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The Economics of Dahlia (*Dahlia variabilis* L.) Cultivation in The Low Hill Conditions of Himachal Pradesh

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ABSTRACT

An investigation on " The economics of dahlia (Dahlia variabilis L.) cultivation in the low hill conditions of Himachal Pradesh," was conducted at RHRTS Dhaulakuan, Himachal Pradesh, from 2021 to 2023. This study intended to observe the impact of planting dates on the benefit-cost ratio of five Dahlia cultivars. Trial was conducted in a Randomized Block Design (Factorial) to study three planting dates for each cultivar, consequential in 15 treatment combinations. The economic analysis evaluated expenses related to cultivation, total income, profits after deductions and the ratio of benefits to expenditures. The 'Matungini' crop, transplanted on October 15th, presented the superlative yield of cut flower stems and tubers, subsequent in significant gross income. Net profits were diverse despite steady input costs with 'Matungini' reaching the peak on October 15th. The benefit-cost ratio reached a value of 2.83. The results highlight the economic significance of choosing suitable cultivars and planting dates to enhance Dahlia cultivation in low hill areas.

Keywords: *Dahlia, benefit cost ratio, cultivars, planting date, economics and income.*

Introduction

Dahlias (*Dahlia variabilis* L.) belong to the Asteraceae family and is a popular choice for garden displays. Moreover, the flower has a great potential to become a popular cut flower in India. This flower originated in hilly regions of Mexico and Central America. Dahlias have always appealed floral enthusiasts and gardeners worldwide with a wide variety of species and cultivars varying in colour, size and shape (Vikas et al., 2015) viz. decorative, pompoms, balls and cactus making it a great choice for floral arrangements, bouquets and centrepieces (Kumar and Yadav 2005). Because of their strength and beauty, dahlias are a favourite flower high in demand among florists for weddings, parties and other special occasions (Gupta, 2015).

In India West Bengal contributes 27% to cut flower output, Karnataka contributes 13% and Odisha contributes 11%. Tamil Nadu, Karnataka, Madhya Pradesh, and Mizoram have excelled in loose flower output with percentages of 19%, 12%, 11%, and 10% respectively, surpassing other states. Major importing countries for Indian floriculture in international trade are the United States, Germany, United Kingdom, Netherlands and the United Arab Emirates (APEDA 2016).

Cultivation of high-value crops has continuously been more beneficial for farmers compared to traditional crops. Their income is greatly influenced by marketing strategies, post-harvest management and value addition Rajput et al. (2020), Tomar et al. (2017) and Tomar et al. (2020).

Productivity and quality of flower crops can be improved by selecting high yielding cultivar and by using good horticultural practices; providing proper agriculture inputs and selecting suitable planting time and following proper intercultural operations like pinching (Thumar et al., 2020), but lack of information on proper planting time for Dahlia has become a great hurdle for growers in generating possible profits through quality dahlia production at specific time in particular regions. In addition to this study also aims at identifying the best cultivars suitable for the region thus generating more profits for the farmers.

By understanding the correlation between the primary indicators of growth and development and the features of high-quality better returns can be obtained (Vikas et al., 2015). This research provides insights to the economic aspects of dahlia production, by computing benefit-cost ratios thereby providing a comprehensive understanding of the financial prospects of dahlia cultivation. This information will prove beneficial to farmers especially to those involved in dahlia cultivation and to investors looking forward to expand the floriculture sector.

Materials and Methods

The economics of dahlia (*Dahlia variabilis* L.*)* cultivation in the low hill conditions of Himachal Pradesh was calculated for a trial conducted at Department of Floriculture and Landscape Architecture, (RHRTS Dhaulakuan, Ponta Sahib) Dr. Yashwant Singh Parmar University of Horticulture and Forestry), Nauni, Solan, (HP) from 2021 to 2023.

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The effect of different planting dates on tuber production in five Dahlia cultivars viz Anarkali, Gargi, Giani Zail Singh, Matungini and Suryadev was studied in low hills and three specific planting dates were chosen i.e September 15th, October 15th and November 15th, creating a total of 15 treatment combinations (5 cultivars × 3 planting dates).
The study was conducted in a randomized block design (RBD) with a factorial layout to thoroughly evaluate the interactions between cultivars and planting dates. Three replications were there for each treatment to make sure the statistical robustness, yielding a total of 45 experimental plots. Each plot had nine plants planted at 45 cm × 45 cm spacing creating a significant dataset for studying how different Dahlia cultivars respond in tuber development to varied planting dates in low hill environments.

