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Research Article

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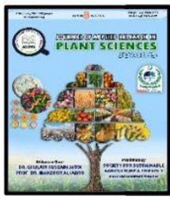

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Effect of Substrate, Growth Condition and Nutrient Application Methods in Morphological and Commercial Attributes of Hybrid Rose (*Rosa indica* L.) Cv. Kardinal

Munawar Hussain Almas[1], Riaz Ali Shah[2], Syed Muhammad Hamayun Tahir[2], Mujahid Manzoor[3*], Muhammad Shafiq[4], Monis Hussain Shah[1], Muhammad Muneeb Hashmi[4], Mobeen Ali[4], Muhammad Hamza Tariq Bhatti[3], Adnan Sami[4], Muhammad Saleem Haider[5]

[1]Directorate of Floriculture (Training and Research), Punjab, Lahore, Pakistan
[2]Horticultural Research Institute for Floriculture and Landscaping, Murree Road, Islamabad, Pakistan
[3]Department of Entomology, Faculty of Agricultural Sciences, University of the Punjab, Lahore, Pakistan
[4]Department of Horticulture, Faculty of Agricultural Sciences, University of the Punjab, Lahore, Pakistan
[5]Department of Plant Pathology, Faculty of Agricultural Sciences, University of the Punjab, Lahore, Pakistan
Corresponding author's email: mujahid.iags@pu.edu.pk.

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Abstract

Rose is an important plant around the world. Different rose varieties have been introduced for its commercial production around the world. That's why, its important to standardize and see the best soil or soilless substrate for better production of commercial cut-flowers of Rose. Soil substrates including partial shade with 70% sunlight and open sun light were used to observe the better commercial production of Rose. The balance fertilizer was applied in both A: Foliar spray (300:300:300 ppm of NPK) along with the various soil substrates of Garden Soil, Perlits and Coco coir dust (GS: PR: CCD; 1:1:1), Garden soil and Leaves compost (GS:LC; 1:1), Garden soil and Perlits (GS: PR) (100%) and Farm Yard Manure, Silt and Leaf compost (FYM: SL: LC; 1:1:1). Distilled water was used as liquid substrate for foliar application. The other nutrient application process was B: soil application of macro nutrient (2g/L of 17:17:17-NPK) along with GS: PR: CCD (1:1:1), GS: LC (1:1), GS: PR (100%) and FYM: SL: CL (1:1:1). The performance of plants was observed by observing the attributes such as Plant survival (%), Number of flowers per plant, flower stem length (cm), Plant health (Number of leaves, leaf size (cm), Flower diameter (mm), Flower stem size (mm) and Flower stem diameter (mm). Completely randomized experimental design (CRD) was used for calculating means of various treatments. The best treatment was FYM: SL: CL for both under partial shade (70%) and open sun light for the significant growth of rose cut flowers.

Keywords: *Foliar, Fertigation, Nutrients, Substrate, Rose, Soil and Soilless*

Introduction

Rose (*Rosa indica* L.) is the most famous in Pakistan and all around the globe. The family *Rosaceae* includes plants that form erect shrubs. It's difficult to find any event where Roses are not used. According to a survey, cut roses are produced on 1300 acres in the province of Punjab (Ahmad, 2009). Presently, 1000 genotypes are familiar to mankind classified as hybrid teas, polyanthus, miniatures, grandifloras, and shrubs. (Terry *et al.*, 2021) Rose petals, buds, and hips have been used as a tea for 4000 years in the Chinese pharmacopeia. The rose hips are rich in vitamin C however it is difficult to isolate after drying and processing. Rose petals are processed as Gulkand used widely as Indian indigenous medicine for cough and throat infections (Nanda and Das, 2015). The use of Roses for beautification is found in Egyptian, Roman, and other prehistoric and historic civilizations (Conner, 2016). The cut flower industry of Punjab is getting prominent day by day. Factors like demand of high quality of cut flower, awareness among people, potential for high return investments and usage for decorative purpose all led it towards the increased rate of production of roses. (Ahmad *et al.*, 2010) The production and cultivation of rose in Pakistan is effected by multiple factors e.g. Infrastructure and facilities for post-harvest, Skilled manpower for Research and Development, professional training facilities for farmers, modern production, propagation, and handling techniques (In vitro response of different cultivars), and lack of standardized production technology with complete guidance about sowing time, post planting care and optimum growing substrate. The yield-limiting factors of hybrid Rose are delayed flowering, small size of flowers, petal drop, less number of flowers on a plant, good plant health, and attractive color of the bloom. The better substrate can enhance the productivity and economical yield of roses. Many chemical and non-chemical approaches along with low storage temperature are being used to make cut flowers last longer or improving their vase life. (Mohammadi *et al.*, 2021) cut flowers were sensitive to exogenous ethylene, manifested in color fading and wilting of sepal tips, induction of anthocyanin formation in female reproductive parts, and floret abscission. (Wongjunta *et al.*, 2021)The present research trial was based on testing the internationally significant growing substrate and fertigation scheme in the most abundantly grown variety of cv. Kardinal for the economic yield of plants.

