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Rachel Vanlalhruaii
Department of Floriculture and Landscape Architecture, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himanchal Pradesh, India

SR Dhiman
Department of Floriculture and Landscape Architecture, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himanchal Pradesh, India

Puja Sharma
Department of Floriculture and Landscape Architecture, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himanchal Pradesh, India

Rajesh Kaushal
Department of Soil Science and Water Management, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himanchal Pradesh, India

Ashu Chandel
Department of Basic Sciences, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himanchal Pradesh, India

Shreedhar Beese
Department of Floriculture and Landscape Architecture, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himanchal Pradesh, India

Corresponding Author:
Rachel Vanlalhruaii
Department of Floriculture and Landscape Architecture, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himanchal Pradesh, India

Economic analysis of inorganic and organic cultivation of different carnation (*Dianthus caryophyllus* L.) genotypes

Rachel Vanlalhruaii, SR Dhiman, Puja Sharma, Rajesh Kaushal, Ashu Chandel and Shreedhar Beese

Abstract
The increasing demand for cut flowers has led to the excessive use of chemical fertilizers and other agrochemicals. While chemical fertilizers provide immediate nutrient availability and promote plant growth, organic fertilization offers long-term soil health and environmental sustainability. Hence, there is a need to explore alternative and eco-friendly supplements to minimize the use of chemical fertilizers. Limited scientific research exists on the use of Jeevamrit, an organic input, in flower crops like carnations. The investigation was conducted at Dr YS Parmar University of Horticulture and Forestry, Nauni, H.P. during 2020-2022 to evaluate the performance and profitability of different carnation genotypes under organic and inorganic fertilization modules. It was found that the organic fertilization module (Jeevamrit @ 20 ml/plant plant as drenching at 30 days interval) performed better in terms of number of flowers per plant and per square metre (5.55 cut flowers per plant and 133.20 cut flowers per m^2) and profitability, as it consistently yielded higher net returns and benefit cost ratios for different genotypes. Among the different genotypes tested, 'Bizet' performed the best under organic fertilization module with highest b:c ratio of 2.38. However, under inorganic fertilization module, 'Bizet' and 'Raggio-de-Sole' (b:c ratio of 2.02) performed better over the rest of the genotypes. This suggests that organic cultivation practices can act as an alternative for chemical fertilizers in consideration to the low input cost along with improving soil health and have the potential to contribute to better financial outcomes in carnation cultivation compared to inorganic fertilization.

Keywords: Carnation, *Dianthus caryophyllus*, cost of cultivation, benefit cost ratio, organic, Jeevamrit, fertigation

Introduction
Carnation (*Dianthus caryophyllus* Linn.) is one of the leading cut flowers of international market belongs to the Caryophyllaceae family having chromosome number 2n=30 and is native to the Mediterranean region. In India, carnations are grown commercially in places having mild climate like Solan, Shimla, Kullu, Kalimpong, Kodaikanal, Srinagar, Ooty and Yercaud. Carnation requires an optimum day temperature of 18.3 ºC whereas, the optimum range of night temperature during winter is 10-11 ºC while in summers it ranges from 13-15.4 ºC with more than 21.5 kilo lux light intensity, cyclic lighting or continuous lighting from dusk to dawn hastens flowering (Blake, 1955) [1]. It is grown under controlled condition as the transitional belt parts/area seems to be ideal for cultivation of flowers on account of favourable climate, soil and other factors (Shiragur, 2004) [6]. The flourishing business of cut flowers has led to indiscriminate use of chemical fertilizers, insecticides, fungicides and growth promoters. Chemical fertilizers play a significant role in modern agriculture as they provide immediate nutrient availability, promote plant growth and increase agricultural productivity. Fertigation has been used as the most effective and convenient means of maintaining optimum fertility level and water supply according to the specific requirements of carnation and soil, resulting into higher yields and better quality. While organic fertilization promotes soil health, environmental sustainability and long-term soil fertility. The choice between chemical and organic fertilizers depends on various factors, including specific crop requirements, environmental considerations and sustainable farming practices. Potential alternatives or supplements and ecofriendly products have to be tested and popularized to educate the farming community so that they can minimize the use of chemical fertilizer by relying on organic and eco-friendly supplements. Jeevamrit contains huge amount of microbial population which multiply and act as a stimulant for improving soil health, intensify microbial activities in soil

and ultimately ensures higher availability and uptake of nutrients by the crops (Palekar, 2006) [4]. There is limited scientific research available on the use of jeevamrit in flower crops. However, there have been studies on the use of organic inputs in flower cultivation, which provide some insight into the potential benefits of jeevamrit. Keeping in view the importance and popularity of carnation and lack of database regarding organic cultivation of this crop, the present studies has been taken up.