Cultivation costs (Rs. /ha): The total costs of various treatments depended on the current market prices of fertilizers, pesticides, field preparation, transplanting, labour costs and cultural and intercultural activities.

Gross income (Rs. /ha): Gross income is the total monetary worth of economic products and by-products obtained from farmed plants based on local market pricing.

a) Net Returns (Rs. /ha): Based on the goods, monetary value and the various inputs used in the tests, this number represents the farmer's actual income.

b) Formula: Net monetary returns (Rs. / ha) = Gross return (Rs. /ha) – Cultivation cost (Rs. /ha)

c) Benefit cost ratio. The benefit-cost ratio is the actual return per rupee generated, indicated as the ratio of total income to cultivation costs. This ratio gives a summary of the advantage a farmer gains compared to the charges applied in a cultivation plan.

d) Formula: Benefit cost ratio = Gross returns (Rs. /ha) / Cost of cultivation (Rs.)

Results and Discussion

Table 1 shows the unique differences in plant quality among the various cultivars and months. Plants attained a topmost plant height of (74.77 cm) when cuttings were transplanted on November 15th, and a lowest plant height was noted (59.85 cm) when cuttings were transplanted on December 15th. Among the cultivars, cv. Suryadev had attained the maximum plant height (109.61 cm), while cv. Gargi had the minimum plant height (52.17 cm). Interaction between month and cultivars depicted that the maximum plant height of (123.37 cm) was taken down when cuttings were transplanted on November 15th for the cv. Suryadev, while the minimum plant height of (46.13 cm) was depicted in December 15th transplanting for the cultivar Gargi. indistinguishable difference in plant height in these cultivars was also observed by Kumar et al. (2009), Vikash et al. (2015), Shukla et al. (2018), Mounika & Saravanan (2019) and Kumar et al. (2024).
For plant spread, it was found that maximum plant spread was attained when cuttings were transplanted on November 15th (41.53 cm) and minimum plant spread was noted in December 15th transplanting (37.09 cm). among the cultivars, cv. Matungini had the reached the maximum plant spread (42.72 cm), while cv. Giani Zail Singh had the minimum (36.66 cm). Interaction between the month and cultivars showed that the maximum plant spread was noticed in November 15th transplanting with cv. Matungini reaching 43.45 cm, while the minimum plant spread was observed in December 15th transplanting for cv. Giani Zail Singh (33.93 cm). Similar notable variations were observed by Vetrivel et al. (2018), Kumar et al. (2009), Verma et al. (2017), Ramya et al. (2019), Thakur et al. 2022, Kumar et al. (2024) in Dahlia and Souvija et al. (2019) in Marigold for plant spread.
As shown in table number 1. it was found that, maximum number of primary branches were formed when cuttings were transplanted on November 15th (5.15) and minimum number of primary branches were noted down in December 15th transplanting (4.61) among the cultivars, cv. Suryadev had maximum number of primary branches (5.99) while cv. Giani Zail Singh had the minimum (4.40). When interaction between the month and cultivars was studied, maximum number of primary branches were noticed in October 15th transplanting, in cv. Suryadev (6.37) while the minimum number of primary branches were observed in December 15th transplanting for cv. Giani Zail Singh (3.84). The findings of present study are in accordance with those of Kumari et al. (2017) in China aster, Gupta et al. (2015), Verma & Kulkarni (2017) and Bajaraya et al. (2018) in dahlia.
The variation in plant height, spread and number of primary branches noticed, can be attributed to lots of physiological factors. When cuttings were transplanted earlier have more time to establish their root system compared to those transplanted late thus have better root growth leading to better nutrient and water uptake with enhanced photosynthesis and growth quality of plant so resulting is taller plants with a greater number of branches (Wheeler RM et al. 1994, Taiz L and Zeiger E. 2010).
Additionally, cuttings were when transplanted in the month of November plants have suitable temperature, these temperatures help in growth, whereas in December month atmosphere cools down and plant metabolic activities becomes slow reducing plant growth rates and minimum plant height, spread and branches (Adams S R et al. 1997). Photoperiodism also play an important role to increase plant height, spread and branches

