

Original Research Article

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Influence of Mulching Materials and Organic Formulations on Plant Growth, Yield and Quality of Cut Flowers of Carnation (*Dianthus caryophyllus* L.) cv. 'Loris'

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ABSTRACT

The present study was carried out at the Hi-tech farm of Department of Floriculture and Landscape Architecture, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during 2019-20 to find out the most suitable organic mulch material and organic nutrient formulation for enhancing plant growth, yield quantum and quality of cut flowers of carnation cv. 'Loris' under protected environment. The experiment was laid out in Completely Randomized Design comprising of 20 treatment combinations of mulch materials (4 levels) and organic formulations (5 levels) replicated thrice. The mulching (M₀: without mulch, M₁: spent mushroom compost, M₂: grass mulch and M₃: pine needles) was done after 15 days of transplanting of rooted cuttings and organic formulations were applied after every 20-25 days interval. The data were recorded for two consecutive flower flushes during the course of study. The results revealed that plants mulched with M₁ (spent mushroom compost) and treated with organic formulation F₂ [i.e. drenching with Consort NPK (1.8 g) + Benefit (7.5 ml in 750 ml of water) at 20-25 days interval and spraying of Bio Nematone + Bio Cure F @ 7.5 ml each in 750 ml of water and Grow Care WS (3.75 g) + Microfood (2.5 ml) + Green Miracle (2.5 ml) + PEPTO (1 ml) in 1 litre of water] recorded maximum plant height (95.47 cm and 97.73 cm), plant spread (18.53 cm and 19.77 cm), number of cut flowers per plant (6.50 & 9.57), duration of flowering (28.77 & 28.97 days), vase life of cut flowers (17.83 & 23.53 days) and minimum days taken to reach harvesting stage (141.00 & 132.33 days) during first and second flush, respectively.

Keywords

Mulch materials,
Organic, Carnation,
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Introduction

Carnation (*Dianthus caryophyllus* L.) is an important commercial cut flower crop of the world and belongs to family Caryophyllaceae and is native to Mediterranean region and

occupies position among top ten cut flowers in the domestic and international trade. Despite the maximization of chemical inputs in the present agricultural circumstances, the yield and quality of cut carnation is declining. The haphazard and indiscriminate use of

fertilizers and pesticides has exhibited ingress of harmful compounds into food chain leading to death of natural enemies, besides degradation of surrounding ecology (Chitale *et al.*, 2012). In addition, the continuous use of chemical fertilizers and plant protection agents of chemical origin has led to the deterioration of soil health in terms of its physical, chemical and biological properties leading to reduction in organic carbon and soil humus including decline in soil microbial reactions. Therefore, use of biofertilizers is emerging as a boon for sustainable crop production. Hence, it is necessary to produce flowers by adopting the technique(s) through which maximum benefits can be obtained by utilizing the finite resources such as water that is the main limiting factor nowadays globally. The application of mulches modifies the nutrient dynamics of fertilizers so as to enable the plants in deriving maximum benefits from them along with higher fertilizer use efficiency. (Mullar and Kotshi, 1994). Therefore, the present investigation was designed to determine the effect of various mulch materials and organic formulations on plant growth and yield of better quality cut flowers of Carnation.

Materials and Methods

The present investigation was carried out at Hi-tech farm of Department of Floriculture and Landscape Architecture of Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during 2019-2020. Different types of mulches (M₁: spent mushroom compost, M₂: grass mulch, M₃: pine needles, M₀: without mulch) and organic formulations were replicated three times in a plot of size 1 × 1m. The experiment was laid out in a completely randomized design (factorial). The rooted cuttings of uniform size and good vigour were planted at a spacing of 20 × 20 cm. Mulching was done 15

days after transplanting of rooted cuttings and organic formulations were applied after every 20-25 days. Well decomposed farmyard manure (FYM) @ 5 kg/m² was incorporated into soil before transplanting. The data were recorded for two consecutive flower flushes during the course of study. The data were recorded on plant height (cm), plant spread (cm), number of cut flowers per plant, days taken to reach harvesting stage, duration of flowering (days) and vase life (days) of cut flowers.

Treatment details

Types of Mulches: 4

M₀: No mulch

M₁: Spent Mushroom Compost (Spent mushroom compost contains about 1-2% nitrogen, 0.2% phosphorus and 1.3% potassium)

M₂: Grass mulch (air dried and applied@1kg/m²)

M₃: Pine needle (air dried and applied@1kg/m²)

Treatments of organic formulations

F₁: Control (only FYM @ 5kg/m²)

F₂: Drenching with Consort NPK @ 1.8g + Benefit @ 7.5 ml in 750 ml/m² at 20-25 days interval and spraying of Bio Nematone + Bio Cure F @ 7.5 ml each in 750 ml of water and Grow Care WS @ 3.75 g + Microfood @ 2.5 ml + Green Miracle @ 2.5 ml + PEPTO @ 1 ml in 1 litre of water.