Materials and methods

The study was laid out in the experimental farm of Department of Floriculture and Landscape Architecture, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during 2020- 2022. The experiment was laid out a Randomized Block Design (2 Factorial) and replicated thrice. Factor-I comprises of fourteen genotypes i.e., eleven mutants *viz*., PM-1, PM-2, PM-3, UHFSCar-1, UHFSCar-2, UHFSCar-3, UHFSCar-4, UHFSCar-5, UHFSCar-6, UHFSCar-7, UHFSCar-11 and three varieties *viz*., Bizet, Tempo and Raggio-de-Sole. Factor-II comprises of the fertilization modules which are inorganic nutrient (Recommended dose of fertilizer) [10-10-10 g/m^2 NPK (as basal) + 100 ppm N + 140 ppm K (as fertigation- twice a week)] and organic nutrient (Jeevamrit @ 20 ml/plant to be applied as drenching at 30 days intervals). The basal doze of chemical fertilizer was mixed with the growing media. 10-10-10 g/m^2 NPK was met through urea- 22 g/m^2, SSP- 62.5 g/m^2 and MOP- 16.6g/m^2. Fertigation was started after 30 days of planting when the plants were established in the growing medium by applying 150 to 250 ml depending upon the age of the plant in the root zone of the plant manually. Different fertilizers like; multi-K (13-0-45), calcium nitrate (commercial grade) and urea were used as a source of nitrogen and potassium. To supply 100 ppm of nitrogen, 60 ppm was applied as nitrate N [potassium nitrate (multi K)- 40 ppm and $Ca(NO_3)_2$ - 20 ppm] by dissolving 311 mg of multi K and 129 mg of $Ca(NO_3)_2$ in 1 litre of water. Remaining 40 ppm N was supplied as ammonical form through urea by dissolving 87 mg in 1 litre of water. For the supply of K_2O, the entire quantity is met through the application of multi-K. Jeevamrit was prepared by mixing cow dung- 1 kg, cow urine- 1 litre, jaggery- 200 gm, pulse flour- 200 gm and a handful soil and water was added to make up to a volume of 20 litres then let it ferment for four days. On the fifth day, drenching was done at a rate of 20 ml/plant. Drenching of jeevamrit was started at 30 days after transplanting at 1:4 dilutions.

To control the insect infestation in organic nutrient module Agnistra: prepared by mixing of 10 litres cow urine, 1 kg tobacco, 200 gm each of green chilli and garlic, 5 kg neem leaves and 2 kg custard apple leaves and Bramhastra: prepared by mixing 10 litres cow urine, 3kgNeem leaves, 2 kg leaves each of custard apple, papaya, pomegranate, guava, *Lantana camera*, *Datura metal*. Agnistra and Bramhastra were sprayed alternatively at weekly interval when the pests appeared at a rate of 2.5% (v/v). The insects and diseases in the inorganic nutrient module were controlled chemically by the use of standard insecticides and fungicides.

The rooted cuttings were transplanted in the polyhouse in a raised bed of 1.20 m x 0.8 m with row to row and plant to plant spacing of 20 cm x 20 cm, thus accommodating 24 plants/plot. Well rotten Farm Yard Manure @ 5 kg/m^2 and vermicompost @ 1 kg/m^2 was supplied as basal dose. Standard single pinching was done at 45 days after planting.

The data of two years were analyzed by simple statistical methods for interpretation of the data using the procedures described by Gomez and Gomez (1984) [4]. The analytical error of individual samples was generally below 5%.

Cost of cultivation was calculated following the production techniques and treatments followed in conducting the experiment. It was calculated for an area of 500 m^2. The cost benefit ratio was worked out on the basis of input and output involved. The cost of labour and various inputs was taken as per the local market rates. Gross monetary return and net return (Rs/500 m^2) was worked out using the following formula.

Gross monetary return (Rs/500 m^2) = value of cut flower

Net returns (Rs/500 m^2) = Gross monetary returns – Total cost of production

$$\text{Cost Benefit Ratio} = \frac{\text{Net Returns}}{\text{Total Expenditure}}$$

Results and discussion

Flower yield is an important factor in deciding the suitability of a particular cultivar for commercial cultivation, which ultimately reflects the cost of cultivation. Data presented in Table 1 shows that during 2020-2021, genotype 'Bizet' (4.83) recorded maximum number of flowers per plant which was found to be at par with 'Tempo' (4.60) and 'Raggio-de-Sole' (4.70) whereas minimum number of flowers per plant recorded was recorded in genotype 'UHFSCar-7' (4.03) which was statistically at par with genotypes 'PM-1' (4.10), 'PM-2' (4.23), 'PM-3' (4.17), 'UHFSCar-1' (4.25), 'UHFSCar-2' (4.27), 'UHFSCar-3' (4.07), 'UHFSCar-4' (4.27), 'UHFSCar-6' (4.13) and 'UHFSCar-11' (4.10). During 2021-2022, that maximum number of flowers per plant was recorded in genotype 'Bizet' (7.23) which was found to be at par with genotypes 'PM-3' (6.93) and 'Raggio-de-Sole' (7.17) whereas 'UHFSCar-2' (6.10) obtained the minimum number of flowers per plant which was at par with 'UHFSCar-7' (6.23). Between the fertilization modules, organic fertilization module (6.77) recorded greater number of flowers per plant over inorganic fertilization module (6.51). Pooled analysis of the two years revealed that maximum number of flowers per plant was obtained in genotype 'Bizet' (6.03) which was found to be at par with 'Raggio-de-Sole' (5.93) whereas genotype 'UHFSCar-7' (5.13) obtained the minimum number of flowers per plant which was found to be at par with genotypes 'PM-2' (5.40), 'UHFSCar-1' (5.32), 'UHFSCar-2' (5.18), 'UHFSCar-4' (5.27), 'UHFSCar-6' (5.35) and 'UHFSCar-11' (5.27). The organic fertilization module (5.55) recorded greater number of flowers per plant over inorganic fertilization module (5.38). In general, number of flowers per plant during 2021-2022 (6.64) was greater over during 2020-2021 (4.30).

The interaction years and genotypes revealed that maximum number of flowers per plant was obtained in genotype 'Bizet' (7.23) during 2021-2022 which was found to be at par with genotypes 'PM-1' (6.87), 'PM-3' (6.93) and 'Raggio-de-Sole' (7.17) of the same year whereas minimum number of flowers per plant recorded was obtained in genotype 'UHFSCar-7' (4.03) during 2020-2021 which was statistically at par with genotypes 'PM-1' (4.10), 'PM-2' (4.23), 'PM-3' (4.17), 'UHFSCar-1'(4.25), 'UHFSCar-2' (4.27), 'UHFSCar-3' (4.07), 'UHFSCar-4' (4.27), 'UHFSCar-6' (4.13) and 'UHFSCar-11' (4.10) during 2020-2021.