Table 1. Effect of planting dates on morphological traits of different dahlia cultivars in different months under low hill conditions

Years	Plant height (cm)			Mean	Plant spread(cm)			Mean	Number of primary branches			Mean
Months / Cultivars	15th Oct	15th Nov	15th Dec		15th Oct	15th Nov	15th Dec		15th Oct	15th Nov	15th Dec	
Anarkali	68.84^{b}	80.56^{a}	59.07^{c}	**69.49^{b}**	37.66^{b}	41.51^{a}	36.98^{b}	**38.72^{cd}**	4.77	5.00	4.37	**4.71^{b}**
Gargi	54.53^{ab}	55.86^{a}	46.13^{b}	**52.17^{e}**	39.18^{b}	42.89^{a}	36.05^{b}	**39.37^{bc}**	4.33	4.57	4.90	**4.60^{b}**
Giani Zail Singh	58.79^{ab}	62.79^{a}	53.78^{b}	**58.45^{c}**	38.54^{a}	37.52^{ab}	33.93^{b}	**36.66^{d}**	4.60	4.77	3.84	**4.40^{b}**
Matungini	49.75^{a}	51.29^{a}	47.08^{a}	**49.37^{d}**	43.28^{a}	43.45^{a}	41.44^{a}	**42.72^{a}**	4.70	5.40	4.33	**4.81^{b}**
Suryadev	112.46^{b}	123.37^{a}	93.01^{c}	**109.61^{a}**	44.56^{a}	42.26^{a}	36.83^{b}	**41.22^{b}**	6.37	6.00	5.60	**5.99^{a}**
Mean	68.88^{b}	74.77^{a}	59.85^{c}	-	**40.64^{b}**	**41.53^{a}**	**37.09^{c}**	-	**4.96^{a}**	**5.15^{a}**	**4.61^{a}**	-

Table 2. Effect of planting dates on flower and tuber production of different dahlia cultivars in different months under low hill conditions

Years	Number of cut stems per plant			Mean	Flower yield per plot			Mean	Tuber yield per plot (Kg)			Mean
Months / Cultivars	15th Oct	15th Nov	15th Dec		15th Oct	15th Nov	15th Dec		15th Oct	15th Nov	15th Dec	
Anarkali	15.13	13.78	9.07	**12.66^{d}**	138.66	127.27	90.74	**118.89^{d}**	3.99^{a}	1.64^{a}	0.38^{c}	**2.00^{a}**
Gargi	15.70	14.34	10.27	**13.43^{c}**	143.84	131.54	94.80	**123.39^{c}**	2.48^{a}	1.09^{b}	0.27^{b}	**1.28^{c}**
Giani Zail Singh	16.53	16.05	10.42	**14.33^{b}**	151.52	147.05	96.24	**131.60^{b}**	2.98^{a}	1.42^{b}	0.33^{c}	**1.57^{b}**
Matungini	18.05	16.50	11.27	**15.27^{a}**	165.10	151.10	103.53	**139.91^{a}**	2.70^{a}	1.37^{b}	0.30^{c}	**1.46^{b}**
Suryadev	13.59	12.38	9.85	**11.94^{e}**	125.04	113.84	83.94	**107.60^{e}**	1.99^{a}	1.01^{b}	0.12^{c}	**1.04^{c}**
Mean	**15.80^{a}**	**14.61^{b}**	**10.17^{c}**	-	**144.83^{a}**	**134.16^{b}**	**93.85^{c}**	-	**2.83^{a}**	**1.30^{b}**	**0.28^{c}**	-

because longer daylight hours provide more light for photosynthesis and growth (Dodd AN et al. 2005).

Additionally genetic makeup of all the cultivars is different, so every cultivar had their own genetic makeup leading to variation in different traits. Genetic traits and environmental condition create significant impact on growth outcomes (Tibbitts TW and Bottenberg G. 1976). Suitable temperature helps in activation of soil microbial activates, which adds in nutrients availability and uptake is higher in November month compare to another cooler month (White PJ and Greenwood DJ. 2013). Synthesis of growth hormone like auxin, gibberellins and cytokinins are also influenced by environmental conditions (Gomes M A D C et al. 2011). Proper sunlight and suitable environmental condition promote the production of these hormone in proper quality and quantities, so they help in proper plant growth and development. Whereas cooler temperature can inhibit hormonal production activities and soil microbial activities (Taiz L and Zeiger E. 2010).