F₃: Drenching with Consort NPK @ 3.75 g + Benefit @ 15 ml in 750 ml/m² at 20-25 days interval and spraying of Bio Nematone + Bio Cure F @ 7.5 ml each in 750 ml of water and Grow Care WS @ 3.75 g + Microfood @ 5 ml + Green Miracle @ 5 ml + PEPTO @ 2 ml in 1 litre of water.

F₄: Drenching with Consort NPK @ 5.5 g + Benefit @ 22.5 ml in 750 ml/m² at 20-25 days interval and spraying of Bio Nematone + Bio Cure F @ 7.5 ml each in 750 ml of water and Grow Care WS @ 3.75 g + Microfood @ 7.5 ml + Green Miracle @ 7.5 ml + PEPTO @ 3 ml in 1 litre of water.

F₅: Drenching with Consort NPK @ 7.5 g + Benefit @ 30 ml in 750 ml/m² at 20-25 days interval and spraying of Bio Nematone + Bio Cure F @ 7.5 ml each in 750 ml of water and Grow Care WS @ 3.75 g + Microfood @ 10 ml + Green Miracle @ 10 ml + PEPTO @ 4 ml in 1 litre of water.

S.No.	Trade Names of Biofertilizers used	Formulations of Biofertilizers
1	Consort NPK	Combined formulations of <i>Azotobacter</i> sp., <i>Bacillus</i> sp. and <i>Frateruria</i> sp.
2	Benefit	Decomposed biomass enriched with suitable organic constituents
3	Bio Nematone	<i>Paecilomyces lilacinus</i>
4	Bio Cure F	<i>Trichoderma viridae</i>
5	Grow Care WS	Arbuscular Mycorrhizae
6	Microfood	Combined formulations of Zn, Fe, Mn, Cu, B, Mo
7	Green Miracle	Fatty alcohol obtained from vegetable oil
8	PEPTO	Bio-stimulant containing Organic Nitrogen

Results and Discussion

Plant height

The data presented in the Table 1 revealed that mulches, organic formulations and their interactions have significantly affected the plant height. Spent mushroom compost was found to be the best mulch in recording maximum plant height (92.35 cm & 94.73 cm) during first and second flush, respectively. However, the plants fertilized with organic formulation F₂ (i.e. drenching of Consort NPK @ 1.8g + Benefit @ 7.5 ml in

750 ml/m² at 20-25 days interval and spraying of Bio Nematone @ 7.5 ml + Bio Cure F @ 7.5 ml in 750 ml of water and Grow Care WS @ 3.75 g + Microfood @ 2.5 ml + Green Miracle @ 2.5 ml + PEPTO @ 1 ml in 1 litre of water) attained maximum height (87.82 cm and 89.92 cm) in the first flush and second flush, respectively. The interaction of organic formulations × mulching materials indicated maximum plant height (95.47 cm and 97.73 cm) in the interaction, M₁×F₂ (i.e. mulching of plants with spent mushroom compost and application of organic formulation F₂). The plants with minimum height (76.13 cm & 78.00 cm) were produced in the interaction, M₀×F₁ (i.e. plots with no mulch and application of organic formulation F₁) during first and second flush, respectively. The production of tallest plants in the treatment combination, M₁×F₂ could be due to the positive influence of mulching in improving the root zone environment and assured supply of vital nutrients including growth enhancing substances by the treatment F₂ to the plants. The results got the support of research work carried out by Pandove *et al.*, (2016) as well as Das and Mishra (2005).

Plant spread

A perusal of data in Table 1 also indicated that maximum values for plant spread (18.11 cm & 19.19 cm) were observed in plants mulched with spent mushroom compost (M₁) during first and second flush, respectively. Among the formulations, the widest spread of plants (17.70 cm & 18.84 cm) was measured with the application of organic formulation F₂ (i.e. drenching of Consort NPK @ 1.8g + Benefit @ 7.5 ml in 750 ml/m² at 20-25 days interval and spraying of Bio Nematone @ 7.5 ml + Bio Cure F @ 7.5 ml in 750 ml of water and Grow Care WS @ 3.75 g + Microfood @ 2.5 ml + Green Miracle @ 2.5 ml + PEPTO @ 1 ml in 1 litre of water at 20-25 days interval) during first and second flush, respectively.