Table 1: Effect of different genotypes of carnation on number of flowers per plant in response to inorganic and organic fertilization modules

Genotypes	2020-2021			2021-2022			Pooled		
	Inorganic fertilization module	Organic fertilization module	Mean	Inorganic fertilization module	Organic fertilization module	Mean	Inorganic fertilization module	Organic fertilization module	Mean
PM-1	4.07	4.13	4.10	6.67	7.07	6.87	5.37	5.60	5.48
PM-2	4.20	4.27	4.23	6.40	6.73	6.57	5.30	5.50	5.40
PM-3	4.07	4.27	4.17	6.73	7.13	6.93	5.40	5.70	5.55
UHFSCar-1	4.22	4.27	4.25	6.33	6.47	6.40	5.28	5.37	5.32
UHFSCar-2	4.33	4.20	4.27	6.07	6.13	6.10	5.20	5.17	5.18
UHFSCar-3	4.07	4.07	4.07	6.73	6.80	6.77	5.40	5.43	5.42
UHFSCar-4	4.20	4.33	4.27	6.27	6.27	6.27	5.23	5.30	5.27
UHFSCar-5	4.47	4.40	4.43	6.27	7.00	6.63	5.37	5.70	5.53
UHFSCar-6	4.07	4.20	4.13	6.20	6.93	6.57	5.13	5.57	5.35
UHFSCar-7	4.00	4.07	4.03	6.20	6.27	6.23	5.10	5.17	5.13
UHFSCar-11	4.00	4.20	4.10	6.27	6.60	6.43	5.13	5.40	5.27
Bizet	4.73	4.93	4.83	7.13	7.33	7.23	5.93	6.13	6.03
Tempo	4.60	4.60	4.60	6.60	6.87	6.73	5.60	5.73	5.67
Raggio-de-Sole	4.67	4.73	4.70	7.20	7.13	7.17	5.93	5.93	5.93
Mean	4.26	4.33	4.30	6.51	6.77	6.64	5.38	5.55	
CD0.05	Genotypes	:	0.43	Genotypes	:	0.32	Genotypes	:	0.27
	Fertilization modules	:	NS	Fertilization modules	:	0.12	Fertilization modules	:	0.10
	Genotypes x Fertilization modules	:	NS	Genotypes x Fertilization modules	:	NS	Genotypes x Fertilization modules	:	NS
							Years	:	0.10
							Years x Fertilization modules	:	NS
							Years x Genotypes	:	0.38
							Years x Genotype x Fertilization modules	:	NS

Table 2: Effect of different genotypes of carnation on number of flowers per square metre in response to inorganic and organic fertilization modules

Genotypes	2020-2021			2021-2022			Pooled		
	Inorganic fertilization module	Organic fertilization module	Mean	Inorganic fertilization module	Organic fertilization module	Mean	Inorganic fertilization module	Organic fertilization module	Mean
PM-1	97.60	99.20	98.40	160.00	169.60	164.80	128.80	134.40	131.60
PM-2	100.80	102.40	101.60	153.60	161.60	157.60	127.20	132.00	129.60
PM-3	97.60	102.40	100.00	161.60	171.20	166.40	129.60	136.80	133.20
UHFSCar-1	101.36	102.40	101.88	152.00	155.20	153.60	126.68	128.80	127.74
UHFSCar-2	104.00	100.80	102.40	145.60	147.20	146.40	124.80	124.00	124.40
UHFSCar-3	97.60	97.60	97.60	161.60	163.20	162.40	129.60	130.40	130.00
UHFSCar-4	100.80	104.00	102.40	150.40	150.40	150.40	125.60	127.20	126.40
UHFSCar-5	107.20	105.60	106.40	150.40	168.00	159.20	128.80	136.80	132.80
UHFSCar-6	97.60	100.80	99.20	148.80	166.40	157.60	123.20	133.60	128.40
UHFSCar-7	96.00	97.60	96.80	148.80	150.40	149.60	122.40	124.00	123.20
UHFSCar-11	96.00	100.80	98.40	150.40	158.40	154.40	123.20	129.60	126.40
Bizet	113.60	118.40	116.00	171.20	176.00	173.60	142.40	147.20	144.80
Tempo	110.40	110.40	110.40	158.40	164.80	161.60	134.40	137.60	136.00
Raggio-de-Sole	112.00	113.60	112.80	172.80	171.20	172.00	142.40	142.40	142.40
Mean	102.33	104.00	103.17	156.11	162.40	159.26	129.22	133.20	
CD0.05	Genotypes	:	10.34	Genotypes	:	7.65	Genotypes	:	6.52
	Fertilization modules	:	NS	Fertilization modules	:	2.89	Fertilization modules	:	2.47
	Genotypes x Fertilization modules	:	NS	Genotypes x Fertilization modules	:	NS	Genotypes x Fertilization modules	:	NS
							Years	:	2.47

						Years x Fertilization modules	:	NS
						Years x Genotypes	:	9.22
						Years x Genotype x Fertilization modules	:	NS

Improvement in yield might be due to stimulation in growth by nutrients *viz*., N (1.96%), P (0.173%) and K (0.280%) in jeevamrit (Devakumar *et al*., 2014) [3] due to the application of jeevamrit at regular intervals. These findings are in line with those reported by Singh (2018) [7] who reported better growth and yield parameters in gerbera with the application of jeevamrit at 20 days intervals. Pathania (2019) [5] and Choudhary *et al*. (2021) [2] also reported that jeevamrit application significantly increases the growth and yield parameters in China aster and marigold, respectively.