From table 2 the unique differences in flowering traits can be observed. Maximum number of cut stems per plant (15.80) were obtained when cuttings were transplanted on October 15th and minimum number of cut stems per plant were noted (10.17) when cuttings were transplanted on December 15th. Among the cultivars, cv. Matungini attained the maximum number of cut stems per plant (15.27), while cv. Suryadev had the minimum number of cut stems per plant (11.94). Interaction between months and cultivars showed that the maximum number of cut stems per plant (18.05) were yielded when cuttings were transplanted on October 15th for the cv. Matungini, while the minimum (9.85) were harvested in December 15th transplanting for the cultivar Suryadev.

The finding of present study is in accordance with those of Kumari et al. (2017) in china aster, Gupta et al. (2015), Verma & Kulkarni (2017) and Bajaraya et al. (2018) in dahlia.

Maximum flower yield per plot was recorded when cuttings were transplanted on October 15th (144.83) and minimum flower yield per plot was noted down in December 15th transplanting (93.85). Among the cultivars, cv. Matungini had the maximum flower yield per plot (139.91), while cv. Suryadev had the minimum Flower yield per plot (107.60). Interaction between the month and cultivars depicted that the maximum flower yield per plot was noticed in October 15th transplanting, with cv. Matungini yielding (165.10 kg), while the minimum was observed in December 15th transplanting for cv. Suryadev (83.94). Similar findings were also reported by Gupta et al. (2015), Shukla et al. (2018) and Verma & Kulkarni (2017) in dahlia.

The maximum tuber yield per plot was noted down (2.83 kg) during October 15th transplanting and the minimum tuber yield (0.28 kg) in December 15th transplanting. Among the cultivars, cv. Anarkali yielded (2.00 kg) of tubers per plot, the maximum, while Suryadev yielded the minimum (1.04 kg). It was found from the Interaction between the month and cultivars that Anarkali achieved the highest tuber production per plot (3.99 kg) in October 15th transplanting whereas Suryadev had the lowest yield (0.124 kg) in December 15th transplanting. The results are consistent with prior research conducted by Kumar et al. (2024), Sheergojri et al. (2013), Sabah et al. (2014) and Zhang et al. (2010) in dahlia.

Among the variation in October to December cultivars, performance decreased due to several reasons and factors, such as temperature, genetic factors, photosynthesis and hormonal changes. When temperature was decreased, plant metabolic processes such as respiration, photosynthesis were slowed down, so this led to decreased flower production and tuber yield as well (Adams S R et al. 1997).

Photoperiodism also affects flower and tuber production. When the day length is long, plants receive maximum light intensity, which helps in a higher number of flower and tuber production (Gomes M A D C et al. 2011) and vice versa when day length is short (Dodd AN et al. 2005), so for this reason, plants are not able to do more photosynthesis and they do not give a higher number of flower and tuber production either.

When soil temperature lowers down during a colder month, it slows down the availability and uptake of essential nutrients, leading to deficiencies that impact plant health, growth and yield (Taiz L and Zeiger E. 2010). The environment also impacts the production of flowers and tubers, as well as the actions of plant hormones, such as higher levels of abscisic acid which are linked to stress responses and dormancy and stop plants from growing and reproducing (Wheeler RM et al. 1994).

An economic study of growing a specific type of dahlia under various planting conditions reveals notable variations in important factors. Data represented in Table 3. and Fig 1. displays the economic analysis for various dahlia cultivars transplanted at different dates. The Matungini variety planted on October 15th yields a maximum of 46,961.04 cut flowers stem, valued at Rs. 1,87,844.16. Suryadev had the lowest yield of cut flower stem on December 15th, with 23,875.89 cut stem costing Rs. 47,751.78. Anarkali planted on October 15th yielded the maximum tuber yield of 1,134.91 kg, valued at Rs. 6,809.46. The variety Gargi planted on December 15th produces the lowest tuber yield of 34.13 kg and costs Rs. 136.52.

