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Original Research Paper

Impact of genotype, nutrients and type of cuttings on rose (*Rosa* spp.) rootstock propagation

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ABSTRACT

An experiment was undertaken to standardize the type of rootstock, nutrient scheduling and type of cuttings for rooting of rose rootstock in factorial completely randomised design with five replications during 2022 to 2023. The treatment includes two rootstocks (V_1: *Rosa multiflora* and V_2: Natal Briar), four different nutrient doses (N_1: 400:200:200 kg, N_2: 600:200:700 kg, N_3: 450:150:525 kg and N_4: 300:100:350 kg NPK ha^{-1} year^{-1}) and three types of cuttings (hardwood, semi-hardwood and soft wood). Results revealed that the maximum number of sprouts (1.84), leaves (9.66) and roots (7.83) per cutting, and length of longest root (5.19 cm) were recorded in rootstock *Rosa multiflora* compared to Natal Briar. Application of 400:200:200 kg NPK ha^{-1} year^{-1}, recorded maximum survival of cuttings (79.11%), minimum days to first sprouting (8.47), maximum number of sprouts (1.91), leaves (10.54) and roots (9.65) per cutting, and length of longest root (6.33 cm) compared to other fertilizer treatments. Among the different types of cuttings, hardwood cuttings recorded minimum days to first sprouting (8.54), greatest thickness of cutting (7.62 mm), number of roots per cutting (7.67) and length of longest root (5.85 cm). These findings could be used to produce high-quality planting material in rose.

Keywords: Cutting type, nutrient, quality planting material, rootstocks, rose

INTRODUCTION

Rose (*Rosa hybrida* L.), family Rosaceae, is popularly called the 'Queen of Flowers' and is acclaimed as world's most popular cut flower (Castilon et al., 2006). In India, the rose is cultivated on an area of 44.55 thousand ha with the production of 181.25 thousand MT of loose flowers and 320.30 thousand MT of cut flowers (Anon, 2024). Roses are generally propagated through vegetative methods such as grafting, budding, stem cutting, stenting, root grafting and tissue culture (Izadi et al., 2013). Rootstocks play an important role in the grafting of English roses for the production of high-quality planting material adapted to adverse soil and weather conditions (Kwon et al., 2022). The success in rooting of rootstock stem cuttings depends on several factors such as the species and cultivar, growing season, vigour of the mother plant, age and the portion of the branch, composition of growing media, moisture level of the rooting substrate, nutrient status of mother plant, prevailing temperature and type of cuttings (hardwood, semi hardwood and softwood cuttings) (Hartmann et al., 2002). Nitrogen, phosphorus and potassium are major and essential nutrients for plant growth and development, and their adequate levels enhance growth (Dhillon et al., 2011). However, there is limited information on the effect of different doses of nutrients mainly N, P and K on the initial growth of rose rootstock seedlings. This study investigated the rooting potential of two rootstocks supplied with varying nutrients and type of cuttings for assessing the shooting and rooting characteristics.

MATERIALS AND METHODS

The investigation was carried out at the ICAR-Indian Institute of Horticultural Research, Bengaluru, during 2022 to 2023 (July to August). The weather parameters during experimental period are presented in Fig. 1. The experimental field is located at 13°72 N latitude and 77°292 E longitude, 890 m above msl. The climate of the experimental site is semi-arid and the soil is red sandy loam with pH of 6.35 and electrical conductivity of 0.13 ds m^{-1}.