Table.1 Effect of different mulch materials and organic formulations on plant height (cm) and plant spread (cm)

	FIRST FLUSH										SECOND FLUSH									
	PLANT HEIGHT(cm)					PLANT SPREAD (cm)					PLANT HEIGHT (cm)					PLANT SPREAD (cm)				
	M ₀	M ₁	M ₂	M ₃	MEAN	M ₀	M ₁	M ₂	M ₃	MEAN	M ₀	M ₁	M ₂	M ₃	MEAN	M ₀	M ₁	M ₂	M ₃	MEAN
F₁	76.13	86.30	82.57	85.10	82.53	16.70	17.83	16.71	17.47	17.18	78.00	88.53	84.60	87.67	84.70	17.87	18.93	17.97	18.47	18.31
F₂	80.50	95.47	83.87	91.43	87.82	17.13	18.53	17.17	17.97	17.70	81.73	97.73	86.60	93.60	89.92	18.20	19.77	18.37	19.03	18.84
F₃	76.67	94.03	84.27	92.93	86.98	16.97	18.20	17.33	17.87	17.59	79.13	96.93	86.93	95.47	89.62	18.10	19.20	18.50	18.70	18.63
F₄	77.20	93.53	82.67	88.67	85.52	17.17	18.07	17.23	17.70	17.54	79.47	95.60	84.87	90.93	87.72	18.17	18.93	18.20	18.90	18.55
F₅	78.10	92.40	83.80	87.50	85.45	16.90	17.93	17.50	17.63	17.49	80.40	94.87	86.07	89.07	87.60	18.10	19.13	18.53	18.90	18.67
MEAN	77.72	92.35	83.43	89.13		16.97	18.11	17.19	17.73		79.75	94.73	85.81	91.35		18.09	19.19	18.31	18.80	
C.D (5%)	F – 1.50 M – 1.35 F x M = 3.01					F- 0.18 M-0.16 F x M - NS					F= 1.54 M = 1.38 F x M= 3.09					F-0.21 M-0.19 F x M- NS				

Table.2 Effect of different mulch materials and organic formulations on number of cut flowers per plant and days taken to reach harvesting

	FIRST FLUSH										SECOND FLUSH									
	NUMBER OF CUT FLOWERS PER PLANT					DAYS TAKEN TO REACH HARVESTING					NUMBER OF CUT FLOWERS PER PLANT					DAYS TAKEN TO REACH HARVESTING				
	M ₀	M ₁	M ₂	M ₃	MEAN	M ₀	M ₁	M ₂	M ₃	MEAN	M ₀	M ₁	M ₂	M ₃	MEAN	M ₀	M ₁	M ₂	M ₃	MEAN
F₁	4.00	5.47	4.57	5.23	4.82	153.57	146.90	152.43	150.77	150.92	6.97	7.67	7.10	7.73	7.37	142.30	139.33	141.67	136.20	139.88
F₂	4.40	6.50	4.67	6.33	5.48	149.67	141.00	149.00	142.67	145.58	9.33	9.57	9.50	9.03	9.36	137.67	132.33	135.67	132.33	134.50
F₃	4.77	5.67	4.67	5.77	5.22	152.90	145.87	151.77	146.67	149.30	7.60	8.67	7.47	9.33	8.27	141.10	133.13	140.23	135.43	137.48
F₄	4.50	6.00	5.23	5.67	5.35	152.33	145.23	150.80	146.67	148.73	7.77	8.87	8.40	8.40	8.36	140.90	134.23	139.00	135.67	137.45
F₅	4.87	5.63	4.90	5.47	5.22	152.53	146.23	151.70	147.20	149.42	7.50	8.83	7.47	8.90	8.18	140.47	135.13	138.23	136.63	137.62
MEAN	4.51	5.85	4.81	5.69		152.18	145.05	151.14	146.79		7.83	8.72	7.99	8.68		140.49	134.83	138.96	135.25	
C.D (5%)	F- 0.33 M-0.30 F x M- NS					F- 0.77 M-0.69 F x M-1.54					F-0.36 M-0.32 F x M-0.72					F-0.73 M-0.66 F x M-1.47				

Table.3 Effect of different mulch materials and organic formulations on duration of flowering (days) and vase life (days)