The total fixed and variable costs amount to Rs. 43,000. The input cost remains constant at Rs. 68,026.28 across all scenarios for the different types and planting dates analysed. The highest gross return (1,92,452.04) and net return (1,09,452.86) was noticed in cultivars Matungini and minimum gross return (47,888.30) and net return (-20,137.98) was noticed in cultivars Suryadev. The benefit-cost ratio peaks at 2.83 for 'Matungini' on October 15th and reaches a minimum of 0.70 for 'Suryadev' on December 15th. These results highlight the significant influence of choosing the right cultivar and planting conditions on the economic results of Dahlia farming. 'Matungini' planted on October 15th showed better performance in various aspects. During the summer, the number of flowers produced and tuber yield were low and of poor quality. Consequently, the market price was also low because the flower's colour was faded. Arancon et al. (2003) Pandey et al. (2017), Sharma et al. (2004) and Vara Prasad Rao (2005) found comparable outcomes while performing economic analysis with other cut flowers.

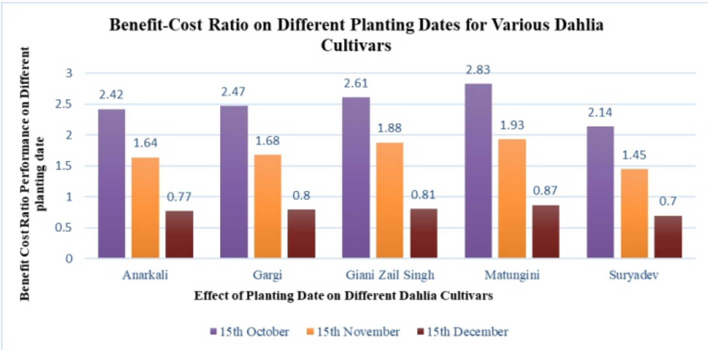

Table 3. Cost of cultivation for flower and tuber of dahlia and net returns for 800m^2 area

Particulars	Quantity required (No.)	Price/Unit (in Rs.)	Total Price (in Rs.)
A1. Fixed Cost			
Rental cost of land	800 m²	5000/800 m²	5000
Planting material	3,800 plants	10/plant	38,000.00
Total	**-**	**-**	**43,000.00**
B1. Variable Cost			
i) Preparatory cultivation			
a. Ploughing with tractor	30 minutes	800/hours	400.00
b. Bed preparation, mixing of farm yard manure and basal dose of fertilizer and planting	2	375	750.00
ii) Intercultural operations			
a. Irrigations	5	375	1,875.00
b. Weeding and hoeing	10	375	3,750.00
c. Pinching and disbudding	3	375	1,125.00
d. Staking	2	375	750.00
e. Harvesting flowers, grading, packaging and preparing for transport	9	375	3,375.00
f. Harvesting of tubers	2	375	750.00
Total	**34**	**-**	**12,775.00**
iii) Manure and fertilizers			
a. Farm yard manure	3000 Kg	2.25/kg	6750
b. Urea (Inorganic)	39 kg	320/50kg	249.6
Single Super Phosphate	75 kg	300/50	450
Muriate Of Potash	19.98 kg	800/50	319.68
c. miscellaneous	-	1000	1000
Total	**-**	**-**	**8,769.28**
iv) Plant protection chemicals Inorganic			

Imidacloprid	500 ml	1500/litre	750
Dithane M-45 (2g/l)	1.2 kg	360/kg	432
Total	**-**	**-**	**1,182.00**
v) Staking material (Bamboo and nylon mesh)			1500
vi) Transportation and Packaging Cost	No.	Rate/Box (Rs.)	Total cost (Rs.)
a) Gunny bags			
1 bundle = 20 cut stems	25	20	500
b) Vehicle charges up to Delhi market			
1 bundle = 20 cut stems	25 bundle/parcel box	300	300
Total	-	-	**800**
C1. Returns			
Dahlia Cultivars (Cut stem Yield)	**Yield (No. of cut stem)**	**Rate/cut stem (Rs.)**	**Total Cost (Rs.)**
1. 1. Anarkali			
15th October planting	39,440.45	4	1,57,761.80
15th November planting	36,200.67	3	1,08,602.01
15th December planting	25,810.08	2	51,620.16
2. 2. Gargi'			
15th October planting	40,913.84	4	1,63,655.36
15th November planting	37,415.23	3	1,12,245.69
15th December planting	26,964.91	2	53,929.82
3. Giani Zail Singh			
15th October planting	43,098.34	4	1,72,393.36
15th November planting	41,826.90	3	1,25,480.70
15th December planting	27,374.50	2	54,749.00
4. Matungini			
15th October planting	46,961.04	4	1,87,844.16
15th November planting	42,978.88	3	1,28,936.64
15th December planting	29,448.07	2	58,896.14
5. Suryadev			
15th October planting	35,566.37	4	1,42,265.48
15th November planting	32,380.64	3	97,141.92
15th December planting	23,875.89	2	47,751.78
Dahlia Cultivars			
(Tuber's yield)	**Yield (Tubers yield kg/800 m2)**	**Rate of tubers/ kg (Rs.)**	**Total Cost (Rs.)**
1. 1. Anarkali			
15th October planting	1,134.91	6	6,809.46
15th November planting	466.48	6	2,798.88
15th December planting	108.08	4	432.32
2. 2. Gargi'			0.00
15th October planting	705.41	6	4,232.46
15th November planting	310.03	6	1,860.18
15th December planting	76.79	4	307.16
3. Giani Zail Singh			0.00
15th October planting	847.63	6	5,085.78
15th November planting	403.90	6	2,423.40
15th December planting	93.86	4	375.44
4. Matungini			0.00
15th October planting	767.98	6	4,607.88
15th November planting	389.68	6	2,338.08
15th December planting	85.33	4	341.32
5. Suryadev			0.00
15th October planting	566.03	6	3,396.18
15th November planting	287.28	6	1,723.68
15th December planting	34.13	4	136.52
Gross return (Rs.)			

