Rs.)**						
	Total number of boxes required for cut flowers	58.725	72.9	84.105	86.4	60.48	130.545
A	Transport of flowers @Rs. 200/box (1 box = 400 cut stems)	17617.5	21870	25231.5	25920	18144	39163.5
B	Cost of box @Rs. 70/box)	4110.75	5103	5887.35	6048	4233.6	9,138.15
C1	Total (a+b) (Rs.)	21728.25	26973	31118.85	31968	22377.6	48301.65
TOTAL EXPENDITURE FOR CUT FLOWERS (A1+B1+C1) (Rs.)		83020.25	88265	92410.85	93260	83669.6	1,09,593.65
D1	**COST OF MAKING ORDINARY BOUQUETS (Rs.)**						
a.	Cost of plastic sheet for making bouquets (@Rs. 5/sheet)	42114.25	76132	38926.75	48790.5	51270.5	97386.5
b.	Cost of Cut greens (@50p/leaf)	42114.25	76132	38926.75	48790.5	51270.5	97386.5
c.	**Labour Cost (Calculated on the basis of 400 ordinary bouquets/man day)**						
	Man days	33.6914	60.9056	31.1414	39.0324	41.0164	77.9092
	Labour Cost for making Ordinary Bouquets (@Rs. 300/man day)	10107.42	18271.68	9342.42	19516.2	12304.92	23372.76
D1	Total (a+b+c) (Rs.)	94335.92	170535.68	94335.92	170535.68	94335.92	170535.68
TOTAL EXPENDITURE FOR ORDINARY BOUQUETS (A1+B1+D1)		1,55,627.92	8,22,611.00	1,48,487.92	178389.2	176137.92	279437.76
E1	**COST OF MAKING SPECIAL BOUQUETS (Rs.)**						
a.	Cost of plastic sheet for making Special Bouquets (@Rs. 10/sheet)	107870.5	133230.825	105611.6	88012.8	116240	119889.1
b.	Cost of cut greens for making Special Bouquets (@50p/leaf)	75509.35	93261.60	73928.12	61608.96	81368	83922.37
c.	**Labour Cost (Calculated on the basis of 300 special bouquets/manday) (Rs.)**						
	Man days	53.93525	66.6154125	52.8058	44.0064	58.12	59.94455
	Labour Cost for making Special Bouquets (Rs. 300/man day)	16180.575	19984.62	15841.74	13201.92	17436	17983.365