Material and Methods

The cultivar (Kardinal) was used for the present research that was purchased from the commercial plant sale market of Islamabad. The research was conducted in pots of 14 inches. There were two growing conditions one in Partial shade (70%) and other in open sun light. In each growing condition Foliar and soil application of macro nutrients were applied. The balance fertilizer was applied in both **A:** Foliar spray (300:300:300 ppm of NPK) along with the various soil substrates of GS: PR: CCD (1:1:1), GS: LC (1:1), GS: PR (100%) and FYM: SL: CL (1:1:1). The liquid substrate was distilled water for foliar application. The foliar application was done after each day. The other nutrient application process was **B:** soil application of macro nutrient (2g/L of 17:17:17-NPK) along with GS: PR: CCD (1:1:1), GS: LC (1:1), GS: PR (100%) and FYM: SL: CL (1:1:1). Each plant was saturated with 2 days interval. The fertigation was carried by mixing above mentioned fertilizer with the canal water having EC: 0.4 dSm-1 and pH: 6.9 pH. The performance of plants was observed by observing the attributes such as Plant survival (%), Number of flowers/Plant, Flowers stem length (cm), Plant health (Number of leaves, leaf size (cm), Flower diameter (mm), Flower stem size (mm) and Flower stem diameter (mm). to observing the variation amongst various treatments completely randomized experimental design (CRD) was used for calculating means (Steel *et al.*, 1980).

Results:

Mean response of cv. Kardinal for fertigation, foliar application and substrate under Partial shade (70%):

The self-explanatory table (<0.05) showed the results that conventional substrate consisting on FYM: SL: CL (1:1:1) with soil application of balance fertilizer with irrigation water (2g/L-NPK (17:17:17)) showed better results compared with soil less substrates such as Control, GS: PR: CCD (1:1:1) and GS: LC (1:1). Foliar application of 300 ppm NPK showed better response of cv. Kardinal for early sprouting of plants (15.67 days), better plant survival rate (100%), Flower stem length (33.80cm), better plant health (Dense foliage), better leaf growth length (3.93cm) and width (5.53cm), better development of flower size (9.53mm), better flower stem diameter (4.73mm) and Number of flowers/plant (10 Nos.) compared with control and other soilless substrates (Table 1). The plants of cv. Kardinal showed better response in conventional soil substrates FYM: SL: CL (1:1:1) with Foliar application (300:300:300 ppm-NPK) against soilless substrates of GS: PR: CCD (1:1:1) and GS: LC (1:1) with fertigation of 2g/L of NPK (17:17:17) balance fertilizer. The cv. Kardinal showed early sprouting of plants (15.00 days) after fall, better plant survival rate (100%), Flower stem length (41.07cm), better plant health (Dense foliage), better leaf growth length (3.90cm) and width (3.63cm), better development of flower size (8.94mm), better flower stem diameter (4.50mm) and Number of flowers/plant (10 Nos.) compared with control and other soilless substrates (Table 1).