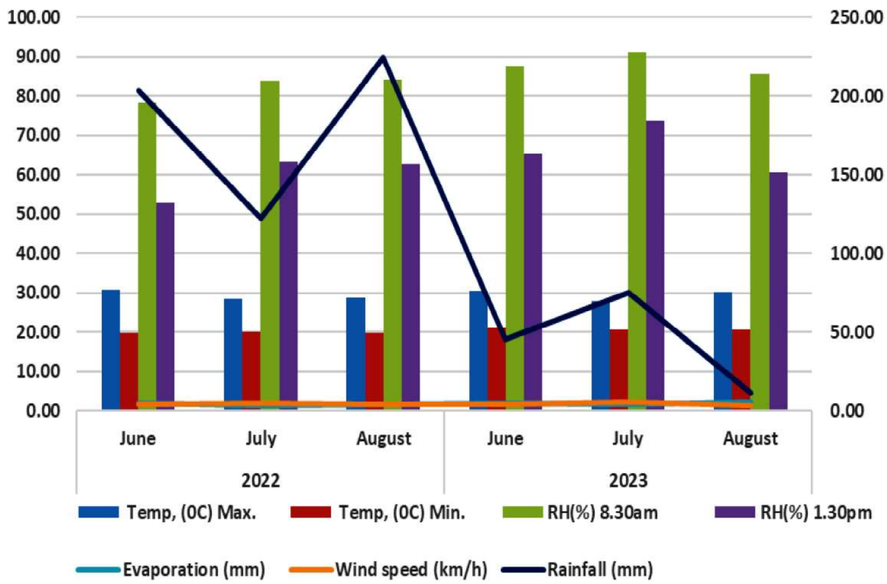

Fig. 1 : Weather parameters during 2022 to 2023

Two rootstocks (V_1-*Rosa multiflora* and V_2-Natal Briar), four different nutrient combinations [N_1-400:200:200 kg (control), N_2-600:200:700 kg, N_3-450:150:525 kg and N_4-300:100:350 kg NPK $ha^{-1}year^{-1}$] and three different types of cuttings (H_1-hardwood, H_2-semi hardwood and H_3-soft wood) were used. Natal Briar is a highly vigorous rootstock with a strong root system and thick shoots, producing abundant, vigorous planting material and ensuring rapid establishment and good scion compatibility. *Rosa multiflora* is a moderately vigorous rootstock with good rooting ability and adaptability, producing relatively thinner shoots and more compact growth suitable for controlled propagation. The experiment was laid out in factorial completely randomized design with five replications.

Rootstocks (*Rosa multiflora* and Natal Briar) were raised in a nursery from the cuttings taken from a mother plants established at ICAR-Indian Institute of Horticultural Research, Bengaluru, India. One month old rooted cuttings were planted in the main field at a spacing of 1x1 m. As a basal dose, 25 t/ha FYM, one-fourth of N and K and half the amount of phosphorus were incorporated for all treatments along with Arka microbial consortium 12.5 kg ha^{-1}. The remaining dose of N, P and K was applied in three equal splits at quarterly intervals during January, April, July and October moths.

For the preparation of stem cuttings, healthy, disease-free stems, approximately one-year-old of about 10-15 cm length were selected and cut from the rootstock mother plants. The cuttings were given a slant cut at the upper end, while a straight cut below the basal bud and placed in a poly bag of six inch filled with red soil as a rooting media. The cuttings were kept under a shade net (green; 50% shade) and need based cultural operations were followed. After 45 days of planting, various growth parameters were recorded.

The plants were carefully uprooted, and the soil adhering to the roots was gently removed by hand to avoid damage. Forty-five days after planting, parameters such as survival percentage, days taken to first sprouting, thickness of cuttings (mm), number of new leaves emerged per cutting, number of roots per cutting, and length of the longest root (cm) were recorded.

Statistical analysis

The data for two seasons were pooled and subjected to analysis of variance (ANOVA) using SAS software, version 9.3. Mean comparisons were performed using the least significant difference test (LSD) at the 1% significance level.

RESULTS AND DISCUSSION

Many vegetative and rooting parameters were significantly different for the two seasons and the pooled mean (Table 1 & 2). The survival percentage of cuttings (Table 1) were recorded highest in Natal Briar (64.58%) during season I. Similarly, application of 400:200:200 kg NPK ha^{-1} $year^{-1}$ recorded the

Table 1 : Vegetative parameters as influenced by nutrients and type of cuttings of rose rootstocks

