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Growth and yield parameters of rose as influenced by different organic manures and their levels

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Abstract
A field experiment was conducted to study the influence of different organic manures and their levels on growth and yield parameters of rose at Deen Dayal Upadhyay Center of Excellence for Organic Farming, CCS Haryana Agricultural University, Hisar during 2020-21. This experiment consisted of three organic manures viz., farmyard manure (FYM), vermicompost and poultry manure with four levels of organic manures viz., control (0 kg/m^2), 4 kg/m^2, 5 kg/m^2 and 6 kg/m^2. It was laid out in split plot design with twelve treatments and three replications. Results revealed that the maximum values in terms of plant height (98.70 cm), plant spread (66.50 cm), number of branches per plant (6.20), stem diameter (2.44 cm), number of leaves per branch (81.19), flower yield per m^2 (0.86 kg) and flower yield per hectare (86.39 q) were recorded with 5 kg/m^2 level of vermicompost. Hence, it may be concluded that the application of 5 kg/m^2 vermicompost was found to have a pronounced effect on maximizing growth and yield parameters of rose.

Keywords: FYM, vermicompost, poultry manure, growth, yield, rose

1. Introduction
Rose is a commercially important flower crop and belongs to the Rosaceae family. It occupies a prime position in domestic as well as global florist trade due to its delicate flowers of attractive shape having brilliant color, majestic fragrance and excellent keeping quality. *Rosa bourboniana* Desportes; commonly known as *Desi Gulaab*, bourbon rose and Rose Edouard or Edward rose. It is a vigorous shrub having fragrant flowers of deep pink colour with a purplish hue. It flowers profusely for a longer duration. Its essential oil content varies from 0.015% to 0.017% (Sood and Nagar, 2004 and Kumar *et al*., 2014) [16, 3]. It is cultivated throughout India; mainly for loose flowers, cut flowers, rose water, *gulkand*, essential oil and rootstock purpose. It is also suitable for garden decoration and landscaping purposes due to its easy culture and profuse blooming habit. Plant nutrients play an important role in the overall growth and development of rose. Its production mainly depends on the nutrient availability status of the soil as it is a perennial crop. Common organic manures like farmyard manure, vermicompost and poultry manure are good reservoirs of readily available plant nutrients and easily available to the grower. Farmyard manure supplies all essential plant nutrients that are vital for plant growth and improves the overall soil health by positively affecting the physical, chemical and biological properties of the soil. It is also a good source of organic carbon that activates the biotic life of the soil flora and fauna (Kumar *et al*., 2021) [4]. Application of farmyard manure significantly increased the saturated hydraulic conductivity and reduced bulk density of soil (Khan *et al*., 2010) [2]. Vermicompost contains plant growth hormones and high levels of soil enzymes that enhance the population of beneficial microbes and nutrient availability to the plant for a longer time (Ndegwa *et al*., 2000) [6]. Poultry manure is a rich source of organic matter content combined with easily available nutrients for plant growth. It is an excellent soil amendment that provides nutrients for growing crops and improves soil quality when applied wisely. Application of poultry wastes improves soil properties, but it also increases soil salinity. Cockerel waste had the highest effect on the physical and biological properties, while the layer waste had the highest effect on the chemical properties of the soil. Out of different types of poultry waste; cockerel waste was found best because it had the ability to increase the porosity and organic matter content of soil (Alabadan *et al*., 2009) [1]. The soil of Haryana is sandy to clay loam in texture having an alkaline reaction with high pH. In such type of soil; growing roses to sustain the productivity and maintain the quality of the flower is a difficult task. Regular use of inorganic fertilizers and chemicals leads to soil degradation.

Rose flowers of better quality can be obtained by application of organic manures as it helps in increasing the maximum water holding capacity, hydraulic conductivity and porosity of the soil. Organic manures play an important role in improving nutrient use efficiency, yield and quality of flowers (Marak *et al*., 2020) [5]. Keeping in view the above facts, this field experiment was conducted with an objective to study the influence of different organic manures and their levels on the growth and yield parameters of rose.