Input Cost (A+B)	Total expenditure	Gross return (Rs.)	Net return (Rs.)	Benefit Cost Ratio
1. 1. Anarkali				
15th October planting	68,026.28	1,64,571.26	96,544.98	**2.42**
15th November planting	68,026.28	1,11,400.89	43,374.61	**1.64**
15th December planting	68,026.28	52,052.48	-15,973.80	**0.77**
2. Gargi				
15th October planting	68,026.28	1,67,887.82	99,861.54	**2.47**
15th November planting	68,026.28	1,14,105.87	46,079.59	**1.68**
15th December planting	68,026.28	54,236.98	-13,789.30	**0.80**
3. Giani Zail Singh				
15th October planting	68,026.28	1,77,479.14	1,09,452.86	**2.61**
15th November planting	68,026.28	1,27,904.10	59,877.82	**1.88**
15th December planting	68,026.28	55,124.44	-12,901.84	**0.81**
4. Matungini				
15th October planting	68,026.28	1,92,452.04	1,24,425.76	**2.83**
15th November planting	68,026.28	1,31,274.72	63,248.44	**1.93**
15th December planting	68,026.28	59,237.46	-8,788.82	**0.87**
5. Suryadev				
15th October planting	68,026.28	1,45,661.66	77,635.38	**2.14**
15th November planting	68,026.28	98,865.60	30,839.32	**1.45**
15th December planting	68,026.28	47,888.30	-20,137.98	**0.70**

Conclusion

This study accomplishes that for the cultivation of dahlia flowers and making the most of profit, It is vital to have information of the right month and the right cultivar for making the maximum profit from flowers cultivation. The Matungini cultivar transplanted on October 15th generated maximum profits as benefit cost ratio was found to be maximum. This research will thus help farmers and gardener involved in cultivation of dahlia to capitalize on their profits by selecting the right month and the right cultivars.

Authors' contributions: All authors contributed significantly to the study: Manish Kumar, Priyanka Thakur, Bharati Kashyap, Pradeep Kumar and Anju Sharma were involved in the conception and design of the experiments. Fieldwork and data collection were conducted by Manish Kumar. Manish Kumar, Priyanka Thakur and Anju Sharma performed the data analysis. Ragini Bhardwaj also helped in writing the research paper. Bharati Kashyap, Pradeep Kumar, Anju Sharma, Ragini Bhardwaj, Nitesh Kaushal, Ali Haidar Shah and Praveen Kumar Sahu provided critical revisions. All authors discussed the results, contributed to the manuscript's final version, and approved the submitted version.

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Abbreviations

Short Name	Full Form
Cm	Centimetre
G	Gram
Kg	Kilo gram
M	Meter
m^2	Meter square
%	Percent
l	Liter
Rs	Rupees
&	And
Ha	Hectare
BC Ratio	Benefit cost ratio

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Disclaimer (Artificial intelligence and conflict)

No type of artificial intelligence has been used in writing this research paper.

Conflict of interest

The authors do not have any conflict of interest.