Data pertaining to number of flowers per square metre is presented in Table 2. During 2020-2021, genotype 'Bizet' (116.00) recorded maximum number of flowers per square metre which was found to be at par with 'Tempo' (110.40) and 'Raggio-de-Sole' (112.80) whereas minimum number of flowers per square metre recorded was recorded in genotype 'UHFSCar-7' (96.80) which was statistically at par with genotypes 'PM-1' (98.40), 'PM-2' (101.60), 'PM-3' (100.00), 'UHFSCar-1'(101.88), 'UHFSCar-2' (102.40), 'UHFSCar-3' (97.60), 'UHFSCar-4' (102.40), 'UHFSCar-6' (99.20) and 'UHFSCar-11' (98.40). During 2021-2022, that maximum number of flowers per square metre was recorded in genotype 'Bizet' (173.60) which was found to be at par with genotypes 'PM-3' (166.40) and 'Raggio-de-Sole' (172.00) whereas 'UHFSCar-2' (146.40) obtained the minimum number of flowers per square metre which was at par with 'UHFSCar-7' (149.60). Organic fertilization module (162.40) recorded greater number of flowers per square metre over inorganic fertilization module (156.11). The two years pooled data showed that maximum number of flowers per square metre was found in genotype 'Bizet' (144.80) which was found to be statistically at par with 'Raggio-de-Sole' (142.40) whereas minimum number of flowers per square metre was obtained in genotype 'UHFSCar-7' (123.20) which was found to be at par with genotypes 'PM-2' (129.60), 'UHFSCar-1' (127.74), 'UHFSCar-2' (124.40), 'UHFSCar-4' (126.40), 'UHFSCar-6' (128.40) and 'UHFSCar-11' (126.40). The organic fertilization module (133.20) recorded greater number of flowers per square metre over inorganic fertilization module (129.22). In general, number of flowers per plant during 2021-2022 (159.26) was greater over during 2020-2021 (103.17). The interaction between years and genotypes revealed that maximum number of flowers per square metre was obtained in genotype 'Bizet' (173.60) during 2021-2022 which was found to be at par with genotypes 'PM-1' (164.80), 'PM-3' (166.40) and 'Raggio-de-Sole' (172.00) of the same year whereas minimum number of flowers per square metre recorded was obtained in genotype 'UHFSCar-7' (116.00) during 2020-2021 which was statistically at par with genotypes 'PM-1' (98.40), 'PM-2' (101.60), 'PM-3' (100.00), 'UHFSCar-1' (101.88), 'UHFSCar-2' (102.40), 'UHFSCar-3' (97.60), 'UHFSCar-4' (102.40), 'UHFSCar-6' (99.40) and 'UHFSCar-11' (98.40) during 2020-2021.

Carnation genotypes were evaluated based on their input cost, gross return, net return and benefit cost ratio. Based on the data presented in Table 3, the genotypes 'Bizet' and 'Raggio-de-Sole' exhibited the highest profitability among the carnation genotypes in inorganic fertilization module during 2020-2021 (1st year). They had the highest net returns and benefit cost ratios, indicating strong financial performance. Both the genotypes had a net return of Rs. 1,00,577.61 and Rs. 97,805.61 and a benefit cost ratio of 0.89 and 0.87, respectively. 'Tempo' also showed relatively good profitability with a net return of Rs. 95,063.61 and a benefit cost ratio of 0.85. 'UHFSCar-5' demonstrated moderate profitability with a net return of Rs. 89,549.61 and a benefit cost ratio of 0.80. The remaining genotypes had lower net returns and benefit cost ratios ranging from approximately Rs. 70,145.61 to Rs. 79,431.81 and 0.64 to 0.71, respectively.

During the 2020-2021, the organic fertilization module observed that the genotypes 'Bizet' and 'Raggio-de-Sole' stood out as the most profitable among the carnation genotypes as shown in Table 4. They demonstrated the highest net returns and benefit cost ratios, indicating strong financial performance. 'Bizet' achieved the highest net return of Rs. 1,16,527.90 with a benefit cost ratio of 1.10, while 'Raggio-de-Sole' attained the second-highest net return of Rs. 1,08,211.90 and a benefit cost ratio of 1.03. Additionally, 'Tempo' and 'UHFSCar-5' showed relatively good profitability with net returns of around Rs. 1,02,667.90 and Rs. 94,411.90 and benefit cost ratios of 0.98 and 0.91, respectively. The remaining genotypes yielded lower net returns and benefit cost ratios, ranging from approximately Rs. 80,551.90 to Rs. 88,807.90 and 0.79 to 0.86, respectively. 'Raggio-de-Sole' exhibited the highest profitability in inorganic fertilization module during 2021-2022 (Table 5). It demonstrated significant net returns of Rs. 2,59,384.63 and benefit cost ratio of 4.01. 'Bizet' also showed strong financial performance with a net return of Rs. 2,56,612.63 and a benefit cost ratio of 3.99. Similarly, 'Tempo', 'PM-1', 'PM-3' and 'UHFSCar-3' and displayed favorable profitability with net returns ranging from approximately Rs. 2,34,466.63 to Rs. 2,39,980.63 and benefit cost ratios between 3.75 and 3.81. The remaining genotypes had relatively lower net returns and benefit cost ratios, but still achieved values between 3.50 and 3.66. For organic fertilization module during 2021-2022, 'Bizet' had the highest net return of Rs. 2,72,069.90 and a benefit cost ratio of 4.70. Other genotypes, such as 'Tempo', 'UHFSCar-6', 'PM-1', 'PM-3', 'UHFSCar-5' and 'Raggio-de-Sole' also exhibited good profitability with net returns ranging from approximately Rs. 2,52,515.90 to Rs. 2,63,603.90 and benefit cost ratios around 4.47 and 4.59 (Table 6). The profitability of various carnation genotypes for the cultivation of two years, 2020-2022 in inorganic fertilization module assessed based on their input cost, gross return, net return and benefit cost ratio showed that the genotypes 'Bizet' and 'Raggio-de-Sole' demonstrated the highest profitability among the carnation genotypes as presented in Table 7. They had the highest net returns and benefit cost ratios, indicating strong financial performance. Both the genotypes had a net return of Rs. 3,57,189.64 and a benefit cost ratio of 2.02. Other genotypes, such as 'UHFSCar-5', 'PM-3', 'UHFSCar-3' and 'Tempo' also exhibited good profitability with net returns ranging from approximately Rs. 3,10,215.64 to Rs 3,29,529.64 and benefit cost ratios around 1.80 and 1.89.