Mean response of cv. Kardinal for fertigation, foliar application and substrate in open sunlight light: The self-explanatory table (<0.05) showed the results that conventional substrate consisting on FYM: SL: CL (1:1:1) with soil application of balance fertilizer with irrigation water (2g/L-NPK (17:17:17)) showed better results compared with soil less substrates such as Control, GS: PR: CCD (1:1:1) and GS: LC (1:1). Foliar application of 300 ppm NPK showed better response of cultivar Kardinal for early sprouting of plants (11.30 days), better plant survival rate (100%), Flower stem length (42.87cm), better plant health (Dense foliage), better leaf growth wise leaf length (4.73cm) and width (4.37cm), better development of flower size (11.08mm), better flower stem diameter (5.43mm) and Number of flowers/plant (16 Nos.) compared with control and other soilless substrates (Table 2). The plants of cv. Kardinal showed better response in conventional soil substrates FYM: SL: CL (1:1:1) with Foliar application (300:300:300 ppm-NPK) against soilless substrates of GS: PR: CCD (1:1:1) and GS: LC (1:1) with fertigation of 2g/L of NPK (17:17:17) balance fertilizer. The cv. Kardinal showed early sprouting of plants (10.67 days) after fall, better plant survival rate (100%), Flower stem length (48.80cm), better plant health (Dense foliage), better leaf length (4.37cm) and width (4.03cm), better development of flower size (10.19 mm), better flower stem diameter (5.43mm) and Number of flowers/plant (16.67 Nos.) compared with control and other soilless substrates (Table 2).

Comparison amongst green net and open field conditions of cultivar kardinal: The results showed a significantly better growth and development in plants that were placed in open sky or under solar irradiation compared with under green net shade as well with (P-value <0.05). The plants showed better growth when nutrients were applied in soil compared with foliar application of macro nutrients. The plants showed early sprouting (18.91 days), better plant survival (100%), Flower stem length (32.90cm), growth volume was observed better (Dense), enlarged leaf size (length) (3.53cm), better leaf size (width) (3.23), better flower diameter (9.11cm), better flower stem diameter (3.72cm) and better number of flowers (11.30/Plant). The better plant growth and development was recorded in solar irradiation (open sky condition), the better and early growth was started (18.11 Days), better plant survival (100%), better flower stem length (36.61cm), plant growth was potential was better (Dense), better leaf size (large) (3.60cm), Better leaf size (width) (3.20cm), better flower size (9.71cm), better stem diameter (4.41cm) and better number of flowers/Plant (13.20 Nos.) (Table 3).

Discussion:

In ornamental plants, formula fertilization is important for enhancing the consumption rate of elements, soil structure quality, plant yield, and quality attributes. Due to that, it is important to know the targeted fertilizer quantity for sustainable agricultural development and environmental protection. Achieving high yields and acceptable quality of Rose flowers demands optimum nutrient applications to the plants (Franco-Hermida *et al.*, 2017). Supply of macronutrients in balance amount promote high yield, acceptable quality, cold resilience, and intact postharvest physiology in Rose (Breś, 2009). Nitrogen (N), Phosphorous (P), and Potassium (K) tend to be excessively applied by growers through fertigation that promotes nutrient balance and produces a high yield (Franco-Hermida *et al.*, 2017). Limiting the application of fertilization imply negatively affects plant growth and marketable produce. Unbalancing of nutrient concentrations around 50% and 33% from optimum level (10.7 and 3.2 meq L^{-1} of N and K, respectively) reduced the number of flowering stems with the increased number of blind shoots in *Rosa hybrida* cv. Tropicana (Chow *et al.*, 2009).

Plant physiologists consider soil as a source of nutrients for plants. Soil is a complex ecosystem that provides a niche for protists, bacteria, fungi, and animals (Kuligowska *et al.*, 2016). Plants are involved in diverse interactions with these soil-dwelling microbiota, which fully depend on ecological possibilities (competitive, exploitative, neutral, commensal, and mutualistic). In agriculture research generally, techniques are developed for the removal of pathogens from the ecological system of plants (Cui *et al.*, 2013) or in the other way such as abiotic stresses (Meena *et al.*, 2017). The microbes in the soil such as fungi and bacteria promote the absorption of applied nutrients. Mycorrhizal fungi and bacteria in nodulated legumes were recognized as root symbionts. Three mechanisms describe how microbial activity can promote plant growth: i. Altering the hormonal signaling in plants (Akbar *et al.*, 2022); ii. Promoting resilience against pathogenic microbial strains by repelling and out-competing (Méndez-Vigo *et al.*, 2013); iii. Increasing soil-borne nutrients through bioactivity of bacteria and other microbes (Jansen *et al.*, 2012). The Same trends were also observed during the present study when rose plants in soil-less substrates did not perform well compared with soil substrates.