References

1. Adams S R, Pearson S and Hadley P. 1997. The Effects of Temperature, Photoperiod and Light Integral on the Time to Flowering of Pansy cv. Universal Violet (*Viola× wittrockiana* Gams.). *Annals of Botany*. 80(1) pp.107-112.

2. APEDA. India Facts and Figures, Agriculture & Processed Food Products Export Developments Authority (*APEDA*), 2016. www.apeda.gov.in

3. Arancon, N.Q., Lee, S., Edwards, C.A. and Atiyeh, R., 2003. Effects of humic acids derived from cattle, food and paper-waste vermicompost's on growth of greenhouse plants: The 7th International symposium on earthworm ecology· Cardiff· Wales· 2002. *Pedobiologia*, *47*(5-6), pp.741-744.

4. Bajaraya B, Kanawjia A, Jaysawal N, Dubey A, Parveen S, Pawaiya S. 2018. Performance of different cultivars of Dahlia (*Dahlia variabilis* L.) under agro-climatic conditions of Gwalior. *Journal of Pharmacognosy and Phytochemistry*;7(6):98-102.

5. Dodd AN, Salathia N, Hall A, Kevei E, Toth R, Nagy F, Hibberd J.M, Millar AJ and Webb AA. 2005. Plant circadian clocks increase photosynthesis, growth, survival, and competitive advantage. *Science*, 309(5734), pp.630-633.

6. Gomes M A D C, Suzuki MS, Cunha MD and Tullii CF. 2011. Effect of salt stress on nutrient concentration, photosynthetic pigments, proline and foliar morphology of Salvinia auriculata Aubl. *Acta Limnologica Brasiliensia*, 23, pp.164-176.

7. Gupta AK, Jaiswal NK, Saravanan S. 2015. Varietal evaluation of different hybrids of dahlia (*Dahlia variabilis* L.) under Allahabad agro-climatic conditions. *International Journal of Agricultural Science Research.* 5(1):55-58.

8. Kumar L, Mahawer LN, Shukla AK, Kaushik RA, Upadhyay B. 2009. Performance of dahlia (*Dahlia. Variabilis* L) cultivars for vegetative, floral and relative economic parameters under sub-humid southern plains and Aravalli hills of Udaipur. *Indian Journal of Agricultural Sciences*. 79(10):816-20.

9. Kumar R, Yadav DS. 2005. Evaluation of Gladiolus Cultivars Under sub-tropical Hills of Meghalaya. *Journal of Ornamental Horticulture*. 8(2):86-90.

10. Kumar, M., Thakur, P., Kashyap, B., Kumar, P., Sharma, A., Bhardwaj, R., Kaushal, N., & Shah, A. H. (2024). Effect of different planting dates on tuber production in dahlia (*Dahlia variabilis* L.) in Low Hill Conditions of Himachal Pradesh, India. *Plant Cell Biotechnology and Molecular Biology*. 25(7-8), 71–78. https://doi.org/10.56557/pcbmb/2024/v25i7-88743

11. Mounika T, Saravanan SS. 2019. Response of different varietal evaluation of dahlia (*Dahlia variabilis* L.) under Prayagraj agro-climatic conditions. *International Journal of Current Microbiology and Applied Sciences.* 8(8):2389-2397.

12. Pandey, S.K., Kumari, S., Singh, D., Singh, V.K. and Prasad, V.M., 2017. Effect of biofertilizers and organic manures on plant growth, flowering and tuber production of dahlia (*Dahlia variabilis* L.) Cv. SP Kamala. *International Journal of Pure & Applied Bioscience*, 5(2), pp.549-555.

13. Rajput, V., Abhishek Kumar, J. and Tomar, S., 2020. Effect of pinching and spacing on growth parameters of African marigold (*Tagets erecta* L.). *Plant archives.* 20, pp.533-37.

14. Ramya HM, Nataraj SK, Lakshmana D, Kumar R. 2019. Studies on genetic variability, heritability and genetic advance in F2 segregating population of cross Arka Archana × AAC-1 in China Aster (*Callistephus chinensis* L. Nees). *International Journal of Current Microbiology and Applied Sciences*. 8(4):1230-1233.

15. Sabah SS, Prasad VM, Saravanan S. 2014. Effect of different organic and inorganic manure on flower yield and tubers yield of dahlia (*Dahlia variabilis*) cv. Glory of India as Intercropping with Damask Rose. *European Academic Research*. 2(3):4265-4273.