During the two-year period from 2020 to 2022 (Table 8), the cost of cultivation in the organic fertilization module revealed that the genotypes 'Bizet' and 'Raggio-de-Sole' consistently displayed the highest net returns and benefit cost ratios. These genotypes exhibited superior profitability compared to other variants, with net returns ranging from approximately Rs. 3,88,597.80 to Rs. 3,71,815.80 and benefit cost ratios ranging from 2.38 to 2.29. This indicates their strong financial performance in cultivation. Additionally, genotypes such as 'PM-3', 'UHFSCar-5' and 'Tempo' also demonstrated relatively high net returns and benefit cost ratios, suggesting favorable profitability. These genotypes showcased net returns ranging from approximately Rs. 3,52,411.80 to Rs. 3,55,183.80 and benefit cost ratios ranging from 2.19 to 2.21.

Table 3: Cost of cultivation of carnation and net returns on an area of 500 m^2 in inorganic fertilization module during 2020-2021 (1st year)

A. Input Cost			
Particulars	**Manday(s) required (No.)**	**Rate (Rs.)**	**Total cost (Rs.)**
Labour			
a. Bed preparation, mixing of farm yard manure and basal dose of fertilizer and planting	5	350/manday	1,750.00
b. Irrigations	20	350/manday	7,000.00
c. Pinching	2	350/manday	700.00
d. Weeding and hoeing	12	350/manday	4,200.00
e. Fertigation/ Drenching and Spraying	20	350/manday	7,000.00
f. Disbudding and deshooting	8	350/manday	2,800.00
g. Staking	2	350/manday	700.00
h. Harvesting of flowers, grading, packaging and loading for transportation	12	350/manday	4,200.00
Total	81		28,350.00
Planting material	Quantity required (No.)	Rate (Rs.)	Total cost (Rs.)
Rooted cuttings considering total planting area as 375 m^2 and planting density of 24 plants/ m^2	24 x 375 = 9000	6/ plant	54,000.00
Manures and fertilizers			
a. Farm yard manure	1875 kg	1.50/kg	2,812.50
b. Vermicompost	375 kg	5.00/kg	1,875.00
c. Urea	16.22 kg	320/50 kg	103.81
d. Single Super Phosphate (SSP)	23.44 kg	300/50 kg	140.64
e. Muriate of Potash (MOP)	6.23 kg	800/50 kg	99.68
f. Multi-K	28.88 kg	4750/50 kg	2,743.60
g. Calcium nitrate	11.98 kg	1300/25 kg	622.96
Total			8,398.19
Plant protection chemicals			
a. Insecticides			
Cypermethrin (1ml/l)	90 x 2 = 180 ml	450/litre	81.00
Imidachloprid (0.5 ml/l)	45 x 2 = 90 ml	1500/litre	135.00
Simba (1 ml/l)	90 x 2 = 180 ml	890/litre	160.20
Total			376.20
b. Fungicides			
Dithane M-45 (2g/l, drenched thrice)	1.5 kg	360/kg	540.00
Bavistin (1g/l, drenched thrice)	0.75 kg	1180/kg	885.00
Total			1425.00
Staking material			
a. Iron poles (cost for 6 months considering total life for 15 years)	200 poles	150/pole	1,000.00
b. Nets			
• 4x4 inch size of mesh, 2 bottom rows (cost for 6 months considering total life for 5 years)	750 m^2	16.80/ m^2	1,260.00
• 5x5 inch size of mesh, 2 upper rows (cost for 6 months considering total life for 5 years)	750 m^2	15.00/ m^2	1,125.00
Total			3,385.00
Transportation and packaging cost			
a) Boxes required (Box size = 95 cm x 40 cm x 22 cm)			
Carnation genotypes	**No.**	**Rate/Box (Rs.)**	**Total cost (Rs.)**
PM-1	36.60	80	2,928.00
PM-2	37.80	80	3,024.00
PM-3	36.60	80	2,928.00
UHFSCar-1	38.01	80	3,040.80
UHFSCar-2	39.00	80	3,120.00
UHFSCar-3	36.60	80	2,928.00