Beneficial microbes found abundantly in soil and around the plant roots like rhizosphere (Romero Navarro *et al.*, 2017). The soil-less mediums/substrates are gaining popularity nowadays. Soilless agriculture is famous due to; it eliminates soil-borne diseases and issues (Boutigny *et al.*, 2020). Studies also describe that fungi such as *Fusarium spp.* are seen to be colonized in roots grown in a coconut-fiber system (organic medium) and other organic substrates. *Pythium spp.* Has also been generally detected in nutrient solutions and on roots penetrated into the organic substrates. Non-specific bacterial genera such as aerobic bacteria are seemed predominant in roots as well as in nutrient solutions. Fluorescent pseudomonas were also frequently detected in roots and in nutrient solutions (Vallance *et al.*, 2011). The nutrient availability is less in soil-less substrate compared with the soil. That's why it is concluded that plant morphological characteristics such as leaf size, the number of leaves and economic yield showed better results in soil as compared to soil-less substrates (Sakhalkar *et al.*, 2022)

Table 1: Mean response of cv. Kardinal for fertigation, foliar application and substrate under partial shade (70%)

Attributes	**Soil Application (2g/L of Balance fertilizer N: P: K (17:17:17))**		**Foliar Application (300:300:300 ppm N:P:K)**						**Control**
	GS:PR:CCD	**GS: LC**	**GS: PR (1:1)**	**FYM: SL: CL**	**GS:PR:CCD**	**GS: LC**	**GS: PR (1:1)**	**FYM: SL: CL**	**Garden Soil**
Number of Days for new branches	23.33±3.42*	24.00±4.31**	17.33±2.32*	15.67±2.12*	26.00±4.42*	24.33±5.43*	15.77±2.12**	15.00±2.32*	29.49±2.33^{NS}
Plant survival (%)	100.00±8.91**	100.00±7.61*	100.00±2.32*	100.00±7.66*	100.00±9.63*	100.00±9.34*	100.00±11.23*	100.00±11.22*	90.00±12.34^{NS}
Flowers stem length (cm)	25.67±4.12*	28.87±3.40*	33.27±2.89*	33.80±3.12*	24.97±3.21*	33.27±5.43*	33.57±3.53**	41.07±3.45*	19.45±2.45*
Plant health (Dense, Sparse)	Sparse	Sparse	Dense	Dense	Sparse	Sparse	Dense	Dense	Sparse
leaf size (length) (cm)	2.27±0.45*	2.90±0.56*	3.83±0.12*	3.93±0.12*	2.77±0.45**	2.67±0.45*	3.87±0.91*	3.90±0.45*	2.17±1.45^{NS}
leaf size (width) (cm)	2.00±0.12*	2.37±0.12*	3.43±0.56*	3.53±0.32*	2.50±0.12*	2.47±0.12*	3.47±0.66*	3.63±0.21**	1.89±0.73^{NS}
Flower diameter (cm)	8.19±0.34**	7.94±1.89*	6.65±1.67**	9.53±1.11*	8.29±2.14*	7.95±2.54*	6.62±1.56*	8.94±1.31*	5.68±1.87^{NS}
Flower stem diameter (cm)	2.53±2.41*	3.23±0.56*	3.10±0.56*	4.73±0.76*	3.13±0.45*	2.33±0.34*	4.10±0.67*	4.50±0.94*	2.39±0.98^{NS}
Number of flowers/Plant	8.67±2.12^{NS}	7.33±1.34**	10.33±2.45^{NS}	10.00±1.99*	8.67±1.33*	8.67±1.43*	10.00±1.56^{NS}	10.00±1.44*	7.45±1.23^{NS}