FIRST FLUSH											SECOND FLUSH									
	DURATION OF FLOWERING (days)					VASE LIFE (days)					DURATION OF FLOWERING (days)					VASE LIFE (days)				
	M ₀	M ₁	M ₂	M ₃	MEAN	M ₀	M ₁	M ₂	M ₃	MEAN	M ₀	M ₁	M ₂	M ₃	MEAN	M ₀	M ₁	M ₂	M ₃	MEAN
F₁	23.53	26.47	23.93	25.87	24.95	13.87	15.37	14.20	15.93	14.84	23.97	26.70	24.33	26.53	25.38	19.70	21.17	20.03	21.80	20.68
F₂	26.30	28.77	26.90	28.50	27.62	16.13	17.83	16.90	17.57	17.11	27.50	28.97	27.43	28.80	28.18	22.03	23.53	22.73	23.30	22.90
F₃	25.87	28.27	26.53	27.97	27.16	15.90	17.30	16.33	16.10	16.41	26.33	28.77	27.13	28.90	27.78	21.73	23.10	22.20	22.07	22.28
F₄	26.20	27.70	26.27	27.47	26.91	14.60	15.60	14.93	14.90	15.01	26.10	28.30	26.87	27.80	27.27	20.27	21.60	20.80	20.83	20.88
F₅	25.50	27.67	25.40	27.17	26.43	15.87	14.70	15.80	15.20	15.40	25.50	27.97	26.00	27.47	26.73	21.77	21.60	20.67	21.00	21.26
MEAN	25.48	27.77	25.81	27.39		15.27	16.16	15.63	15.94		25.88	28.14	26.35	27.90		21.10	22.20	21.29	21.80	
C.D. (5%)	F- 0.42 M-0.38 F x M- NS					F- 0.64 M-0.58 F x M- 1.29					F-0.66 M-0.59 F x M- NS					F-0.62 M-0.55 F x M- NS				

The interaction of mulch \times organic formulations recorded maximum plant spread (18.53 cm and 19.77 cm) in the interaction, $M_1 \times F_2$ (i.e. mulching of plants with spent mushroom compost and application of organic formulation F_2). However, minimum plant spread (16.70 cm & 17.87 cm) was reported in the interaction, $M_0 \times F_1$ (i.e. plants without any mulch and fertilized with organic formulation F_1) during first and second flush, respectively. The more spread of plants in the interaction, $M_1 \times F_2$ might be due to the fact that mulching had ensured congenial environment for better root growth and development of plants through the moderation of hydrothermal regimes of rhizosphere. Moreover, the application of F_2 organic formulation had increased the availability and continuous supply of nutrients due to the action of biofertilizers such as *Azotobacter* sp., which fixes the atmospheric nitrogen as well as make the soil nitrogen and phosphorus available to the plants by catalyzing phosphate solubilising activity (Pandove *et al.*, 2016).

Number of cut flowers per plant

The data enumerated in Table 2 elucidated that among the mulches, maximum number of cut flowers per plant (5.85 and 8.72) were observed in spent mushroom compost (M_1) during first and second flush, respectively. Also, plants fertilized with organic formulation F_2 (i.e. drenching of Consort NPK @ 1.8g + Benefit @ 7.5 ml in 750 ml/m² at 20-25 days interval and spraying of Bio Nematone @ + Bio Cure F @ 7.5 ml each in 750 ml of water and Grow Care WS @ 3.75 g + Microfood @ 2.5 ml + Green Miracle @ 2.5 ml + PEPTO @ 1 ml in 1 litre of water at 20-25 days interval) had produced maximum number of cut flowers per plant (5.48 and 9.36) in first and second flush, respectively. Among the treatment combinations, yield of cut flowers per plant

(6.50 & 9.57) was observed to be highest in the interaction, $M_1 \times F_2$ (i.e. mulching of plants with spent mushroom compost mulch and application of organic formulation F_2) and minimum (4 & 6.97) were recorded in the interaction, $M_0 \times F_1$ (i.e. plants with no mulch and control treatment) during both the flushes. The highest yield of cut flowers may be attributed to the fact that the conjoint use of mulching (M_1) and feeding of plants with the required organic formulations (F_2) might have helped in promoting better growth of the plants leading to greater vegetative biomass production mainly due to moderation of the soil moisture, temperature and enhancing biological activities besides higher supply and uptake of nutrients including other organic substances which ultimately increased the number of laterals per plant. These laterals in the due course of time become reproductive shoots bearing quality blooms. Hence, producing more number of cut flowers per plant (Li *et al.*, 1998; Blom *et al.*, 2008).