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E1	Total (a+b+c) (Rs.)	199560.425	246477.03	195381.46	162823.68	215044	221794.835
TOTAL EXPENDITURE FOR SPECIAL BOUQUETS (A1+B1+E1) (Rs.)		260852.425	307769.026	256673.46	224115.68	276336	283086.835
F1	**COST OF MAKING ORDINARY FLOWER ARRANGEMENTS (Rs.)**						
a.	Cost of floral bricks for making Ordinary Flower Arrangements (@Rs. 10/brick)	2,42,776	6,09,055	2,67,497.03	2,45,760	2,91,084.39	8,11,555
b.	Cost of cut greens for making Ordinary Flower Arrangements (@50p/ leaf)	60694.20	152263.8	66874.26	61440	72771.01	202888.7
c.	**Labour Cost (@Calculated on the basis of 300 ordinary flower arrangements/man day) (Rs.)**						
	Man days	60.70	152.27	66.87	61.44	72.77	202.88
	Labour cost for making Ordinary Flower Arrangements (@Rs. 300/man day)	18208.2	45679.125	20062.275	18432	21831.3	60866.625
F1	Total (a+b+c) (Rs.)	3,21,678.21	8,06,997.93	3,54,433.56	1,84,061.30	3,85,686.78	4,29,617
TOTAL EXPENDITURE FOR MAKING ORDINARY FLOWER ARRANGEMENTS (A1+B1+F1) (Rs.)		3,82,970.21	8,68,289.93	4,15,725.56	3,86,924.00	4,43,628.78	11,36,602
G1	**COST OF MAKING SPECIAL FLOWER ARRANGEMENTS (Rs.)**						
a.	Cost of floral bricks for making Special flower arrangements (@Rs. 10/brick)	114644.25	1,22,953.02	1,33,170.20	1,04,189.30	1,07,237.20	1,65,862.00
b.	Cost of cut greens for making Special Flower Arrangements (@50p/ leaf)	40125.50	43033.56	46609.57	36466.25	37533.02	58051.7
c.	Cost of cycas leaves for Special Flower Arrangements @Rs 10	573221.25	614765.1	665851	520946.5	536186	829310
d.	**Labour Cost for making value-added products (Calculated on the basis of 300 special flower arrangements/man day) (Rs.)**						
	Man days	38.21	40.98	44.39	34.73	35.74	55.29
	Labour cost for making Special Flower Arrangements (@Rs. 300/man day)	11464.425	12295.302	13317.02	10418.93	10723.72	16586.2
G1	Total (a+b+c+d) (Rs.)	739455.42	7,93,046.98	8,58,947.79	6,72,020.99	6,91,679.94	10,69,809.9
TOTAL EXPENDITURE FOR MAKING SPECIAL FLOWER ARRANGEMENTS (A1+B1+G1) (Rs.)		800747.42	8,54,338.98	9,20,239.79	7,33,312.99	7,52,971.94	11,31,101.9
PRODUCTION AND SALE							
1	**Cut Stems (NUMBERS)**	23490	29160	33642	34560	24192	52218
	GROSS RETURNS (SALE) (Rs.)	117450	145800	168210	172800	120960	261090
2	**Ordinary Bouquets**	16845.7	30452.8	15570.7	19516.2	20508.2	38954.6
	GROSS RETURNS (SALE) (Rs.)	16,84,569	30,45,276	15,57,072	19,51,624	20,50,822	38,95,463
3	**Special Bouquets**	21574.1	26646.165	21122.32	17602.56	23248	23977.82
	GROSS RETURNS (SALE) (Rs.)	32,36,115	3996924	31,68,348	26,40,384	34,87,200	35,96,673
4	**Ordinary Flower Arrangements**	24,278	60,906	26,750	24,576	29,108.40	81,156
	GROSS RETURNS (SALE) (Rs.)	2427760	6090550	2674970	2457600	2910840	8115550
5	**Special Flower Arrangements**	11464.425	12295.302	13317.02	10418.93	10723.72	16586.2
	GROSS RETURNS (SALE) (Rs.)	28,66,106	3073825.5	33,29,255	26,04,733	26,80,930	41,46,550
NET RETURNS (GROSS RETURNS-TOTAL EXPENDITURE) (Rs.)							
1	Cut Stems	34429.75	57535	75799.15	79540	37290.4	1,51,496.35
2	Ordinary Bouquets	14,23,716.6	27,37,507	13,00,399	17,27,508.3	17,74,486	36,12,376.2
3	Special Bouquets	29,75,263	36,89,155	29,11,674.5	24,16,268.3	32,10,864	33,13,586.2
4	Ordinary Flower Arrangements	20,44,790	52,22,260	22,59,244	20,70,676	24,67,211.2	69,78,948
5	Special Flower Arrangements	20,65,359	22,19,486.5	24,09,015	18,71,420	19,27,958.1	30,15,448.1
COST BENEFIT RATIO (GROSS RETURNS ÷ TOTAL EXPENDITURE)							
1	Cut Stems	1.41	1.65	1.82	1.85	1.45	2.38
2	Ordinary Bouquets	10.82	13.14	10.49	10.94	11.64	13.94
3	Special Bouquets	12.41	12.99	12.34	11.78	12.62	12.71
4	Ordinary Flower Arrangements	6.34	7.01	6.43	6.35	6.56	7.14
5	Special Flower Arrangements	3.58	3.60	3.6	3.55	3.56	3.67

*Transport cost excluded for value-added products

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flower arrangements was more (13.90 days) under refrigerated conditions as compared to ambient storage conditions (9.67 days). Among different genotypes evaluated for cut flower production, maximum storage life was exhibited by the special flower arrangement prepared from the genotype combination of 'Solan Shringar' + 'UHFSChr132' (V_2+V_5) (13.00 days) followed by the storage life of the special flower arrangements of the genotypes 'Solan Shringar' + 'UHFSChr133' (V_2+V_6) (12.83 days). The interaction between genotypes and storage conditions maximum storage life was exhibited under refrigerated storage conditions by the special flower arrangement prepared from the genotype combination of 'Solan Shringar' + 'UHFSChr133' (V_2+V_6) (15.33 days).

The analysis of cost of production of chrysanthemum genotypes for cut flower production and different value-added products prepared from flowers of the genotypes on an area of 800 m^2 was done to calculate the cost benefit ratio (Table 3). For calculating different costs, the local rates of the material used, labour and land were considered. The average yield data of each genotype was considered to work out the total results of the profit and cost benefit ratio. For cut flower production, maximum cost benefit ratio was recorded in genotype 'UHFSChr1-33' (2.38). However, after preparation of value-added products i.e., ordinary bouquets, the benefit cost ratio was increased and it was recorded maximum to be in 'UHFSChr133' (13.94). After preparing special bouquets by the combination of the same genotypes, maximum cost benefit ratio was exhibited in the special bouquet consisting of genotype 'UHFSChr133' (12.71). Flower arrangements of the similar genotypes also showed increased cost benefit ratio (7.14). Special flower arrangements of 'UHFSChr133' also showed increased cost benefit ratio (3.67) over that recorded after selling cut flowers. It was then noted that ordinary bouquets prepared from cut flowers are the products that fetch maximum prices in the market and lead to profit maximization of the seller. From the present calculations, it can be inferred that selling of flowers after preparation of suitable value-added products i.e., bouquets and flower arrangements as compared to selling the cut flowers as such can lead to increased returns to the farmer and lead to his profit maximization.

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Authors' contribution

Conceptualization of research work and designing of experiments (BK, SRD, DC); Execution of lab/field experiment and data collection (DC); Analysis of data and interpretation (DC, BK, SRD, MK, AS); Preparation of manuscript (DC, BK)

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