Garden Soil, Perlits & Coco coir dust (GS: PR: CCD)

Table 2 Mean response of cv. Kardinal for fertigation, foliar application and substrate in open light

Attributes	**Soil application 2g/L of Balance fertilizer N: P: K (17:17:17)**				**Foliar Application 300:300:300 ppm N:P:K**				**Compost**
	GS:PR:CCD	**GS: LC**	**GS: PR (1:1)**	**FYM: SL: CL**	**GS:PR:CCD**	**GS: LC**	**GS: PR (1:1)**	**FYM: SL: CL**	**Garden Soil**
Number of Days for new branches	21.13±3.34*	22.73±2.45**	15.87±2.35^{NS}	11.30±1.24^{NS}	22.77±3.23*	20.87±3.23*	14.77±2.34^{NS}	10.67±2.13**	22.6±0.32
Plant survival (%)	100.00±10.23**	100.00±9.22*	100.00±6.54^{NS}	100.00±14.33**	100.00±8.56**	100.00±7.98**	100.00±11.23	100.00±13.44*	100±0.43
Flowers stem length (cm)	30.13±3.56*	41.20±4.56^{NS}	39.13±2.76**	42.87±4.31^{NS}	27.00±2.31*	39.50±3.45*	38.57±3.23	48.80±3.98*	22.5±4.32
Plant health (dense, sparse)	Sparse	Sparse	Dense	Dense	Sparse	Sparse	Dense	Dense	Sparse
leaf size (length) (cm)	2.60±0.53**	3.13±0.98**	4.53±0.34*	4.73±0.98**	2.97±0.56*	3.03±0.89*	4.30±1.56	4.37±0.45*	2.67±0.56

leaf size (width) (cm)	1.93±0.34*	2.57±1.23*	4.07±0.71*	4.37±1.34*	2.60±0.34*	2.63±0.67**	3.37±1.23	4.03±0.41*	2.12±0.23
Flower diameter (mm)	10.15±2.34**	10.05±2.45^{NS}	8.81±01.56**	11.08±1.78*	10.03±2.34*	10.07±1.67**	8.28±2.12	10.19±1.67*	8.91±1.45
Flower stem diameter (mm)	4.00±0.98^{NS}	4.17±0.99*	5.33±0.22*	5.43±1.25*	3.83±1.43^{NS}	2.73±0.67**	5.27±1.56	5.43±1.12*	3.23±0.78
Number of flowers/Plant	12.33±2.09*	10.33±1.34**	15.67±1.56*	16.00±2.45*	10.00±2.13^{NS}	10.67±0.56^{NS}	16.67±2.12	16.67±2.34^{NS}	10.34±1.21

Garden Soil, Perlits & Coco coir dust (GS: PR: CCD)

Table 3 Comparison amongst green net and open field conditions of cv. Kardinal

Attributes	**Foliar Application**	**Soil Application**	**Partial shade (70%)**	**Open Light**
Number of Days for new branches	20.20±3.34^{NS}	18.91±3.54**	20.20±2.33*	18.11±2.34**
Plant survival (%)	99.0±11.31^{NS}	100.0±12.34^{NS}	100.0±14.34^{NS}	100.0±10.34^{NS}
Flowers stem length (cm)	32.9±4.76^{NS}	34.42±5.43**	33.21±4.56^{NS}	36.61±3.23*
Plant health (dense, sparse)	Dense	Dense	Dense	Dense
leaf size (length) (cm)	3.31±0.12^{NS}	3.53±0.35*	3.30±0.45^{NS}	3.60±0.12**
leaf size (width) (cm)	3.02±0.23^{NS}	3.23±0.76*	3.01±0.45*	3.20±0.32*
Flower diameter (mm)	8.51±1.45^{NS}	9.11±2.56*	8.02±1.23^{NS}	9.71±2.12*
Flower stem diameter (mm)	3.72±0.56^{NS}	4.12±0.67**	3.51±0.65*	4.41±0.88^{NS}
Number of flowers/Plant	10.90±2.34**	11.30±3.23*	9.30±2.34^{NS}	13.20±3.23

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