UHFSCar-4	37.80	80	3,024.00
UHFSCar-5	40.20	80	3,216.00
UHFSCar-6	36.60	80	2,928.00
UHFSCar-7	36.00	80	2,880.00
UHFSCar-11	36.00	80	2,880.00
Bizet	42.60	80	3,408.00
Tempo	41.40	80	3,312.00
Raggio-de-Sole	42.00	80	3,360.00
b) Cellophane paper required			
Carnation genotypes	**Kilo gram**	**Rate (300 Rs/kg)**	**Total cost (Rs.)**
PM-1	0.8	300	240.00
PM-2	0.9	300	270.00
PM-3	0.8	300	240.00
UHFSCar-1	0.8	300	240.00
UHFSCar-2	0.8	300	240.00
UHFSCar-3	0.8	300	240.00
UHFSCar-4	0.8	300	240.00
UHFSCar-5	0.8	300	240.00
UHFSCar-6	0.8	300	240.00
UHFSCar-7	0.8	300	240.00
UHFSCar-11	0.8	300	240.00
Bizet	1.0	300	300.00
Tempo	0.9	300	270.00
Raggio-de-Sole	1.0	300	300.00
c) Vehicle charges up to Delhi flower market			
Carnation genotypes			
PM-1	36.60	300	10,980.00
PM-2	37.80	300	11,340.00
PM-3	36.60	300	10,980.00
UHFSCar-1	38.01	300	11,403.00
UHFSCar-2	39.00	300	11,700.00
UHFSCar-3	36.60	300	10,980.00
UHFSCar-4	37.80	300	11,340.00
UHFSCar-5	40.20	300	12,060.00
UHFSCar-6	36.60	300	10,980.00
UHFSCar-7	36.00	300	10,800.00
UHFSCar-11	36.00	300	10,800.00
Bizet	42.60	300	12,780.00
Tempo	41.40	300	12,420.00
Raggio-de-Sole	42.00	300	12,600.00

Returns

Carnation genotypes	Yield (no. of cut flowers)	Market price of cut stem during the flowering time (Rs.)	Gross returns (Rs.)
PM-1	36600	5	1,83,000.00
PM-2	37800	5	1,89,000.00
PM-3	36600	5	1,83,000.00
UHFSCar-1	38010	5	1,90,050.00
UHFSCar-2	39000	5	1,95,000.00
UHFSCar-3	36600	5	1,83,000.00
UHFSCar-4	37800	5	1,89,000.00
UHFSCar-5	40200	5	2,01,000.00
UHFSCar-6	36600	5	1,83,000.00
UHFSCar-7	36000	5	1,80,000.00
UHFSCar-11	36000	5	1,80,000.00
Bizet	42600	5	2,13,000.00
Tempo	41400	5	2,07,000.00
Raggio-de-Sole	42000	5	2,10,000.00

Gross Returns (Rs.)

Carnation genotypes	Input cost (A)(i)+(ii)+(iii)+(iv)+(v)+(vi)(a+b+c)	Gross return (Rs.)	Net return (Rs.)	Benefit cost ratio
PM-1	1,10,082.39	1,83,000.00	72,917.61	0.66
PM-2	1,10,568.39	1,89,000.00	78,431.61	0.71
PM-3	1,10,082.39	1,83,000.00	72,917.61	0.66
UHFSCar-1	1,10,618.19	1,90,050.00	79,431.81	0.72
UHFSCar-2	1,10,994.39	1,95,000.00	84,005.61	0.76
UHFSCar-3	1,10,082.39	1,83,000.00	72,917.61	0.66
UHFSCar-4	1,10,538.39	1,89,000.00	78,461.61	0.71

UHFSCar-5	1,11,450.39	2,01,000.00	89,549.61	0.80
UHFSCar-6	1,10,082.39	1,83,000.00	72,917.61	0.66
UHFSCar-7	1,09,854.39	1,80,000.00	70,145.61	0.64
UHFSCar-11	1,09,854.39	1,80,000.00	70,145.61	0.64
Bizet	1,12,422.39	2,13,000.00	1,00,577.610	0.89
Tempo	1,11,936.39	2,07,000.00	95,063.61	0.85
Raggio-de-Sole	1,12,194.39	2,10,000.00	97,805.61	0.87

Table 4: Cost of cultivation of carnation and net returns on an area of 500 m^2 in organic fertilization module during 2020-2021 (1st year)

A. Input Cost			
Particulars	**Manday(s) required (No.)**	**Rate (Rs.)**	**Total cost (Rs.)**
i) Labour			
a. Bed preparation, mixing of farm yard manure and basal dose of fertilizer and planting	4	350/manday	1,400.00
b. Irrigations	20	350/manday	7,000.00
c. Pinching	2	350/manday	700.00
d. Weeding and hoeing	12	350/manday	4,200.00
e. Drenching and Spraying	8	350/manday	2,800.00
f. Disbudding and deshooting	8	350/manday	2,800.00
g. Staking	2	350/manday	700.00
h. Harvesting of flowers, grading, packaging and loading for transportation	12	350/manday	4,200.00
Total	68		23,800.00
ii) Planting material	**Quantity required (No.)**	**Rate (Rs.)**	**Total cost (Rs.)**
Rooted cuttings considering total planting area as 375 m^2 and planting density of 24 plants/ m^2	24 x 375 = 9000	6/ plant	54000.00
iii) Manures and fertilizers			
a. Farm yard manure	1875 kg	1.50/kg	2812.50
b. Vermicompost	375 kg	5.00/kg	1875.00
c. Jeevamrit	1080 litre	2/l	2160.00
Total			6847.50
iv) Plant protection chemicals			
a. Agniastra (25 ml/l)	4.46 litre	35/l	156.10
b. Bhramastra (25 ml/l)	4.46 litre	25/l	111.50
Total			267.60
v) Staking material			
a. Iron poles (cost for 6 months considering total life for 15 years)	200 poles	150/pole	1000.00
b. Nets			
• 4x4 inch size of mesh, 2 bottom rows (cost for 6 months considering total life for 5 years)	750 m^2	16.80/ m^2	1260.00
• 5x5 inch size of mesh, 2 upper rows (cost for 6 months considering total life for 5 years)	750 m^2	15.00/ m^2	1125.00
Total			3385.00
vi) Transportation and packaging cost			
a) Boxes required (Box size = 95 cm x 40 cm x 22 cm)			
Carnation genotypes	**No.**	**Rate/Box (Rs.)**	**Total cost (Rs.)**
PM-1	37.20	80	2,976.00
PM-2	38.40	80	3,072.00
PM-3	38.40	80	3,072.00
UHFSCar-1	38.40	80	3,072.00
UHFSCar-2	37.80	80	3,024.00
UHFSCar-3	36.60	80	2,928.00
UHFSCar-4	39.00	80	3,120.00
UHFSCar-5	39.60	80	3,168.00
UHFSCar-6	37.80	80	3,024.00
UHFSCar-7	36.60	80	2,928.00
UHFSCar-11	37.80	80	3,024.00
Bizet	44.40	80	3,552.00
Tempo	41.40	80	3,312.00
Raggio-de-Sole	42.60	80	3,408.00
b) Cellophane paper required			
Carnation genotypes	**Kilo gram**	**Rate (300 Rs/kg)**	**Total cost (Rs.)**
PM-1	0.8	300	240.00