Days taken to reach harvesting stage

An inquisition of data (Table 2) revealed that mulching of plants with spent mushroom compost (M_1) has taken minimum time to reach harvesting stage (145.05 & 134.83 days) during first and second flush, respectively. Similarly, the plants fertilized with organic formulation F_2 (i.e. drenching of Consort NPK @ 1.8g + Benefit @ 7.5 ml in 750 ml/m² at 20-25 days interval and spraying of Bio Nematone + Bio Cure F @ 7.5 ml each in 750 ml of water and Grow Care WS @ 3.75 g + Microfood @ 2.5 ml + Green Miracle @ 2.5 ml + PEPTO @ 1 ml in 1 litre of water) also took lesser number of days for harvesting stage of cut flowers (145.58 & 134.50 days) during first and second flush, respectively. The interaction of mulching \times organic formulations also resulted in minimum time to reach harvesting stage (141.00 & 132.33 days) in the interaction,

$M_1 \times F_2$ (i.e. plants mulched with spent mushroom compost mulch and application of organic formulation F_2). Whereas, maximum time was recorded in the interaction, $M_0 \times F_1$ (i.e. unmulched plots with control treatment) during both the flushes. Mulch creates conducive root zone environment besides increasing the soil temperature that led to early maturing of plants. The results are in close proximity with the findings of Bohra *et al.*, (2016). Also, Usman *et al.*, (2005) had reported parallel results by using straw mulch. Moreover, the application of biofertilizers *viz.*, *Trichoderma* might have helped in uptake of micronutrients and provided essential plant growth promoting substances which stimulated early plant growth and early flowering as well. The results are in accordance with the findings of Dubey *et al.*, (2008) in gladiolus.

Duration of flowering

The data in Table 3 elucidated maximum duration of flowering (27.77 & 28.14 days) in both the flushes, when mulched with spent mushroom compost (M_1). Among the formulations, maximum flowering duration (27.62 & 28.18 days) was observed with F_2 (i.e. drenching of Consort NPK @ 1.8g + Benefit @ 7.5 ml in 750 ml/m² at 20-25 days interval and spraying of Bio Nematone @ 7.5 ml + Bio Cure F @ 7.5 ml in 750 ml of water and Grow Care WS @ 3.75 g + Microfood @ 2.5 ml + Green Miracle @ 2.5 ml + PEPTO @ 1 ml in 1 litre of water). The interaction of mulching \times organic formulations was found to be non-significant.

The longest duration of flowering due to combined effects of mulching with spent mushroom compost mulch and organic formulation F_2 may be as a consequence of positive role of mulching to ensure no weeds as well as nutrients supplied by the organic formulation F_2 . Consequently, the plants kept on developing quality shoots which later on became reproductive in phased manner. Hence, resulting in more duration of flowering. Similar findings were reported by Bohra *et al.*, (2016) in rose under mulched plots, Gangadharan and

Gopinath (2000), Godse *et al.*, (2006) and Dalve *et al.*, (2009) in gladiolus.

Vase life

An inquisition of data (Table 3) indicated that the cut flowers harvested from the plants mulched with M_1 (spent mushroom compost) exhibited maximum vase life (16.16 & 22.20 days) in first and second flush, respectively. Similarly, vase life of cut stems was recorded to be longest (17.11 & 22.90 days) when obtained from the plants fertilized with organic formulation F_2 (i.e. drenching of Consort NPK @ 1.8g + Benefit @ 7.5 ml in 750 ml/m² at 20-25 days interval and spraying of Bio Nematone + Bio Cure F @ 7.5 ml each in 750 ml of water and Grow Care WS @ 3.75 g + Microfood @ 2.5 ml + Green Miracle @ 2.5 ml + PEPTO @ 1 ml in 1 litre of water at 20-25 days interval) during both the flushes. The conjoint use of mulching and organic formulations exhibited maximum vase life (17.83 & 23.53 days) of cut flower carnation in the interaction, $M_1 \times F_2$ (i.e. mulching of plants with spent mushroom compost mulch and application of organic mulch F_2) during both the flushes. The vase life of cut flower was reported to be highest when the cut flowers were taken from those plants mulched with spent mushroom compost and treated with organic formulation F_2 which could be due to the positive role of combined effects of spent mushroom compost as mulch material and feeding the plants with F_2 in enhancing the plant growth and exhibiting the production of better quality cut blooms. Use of mulches help in checking any weed invasion to reduce the nutrient losses due to better weed control and improve the hydrothermal regimes of soil. So much so, the application of organic formulations has ensured the supply and uptake of nutrients on sustainable basis resulting in better growth and development of plants. The plants exhibited better flowering and ultimately produced best quality blooms. Accordingly, the cut blooms were sturdy, longer and exhibited higher weight comparatively. These cut flowers when placed in the vases remained fresh and attractive for longer period (Bohra *et al.*, 2016).

Based on research work, it can be concluded that cut flowers with best growth, yield and quality were obtained from the plants mulched with spent mushroom compost and treated with organic formulation F₂. Hence, it can be recommended for commercial production.

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