16. Sharma, A. and Agarwal, A.K., 2004. Organic farming: Today's revolution, tomorrow's prosperity. *Agrobios Newsletter*, 3(2), pp.16-18.

17. Sheergojri GA, Rather ZA, Khan FU, Nazki IT, Qadri ZA. 2013. Effect of chemical fertilizers and bio-inoculants on growth and flowering of dahlia (*Dahlia variabilis* Desf.) cv.'Pink Attraction'. *Applied Biological Research*. 15(2):121-129.

18. Shukla P, Prasad V, Ainarkar AA. Evaluation of dahlia hybrids (Dahlia variabilis L.) under allahabad agro- climate conditions. *Journal of Pharmacognosy and Phytochemistry*. 2018;7(5):1109-1113.

19. Soujanya P, Kulkarni BK, Kumar R, Munikrishnappa PM, Shivapriya M, Harshavardhan M. 2018. Evaluation of rose (*Rosa hybrida* L.) varieties for growth, yield and quality under eastern dry zone of Karnataka. *Journal of Pharmacognosy and Phytochemistry*. 7(5):165-168.

20. Taiz L and Zeiger E. 2010. Plant physiology 5th (Ed.). Sunderland. Sinauer Assoc. Inc., Publishers, *Sunderland Masschusetts*.

21. Thakur, P., Shah, A.H., Adhikari, Y., Kumar, M. and Verma, S., 2022. Dahlia cultivation in India and abroad: A review. *International Journal of Plant & Soil Science*, 34(19), pp.240-251.

22. Thumar B V, Chovatiya N V, A M Butani, V B Bhalu and Manisha. 2020. Effect of planting time and pinching on growth of chrysanthemum (*Dendranthema grandiflora*) Cv. Ratlam selection. *Journal of Pharmacognosy and Phytochemistry* 9: 411-13.

23. Tibbitts TW and Bottenberg G. 1976. Growth of lettuce under controlled humidity levels. *Journal of the American Society for Horticultural Science*, (101) 70-73 ref. 12

24. Tomar, S., Singh, S.K., Dubey, A.K. and Singh, J.P., 2017. Abhishek. Role of plant hormones on vegetative growth of tomato (*Lycopersicon esculentum* Mill.). *International Journal of Current Microbiology and Applied Sciences*, 6(9), pp.3319-23.

25. Tomar, S., Singh, Y.K. and Dubey, S., 2020. Effect of integrated nutrient management on nutrient supply, productivity and soil fertility in Pearl millet (*Pennisetum glaucum* L.). *International Journal of Agricultural Invention*, 4(1), pp.124-128.

26. Vara Prasad Rao 2005. Studied the economics of production of cut flowers in polyhouse in Sindhudurg and Ratnagiri district. *Indian Journal of Agricultural Sciences*. 34(8):71-78.

27. Verma J, Kulkarni BS. 2017. Evaluation of Dahlia genotypes for growth and yield characters under dry zone of Karnataka, India *International Journal of Current Microbiology and Applied Sciences*. 2017;6(11):402-409.

28. Vetrivel T, Lakshmanan V, Jawaharlal M. 2018. Correlation and path analysis studies in Gladiolus (*Gladiolus hybrids* Hort.) *Journal of Applied and Natural Science*. 10(1):216-22.

29. Vikas DM, Patil VS, Dorajeerao AVD. 2015. Evaluation of dahlia genotypes based on vegetative and quality characters. *Plant Archives*. 15(1):283-286.

30. Wheeler RM, Mackowiak CL, Sager JC, Yorio NC, Knott WM and Berry WL. 1994. Growth and gas exchange by lettuce stands in a closed, controlled environment. *Journal of the American Society for Horticultural Science*, 119(3), pp.610-615.

31. White PJ and Greenwood DJ. 2013. Properties and management of cationic elements for crop growth. *Soil conditions and plant growth*, pp.160-194.

32. Zhang Wen Jun ZW, Lu Jian Wei LJ, Jiang Zhi Ping JZ, Wang YaYi, WY. 2010. Effects of nitrogen, phosphorus, and potassium fertilizer on the growth, blossom, and N, P, K uptake in *Calendula officinalis* L. *Journal of Wuhan Botanical Research*. 28(4):491-496.