2. Materials and Methods

This experiment was conducted at Deen Dayal Upadhayay Centre of Excellence for Organic Farming, Chaudhary Charan Singh Haryana Agricultural University, Hisar (Haryana) during 2020-21. The climate of the Hisar region is semi-arid with hot and dry summer and extremely cold winter. Around 80% of annual precipitation (about 450 mm) is received from July to September and the remaining 20% of annual precipitation is received from December to February. The precipitation is highly inconsistent with 20-30% annual and 30-50% seasonal variations. This experiment consisted of three organic manures *viz*., farmyard manure (FYM), vermicompost and poultry manure with four levels of organic manures *viz*., 0 kg/m^2 (control), 4 kg/m^2, 5 kg/m^2 and 6 kg/m^2. It was laid out in split plot design with twelve treatments and three replications. The field was prepared well in advance by ploughing and harrowing and brought to a fine tilth by proper leveling. The soil of the experimental field was loamy in texture and basic in reaction. It had high availability of organic carbon, available phosphorus and available potassium but low availability of nitrogen. One year old plants of rose *(Rosa bourboniana*) were procured from a nursery located near Hisar. Organic manures *viz*., FYM, vermicompost and poultry manure used in this experiment were taken from the Department of Agronomy and DDUCE-OF, CCS Haryana Agricultural University, Hisar. FYM, vermicompost and poultry manure were mixed in soil according to the treatment combination in the respective plots before two weeks of planting. Planting of rose was done at a spacing of 75 cm × 60 cm in plots of 2.25 m x 1.80 m size on 17th September 2020 followed by light irrigation. Irrigation was applied by flood irrigation method as per crop requirement. Five representative plants were selected and tagged in each plot for recording data on various growth and yield parameters. All recorded data were subjected to statistical analysis with split plot design (SPD) for analysis of variance (ANOVA) with the help of OPSTAT software (Sheoran *et al*., 1998) [12].

3. Results and Discussion

3.1 Growth Parameters

Organic manures had exerted a significant effect on all growth parameters viz., plant height, plant spread, number of branches per plant, stem diameter and number of leaves per branch as evident from the data presented in Table 1 to 5. The maximum plant height (89.55 cm) was recorded with vermicompost significantly followed by poultry manure (83.65 cm) and the minimum plant height (80.58 cm) was recorded in farmyard manure (Table 1). The maximum plant spread (62.20 cm) and stem diameter (2.13 cm) was recorded with vermicompost, which was found statistically at par with poultry manure (61.95 cm and 2.10 cm, respectively), however, the minimum plant spread (58.96 cm) and stem diameter (1.91 cm) was recorded in the treatment comprising farmyard manure (Table 2 and 5). The maximum number of branches per plant (5.72) was recorded with vermicompost application and the minimum number of branches per plant (5.34) was recorded in farmyard manure treatment, which was found at par with poultry manure treatment (5.50) (Table 3). It may be because vermicompost act as a good source of macronutrients as well as micronutrients and enhanced vegetative growth. Vermicompost significantly augmented soil enzymatic activities and beneficial microbes that ultimately resulted in to increase in various growth parameters like plant height, plant spread, number of branches per plant and stem diameter. Similar findings were observed by Patel *et al*. (2017) [8] and Sendhilnathan *et al*. (2019b) [10] in rose. These results are in consonance with the findings of Singh *et al.* (2015) [15] in marigold and Sendhilnathan *et al.* (2017) [11] in *Jasminum sambac*. In case of number of leaves per branch; the maximum value (71.33) was recorded with poultry manure treatment followed by vermicompost treatment (69.99) among various organic manures, however, the minimum value (64.80) was obtained in farmyard manure treatment (Table 4). This increase in the number of leaves per plant in poultry manure treatment; might be since poultry manure increased the water holding capacity of the soil, which improved the soil microbial activity and availability of micronutrients. Similar results were obtained by Singh *et al*. (2006) [14] in rose cv. Gruss-an-Teplitz.