PM-2	1.0	300	300.00
PM-3	1.0	300	300.00
UHFSCar-1	0.8	300	240.00
UHFSCar-2	0.8	300	240.00
UHFSCar-3	0.8	300	240.00
UHFSCar-4	0.8	300	240.00
UHFSCar-5	0.8	300	240.00
UHFSCar-6	0.8	300	240.00
UHFSCar-7	0.8	300	240.00
UHFSCar-11	0.8	300	240.00
Bizet	1.0	300	300.00
Tempo	1.0	300	300.00
Raggio-de-Sole	1.0	300	300.00
c) Vehicle charges up to Delhi flower market			
Carnation genotypes			
PM-1	37.20	300	11,160.00
PM-2	38.40	300	11,520.00
PM-3	38.40	300	11,520.00
UHFSCar-1	38.40	300	11,520.00
UHFSCar-2	37.80	300	11,340.00
UHFSCar-3	36.60	300	10,980.00
UHFSCar-4	39.00	300	11,700.00
UHFSCar-5	39.60	300	11,880.00
UHFSCar-6	37.80	300	11,340.00
UHFSCar-7	36.60	300	10,980.00
UHFSCar-11	37.80	300	11,340.00
Bizet	44.40	300	13,320.00
Tempo	41.40	300	12,420.00
Raggio-de-Sole	42.60	300	12,780.00

B. Returns

Carnation genotypes	Yield (no. of cut flowers)	Market price of cut stem during the flowering time (Rs.)	Gross returns (Rs.)
PM-1	37200	5	1,86,000.00
PM-2	38400	5	1,92,000.00
PM-3	38400	5	1,92,000.00
UHFSCar-1	38400	5	1,92,000.00
UHFSCar-2	37800	5	1,89,000.00
UHFSCar-3	36600	5	1,83,000.00
UHFSCar-4	39000	5	1,95,000.00
UHFSCar-5	39600	5	1,98,000.00
UHFSCar-6	37800	5	1,89,000.00
UHFSCar-7	36600	5	1,83,000.00
UHFSCar-11	37800	5	1,89,000.00
Bizet	44400	5	2,22,000.00
Tempo	41400	5	2,07,000.00
Raggio-de-Sole	42600	5	2,13,000.00

C. Gross Returns (Rs.)

Carnation genotypes	Input cost (A)(i)+(ii)+(iii)+(iv)+(v)+(vi)(a+b+c)	Gross return (Rs.)	Net return (Rs.)	Benefit cost ratio
PM-1	1,02,676.10	1,86,000.00	83,323.90	0.81
PM-2	1,03,192.10	1,92,000.00	88,807.90	0.86
PM-3	1,03,192.10	1,92,000.00	88,807.90	0.86
UHFSCar-1	1,03,132.10	1,92,000.00	88,867.90	0.86
UHFSCar-2	1,02,904.10	1,89,000.00	86,095.90	0.84
UHFSCar-3	1,02,448.10	1,83,000.00	80,551.90	0.79
UHFSCar-4	1,03,360.10	1,95,000.00	91,639.90	0.89
UHFSCar-5	1,03,588.10	1,98,000.00	94,411.90	0.91
UHFSCar-6	1,02,904.10	1,89,000.00	86,095.90	0.84
UHFSCar-7	1,02,448.10	1,83,000.00	80,551.90	0.79
UHFSCar-11	1,02,904.10	1,89,000.00	86,095.90	0.84
Bizet	1,05,472.10	2,22,000.00	1,16,527.90	1.10
Tempo	1,04,332.10	2,07,000.00	1,02,667.90	0.98
Raggio-de-Sole	1,04,788.10	2,13,000.00	1,08,211.90	1.03

Table 5: Cost of cultivation of carnation and net returns on an area of 500 m^2 in inorganic fertilization module during 2021-2022 (2nd year)

Carnation genotypes	Input cost (eliminating bed preparations, planting and basal doze of fertilizers)	Gross return (Rs.)	Net return (Rs.)	Benefit cost ratio
PM-1	62,761.37	3,00,000.00	2,37,238.63	3.78
PM-2	61,789.37	2,88,000.00	2,26,210.63	3.66
PM-3	63,019.37	3,03,000.00	2,39,980.63	3.81
UHFSCar-1	61,561.37	2,85,000.00	2,23,438.63	3.63
UHFSCar-2	60,649.37	2,73,000.00	2,12,350.63	3.50
UHFSCar-3	63,019.37	3,03,000.00	2,39,980.63	3.81
UHFSCar-4	61,303.37	2,82,000.00	2,20,696.63	3.60
UHFSCar-5	61,333.37	2,82,000.00	2,20,666.63	3.60
UHFSCar-6	61,105.37	2,79,000.00	2,17,894.63	3.57
UHFSCar-7	61,075.37	2,79,000.00	2,17,924.63	3.57
UHFSCar-11	61,333.37	2,82,000.00	2,20,666.63	3.60
Bizet	64,387.37	3,21,000.00	2,56,612.63	3.99
Tempo	62,533.37	2,97,000.00	2,34,466.63	3.75
Raggio-de-Sole	64,615.37	3,24,000.00	2,59,384.63	4.01