Table 1: Influence of different organic manures and their levels on plant height (cm) of rose

Treatments	**Level of organic manure (L)**				
Organic manure (M)	**Control (0 kg/m^2)**	**4 kg/m^2**	**5 kg/m^2**	**6 kg/m^2**	**Mean**
Farmyard manure (FYM)	73.30	76.20	84.50	88.30	80.58
Vermicompost	76.00	86.30	98.70	97.20	89.55
Poultry manure	76.00	80.80	88.30	89.50	83.65
Mean	75.10	81.10	90.50	91.67	
C.D. (P = 0.05)	Organic manure (M) = 0.79				
	Level of organic manure (L) = 0.84				
	Factor L at same level of M = 1.55				
	Factor M at same level of L = 1.48				

Table 2: Influence of different organic manures and their levels on plant spread (cm) of rose

Treatments	**Level of organic manure (L)**				
Organic manure (M)	Control (0 kg/m^2)	4 kg/m^2	5 kg/m^2	6 kg/m^2	Mean
Farmyard manure (FYM)	53.50	59.50	61.10	61.74	58.96
Vermicompost	55.50	60.80	66.50	66.00	62.20
Poultry manure	56.30	63.50	64.90	63.10	61.95

Mean	55.10	61.27	64.17	63.61	
C.D. (P = 0.05)	Organic manure (M) = 1.01				
	Level of organic manure (L) = 0.82				
	Factor L at same level of M = 1.55				
	Factor M at same level of L = 1.58				

Plant height increased significantly with every increase in the level of organic manures. The maximum plant height (91.67 cm) was recorded with 6 kg/m^2 level and the minimum plant height (75.10 cm) was recorded from the control (Table 1). Stem diameter and number of leaves per branch increased significantly with the increasing dose of organic manures up to the level of 5 kg/m^2 thereafter a slight but significant decrease in all these growth parameters was recorded at 6 kg/m^2 level. Application of 5 kg/m^2 level of organic manures resulted in the highest values in terms of number of leaves per branch by 6 kg/m^2 level (73.88 and 2.23 cm, respectively). However, the lowest values for number of leaves per branch (55.63) and stem diameter (1.65 cm) were obtained in control (Table 4 and 5). Plant spread and number of branches per plant increased significantly with every increase in the level of organic manures from control (0 kg/m^2) to 5 kg/m^2 but thereafter a slight non-significant decrease in these growth parameters was recorded at 6 kg/m^2 level. Among various levels of organic manures, the maximum values in terms of plant spread (64.17 cm) and number of branches per plant (5.83) were recorded when 5 kg/m^2 level was applied, which was found at par with 6 kg/m^2 level (63.61 cm and 5.75, respectively). However, the minimum plant spread (55.10 cm) and number of branches per plant (5.07) was obtained in control (Table 2 and 3). It may be because organic manure application increased the readily available nitrogen in the soil, which enhanced plant metabolic activities and thus increased various growth parameters. These results are in line with the findings of Olubode *et al*. (2015) [7] and Sendhilnathan *et al.* (2019b) [10] in rose.

Table 3: Influence of different organic manures and their levels on number of branches per plant in rose

Treatments	**Level of organic manure (L)**				
Organic manure (M)	**Control (0 kg/m^2)**	**4 kg/m^2**	**5 kg/m^2**	**6 kg/m^2**	**Mean**
Farmyard manure (FYM)	5.20	5.30	5.40	5.45	5.34
Vermicompost	5.10	5.60	6.20	6.00	5.72
Poultry manure	4.90	5.40	5.90	5.80	5.50
Mean	5.07	5.43	5.83	5.75	
C.D. (P = 0.05)	Organic manure (M) = 0.17				
	Level of organic manure (L) = 0.14				
	Factor L at same level of M = 0.28				
	Factor M at same level of L = 0.28				

Table 4: Influence of different organic manures and their levels on number of leaves per branch in rose

Treatments	**Level of organic manure (L)**				
Organic manure (M)	**Control (0 kg/m^2)**	**4 kg/m^2**	**5 kg/m^2**	**6 kg/m^2**	**Mean**
Farmyard manure (FYM)	54.60	60.90	70.37	73.33	64.80
Vermicompost	54.90	70.75	81.19	73.12	69.99
Poultry manure	57.40	72.65	80.08	75.20	71.33
Mean	55.63	68.10	77.21	73.88	
C.D. (P = 0.05)	Organic manure (M) = 0.92				
	Level of organic manure (L) = 0.74				
	Factor L at same level of M = 1.41				
	Factor M at same level of L = 1.43				

Interaction amidst organic manures and their levels was found significant in influencing plant height, plant spread, number of branches per plant, number of leaves per branch and stem diameter (Table 1 to 5). Among all the levels of different organic manures, application of 5 kg/m^2 vermicompost resulted in the maximum plant height (98.70 cm), plant spread (66.50 cm) and number of branches (6.20), which was found statistically at par with 6 kg/m^2 level of vermicompost (97.20 cm, 66.00 cm and 6.00, respectively). Likewise, the maximum stem diameter (2.44 cm) and number of leaves per branch (81.19) were obtained with 5 kg/m^2 level of vermicompost followed by the same level of poultry manure (2.42 cm and 80.08, respectively). It may be due to the increase in beneficial soil microorganisms, humic materials and plant growth promoting substances by application of the required amount of vermicompost that ultimately promoted the plant growth. These results are in harmony with the findings of Sendhilnathan *et al.* (2019a) [9] in celosia. Among all levels of farmyard manure; the maximum plant height (88.30 cm) and number of leaves per branch (73.33) were recorded when 6 kg/m^2 level of farmyard manure was applied and the minimum (73.30 cm and 54.60, respectively) was recorded in control (Table 1 and 4). Likewise; the maximum plant spread (61.74 cm) was recorded at 6 kg/m^2 level of farmyard manure followed by 5 kg/m^2 level of farmyard manure (61.10 cm) and minimum plant spread (53.50 cm) was recorded in control (Table 2). However, the maximum stem diameter (2.15 cm) was obtained with 5 kg/m^2 level of farmyard manure followed by 6 kg/m^2 level of farmyard manure (2.09 cm) and the minimum stem diameter (1.58 cm) was recorded in control (Table 5). All farmyard manure levels were found at par with each other in influencing the number of branches per plant. However, the maximum number of branches per plant (5.45) was recorded when 6 kg/m^2 level of farmyard manure was applied and the minimum number of branches per plant (5.20) was recorded from the control (Table 3). In case of vermicompost; the maximum plant height (98.70 cm), maximum plant spread (66.50 cm) and maximum number of

branches (6.20) were obtained by application of 5 kg/m^2 level followed by 6 kg/m^2 level (97.20 cm, 66.00 cm and 6.00, respectively) and the minimum (76.00 cm, 55.50 cm and 5.10, respectively) was recorded in control (Table 1 to 3). Likewise, the maximum number of leaves per branch (81.19) and stem diameter (2.44 cm) were also obtained with 5 kg/m^2 level and the minimum (54.90 and 1.66 cm, respectively) in control of vermicompost (Table 4 and 5). Concerning poultry manure; the maximum plant height (89.50 cm) was obtained at 6 kg/m^2 level followed by 5 kg/m^2 level (88.30 cm) and minimum plant height was found in the control (76.00 cm) (Table 1). However, the maximum plant spread was obtained with 5 kg/m^2 level (64.90 cm) followed by 4 kg/m^2 (63.50 cm) and the minimum plant spread (56.30 cm) was observed in the control of poultry manure (Table 2). Similarly, the maximum number of leaves per branch (80.08) and maximum stem diameter (2.42 cm) were obtained with 5 kg/m^2 level of poultry manure, whereas the minimum (57.40 and 1.70 cm, respectively) was recorded in control (Table 4 and 5). Furthermore, the maximum number of branches per plant (5.90) was recorded with the use of 5 kg/m^2 level followed by 6 kg/m^2 level (5.80) and the minimum (4.90) was recorded in control among different levels of poultry manure (Table 3).

Table 5: Influence of different organic manures and their levels on stem diameter (cm) of rose

Treatments	Level of organic manure (L)				
Organic manure (M)	Control (0 kg/m^2)	4 kg/m^2	5 kg/m^2	6 kg/m^2	Mean
Farmyard manure (FYM)	1.58	1.83	2.15	2.09	1.91
Vermicompost	1.66	2.08	2.44	2.32	2.13
Poultry manure	1.70	2.01	2.42	2.27	2.10
Mean	1.65	1.97	2.34	2.23	
C.D. (P= 0.05)	Organic manure (M) = 0.05				
	Level of organic manure (L) = 0.05				
	Factor L at same level of M = 0.09				
	Factor M at same level of L = 0.09				