Table 6: Cost of cultivation of carnation and net returns on an area of 500 m^2 in organic fertilization module during 2021-2022 (2nd year)

Carnation genotypes	Input cost (eliminating bed preparations and planting)	Gross return (Rs.)	Net return (Rs.)	Benefit cost ratio
PM-1	57,168.10	3,18,000.00	2,60,831.90	4.56
PM-2	56,028.10	3,03,000.00	2,46,971.90	4.41
PM-3	57,396.10	3,21,000.00	2,63,603.90	4.59
UHFSCar-1	55,086.10	2,91,000.00	2,35,913.90	4.28
UHFSCar-2	53,886.10	2,76,000.00	2,22,113.90	4.12
UHFSCar-3	56,226.10	3,06,000.00	2,49,773.90	4.44
UHFSCar-4	54,312.10	2,82,000.00	2,27,687.90	4.19
UHFSCar-5	56,940.10	3,15,000.00	2,58,059.90	4.53
UHFSCar-6	56,712.10	3,12,000.00	2,55,287.90	4.50
UHFSCar-7	54,312.10	2,82,000.00	2,27,687.90	4.19
UHFSCar-11	55,542.10	2,97,000.00	2,41,457.90	4.35
Bizet	57,930.10	3,30,000.00	2,72,069.90	4.70
Tempo	56,484.10	3,09,000.00	2,52,515.90	4.47
Raggio-de-Sole	57,396.10	3,21,000.00	2,63,603.90	4.59

Table 7: Cost of cultivation of carnation and net returns on an area of 500 m^2 in inorganic fertilization module during 2020-2022 (2 years)

Carnation genotypes	Input cost (A)(i)+(ii)+(iii)+(iv)+(v)+(vi)(a+b+c)	Gross return (Rs.)	Net return (Rs.)	Benefit cost ratio
PM-1	1,72,844.36	4,83,000.00	3,10,155.64	1.79
PM-2	1,72,358.36	4,77,000.00	3,04,641.64	1.77
PM-3	1,73,102.36	4,86,000.00	3,12,897.64	1.81
UHFSCar-1	1,72,180.16	4,75,050.00	3,02,869.84	1.76
UHFSCar-2	1,71,644.36	4,68,000.00	2,96,355.64	1.73
UHFSCar-3	1,73,102.36	4,86,000.00	3,12,897.64	1.81
UHFSCar-4	1,71,842.36	4,71,000.00	2,99,157.64	1.74
UHFSCar-5	1,72,784.36	4,83,000.00	3,10,215.64	1.80
UHFSCar-6	1,71,188.36	4,62,000.00	2,90,811.64	1.70
UHFSCar-7	1,70,930.36	4,59,000.00	2,88,069.64	1.69
UHFSCar-11	1,71,188.36	4,62,000.00	2,90,811.64	1.70
Bizet	1,76,810.36	5,34,000.00	3,57,189.64	2.02
Tempo	1,74,470.36	5,04,000.00	3,29,529.64	1.89
Raggio-de-Sole	1,76,810.36	5,34,000.00	3,57,189.64	2.02

Table 8: Cost of cultivation of carnation and net returns on an area of 500 m^2 in organic fertilization module during 2020-2022 (2 years)

Carnation genotypes	Input cost (A)(i)+(ii)+(iii)+(iv)+(v)+(vi)(a+b+c)	Gross return (Rs.)	Net return (Rs.)	Benefit cost ratio
PM-1	1,59,844.20	5,04,000.00	3,44,155.80	2.15
PM-2	1,59,220.20	4,95,000.00	3,35,779.80	2.11
PM-3	1,60,588.20	5,13,000.00	3,52,411.80	2.19
UHFSCar-1	1,58,218.20	4,83,000.00	3,24,781.80	2.05
UHFSCar-2	1,56,790.20	4,65,000.00	3,08,209.80	1.97
UHFSCar-3	1,58,674.20	4,89,000.00	3,30,325.80	2.08
UHFSCar-4	1,57,672.20	4,77,000.00	3,19,327.80	2.03
UHFSCar-5	1,60,528.20	5,13,000.00	3,52,471.80	2.20
UHFSCar-6	1,59,616.20	5,01,000.00	3,41,383.80	2.14
UHFSCar-7	1,56,760.20	4,65,000.00	3,08,239.80	1.97

UHFSCar-11	1,58,446.20	4,86,000.00	3,27,553.80	2.07
Bizet	1,63,402.20	5,52,000.00	3,88,597.80	2.38
Tempo	1,60,816.20	5,16,000.00	3,55,183.80	2.21
Raggio-de-Sole	1,62,184.20	5,34,000.00	3,71,815.80	2.29

Conclusion

Overall, the organic fertilization module (Jeevamrit @ 20 ml/plant as drenching at 30 days interval) performed better in terms of number of flowers per plant and per square metre (5.55 cut flowers per plant and 133.20 cut flowers per m^2) and profitability, as it consistently yielded higher net returns and benefit cost ratios for different genotypes. Among the different genotypes tested, 'Bizet' performed the best under organic fertilization module with highest b:c ratio of 2.38. However, under inorganic fertilization module, 'Bizet' and 'Raggio-de-Sole' (b:c ratio of 2.02) performed better over the rest of the genotypes. This suggests that organic cultivation practices can act as an alternative for chemical fertilizers in consideration to the low input cost along with improving soil health and have the potential to contribute to better financial outcomes in carnation cultivation compared to inorganic fertilization.

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