3.2 Yield parameters

All Organic manures had exerted a significant influence on flower yield per m^2 as well as flower yield per hectare (Table 6 and 7). The maximum values in terms of flower yield per m^2 (0.68 kg) and flower yield per hectare (68.06 q) were recorded with vermicompost application followed by poultry manure application (0.65 kg and 65.38 q, respectively). However, the minimum flower yield per m^2 (0.55 kg) and flower yield per hectare (55.43 q) was recorded with farmyard manure application. The improvement in all yield parameters could be related to the fact that vermicompost application improved the level of growth promoting chemicals and nutrient availability in the soil to plant system, resulting in greater nutrient uptake and accumulation of more photosynthates in the plant. Similar findings were reported by Patel *et al*. (2017) [8] in rose cv. Gladiator. These results are also in confirmation with the findings of Singh *et al.* (2015) [15] in marigold, Sendhilnathan *et al*. (2017) [11] in *Jasminum sambac* and Sendhilnathan *et al.* (2019a) [9] in Celosia. The flower yield per m^2 and flower yield per hectare increased significantly with the increasing level of organic manures up to 5 kg/m^2 but thereafter a significant decrease in these yield parameters was recorded at 6 kg/m^2 level (Table 6 and 7). Application of organic manures at 5 kg/m^2 level resulted in maximum flower yield per m^2 (0.76 kg) and maximum flower yield per hectare (75.75 q) followed by organic manures applied at 6 kg/m^2 level (0.74 kg and 73.68 q, respectively). Though, the minimum flower yield per m^2 (0.41 kg) and flower yield per hectare (41.41q) was recorded in control. This increase in flower yield might have occurred due to better nutrient availability and improved carbon to nitrogen (C/N) ratio of soil by organic manures application. Similar findings were obtained by Singh (2006) [13] and Olubode *et al*. (2015) [7] in rose.

Table 6: Influence of different organic manures and their levels on flower yield per m^2 (kg) in rose

Treatments	Level of organic manure (L)				
Organic manure (M)	**Control (0 kg/m^2)**	**4 kg/m^2**	**5 kg/m^2**	**6 kg/m^2**	**Mean**
Farmyard manure (FYM)	0.40	0.50	0.63	0.69	0.55
Vermicompost	0.43	0.62	0.86	0.81	0.68
Poultry manure	0.42	0.70	0.78	0.72	0.65
Mean	0.41	0.61	0.76	0.74	
C.D. (P= 0.05)	Organic manure (M) = 0.01				
	Level of organic manure (L) = 0.01				
	Factor L at same level of M = 0.02				
	Factor M at same level of L = 0.02				

Interaction between organic manures and their levels was found significant in influencing the flower yield per m^2 and flower yield per hectare (Table 6 - 7). Application of 5 kg/m^2 vermicompost resulted in the maximum flower yield per m^2 (0.86 kg) and flower yield per hectare (86.39 q). It may be due to the fact that more carbohydrates are assimilated as a result of vermicompost use as it provides an optimum dose of nutrients. Farmyard manure, vermicompost and poultry manure differed significantly in influencing the flower yield per m^2 as well as flower yield per hectare at all the levels of their application. These results are in close conformity with the findings of Singh (2006) [13] and Sendhilnathan *et al*. (2019b) [10] in rose.

Table 7: Effect of different organic manures and their levels on flower yield per hectare (q) in rose

Treatments	Level of organic manure (L)				
Organic manure (M)	Control (0 kg/m^2)	4 kg/m^2	5 kg/m^2	6 kg/m^2	Mean
Farmyard manure (FYM)	39.55	50.15	63.34	68.68	55.43
Vermicompost	42.82	62.37	86.39	80.67	68.06
Poultry manure	41.86	70.49	77.51	71.68	65.38
Mean	41.41	61.01	75.75	73.68	
C.D. (P= 0.05)	Organic manure (M) = 1.20				
	Level of organic manure (L) = 0.75				
	Factor L at same level of M = 1.49				
	Factor M at same level of L = 1.67				

4. Conclusion

It is concluded from the present investigation that soil application of vermicompost at the level of 5 kg/m^2 could be considered the best treatment combination for maximizing growth and yield in rose under open cultivation. The maximum values in terms of various growth parameters like plant height (98.70 cm), plant spread (66.50 cm), number of branches per plant (6.20), number of leaves per branch (81.19) and stem diameter (2.44 cm) were recorded with 5 kg/m^2 level of vermicompost. This treatment combination was also found promising in terms of flower yield per m^2 (0.86 kg) as well as flower yield per hectare (86.39 q).

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