Treatment	Per cent survival (%)			Sprouting (days)			Sprouts/cutting (No.)		
	Season I	Season II	Pooled	Season I	Season II	Pooled	Season I	Season II	Pooled
Factor A: Type of rootstock									
V_1	61.56	77.89	69.73	12.32	12.10	12.21	1.96	1.73	1.84
V_2	64.58	75.00	69.79	10.92	10.04	10.48	1.84	1.67	1.75
SE(m)±	1.06	1.67	0.95	0.17	0.38	0.23	0.04	0.04	0.03
CD at 5%	2.98	NS	NS	0.47	1.08	0.66	0.11	NS	0.08
Factor B: Nutrient dose									
N_1	79.98	78.24	79.11	8.33	8.61	8.47	2.08	1.74	1.91
N_2	65.64	80.54	73.09	11.77	10.35	11.06	1.81	1.79	1.89
N_3	56.89	75.61	66.25	12.70	12.11	12.40	1.89	1.65	1.77
N_4	49.76	71.41	60.59	13.67	13.21	13.44	1.82	1.63	1.72
SE(m)±	1.59	2.36	1.35	0.23	0.54	0.33	0.06	0.06	0.04
CD at 5%	4.21	6.63	3.79	0.66	1.53	0.93	0.16	NS	0.11
Factor C: Type of cutting									
H_1	65.26	77.15	71.21	10.63	10.45	10.54	1.94	1.76	1.85
H_2	63.07	77.01	70.04	11.85	11.02	11.44	1.88	1.65	1.77
H_3	60.87	75.19	68.03	12.38	11.73	12.06	1.87	1.69	1.78
SE(m)±	1.38	2.05	1.17	0.20	0.47	0.29	0.05	0.05	0.03
CD at 5%	NS	NS	NS	0.57	NS	0.81	NS	NS	NS
Interaction effect (AXBXC)									
$V_1N_1H_1$	69.63	83.32	76.48	7.72	10.16	8.94	2.16	1.80	1.98
$V_1N_1H_2$	74.19	75.71	74.95	9.28	8.60	8.94	2.26	1.58	1.92
$V_1N_1H_3$	76.69	85.26	80.97	9.28	7.96	8.62	1.89	1.84	1.86
$V_1N_2H_1$	75.74	87.08	81.42	10.80	9.28	10.04	2.17	1.74	1.95
$V_1N_2H_2$	63.35	73.81	68.58	14.08	12.72	13.40	1.92	1.84	1.88
$V_1N_2H_3$	56.31	70.58	63.44	11.68	11.52	11.60	1.90	1.54	1.72
$V_1N_3H_1$	59.57	79.53	69.55	12.12	11.20	11.66	1.72	1.50	1.61
$V_1N_3H_2$	55.42	83.41	69.41	12.72	12.56	12.64	2.09	1.82	1.95
$V_1N_3H_3$	59.56	76.19	67.88	14.44	16.92	15.68	1.73	1.68	1.70
$V_1N_4H_1$	47.38	57.12	52.25	14.48	14.20	14.34	1.97	1.78	1.87
$V_1N_4H_2$	54.47	76.91	65.69	14.80	14.44	14.62	1.66	1.70	1.68
$V_1N_4H_3$	46.38	85.79	66.09	16.44	15.68	16.06	2.05	1.90	1.97
$V_2N_1H_1$	87.52	84.34	85.93	7.36	7.68	7.52	1.89	1.62	1.75
$V_2N_1H_2$	85.84	91.81	88.82	7.28	8.08	7.68	1.84	1.52	1.68
$V_2N_1H_3$	86.00	49.00	67.50	9.08	9.20	9.14	2.44	2.07	2.25
$V_2N_2H_1$	53.57	83.52	68.54	9.80	9.28	9.54	1.66	2.26	1.96
$V_2N_2H_2$	70.29	80.60	75.44	11.72	9.44	10.58	1.56	1.64	1.68
$V_2N_2H_3$	74.56	87.64	81.18	12.52	9.88	11.20	1.66	1.70	1.68
$V_2N_3H_1$	73.39	59.78	66.54	11.48	10.72	11.10	2.29	1.66	1.97
$V_2N_3H_2$	40.96	78.68	59.82	12.36	10.68	11.52	1.80	1.58	1.69
$V_2N_3H_3$	52.54	76.05	64.37	13.08	10.56	11.82	1.69	1.64	1.66
$V_2N_4H_1$	55.39	82.52	68.96	11.28	11.12	11.20	1.66	1.70	1.68
$V_2N_4H_2$	60.02	55.17	57.57	12.56	11.68	12.12	1.94	1.50	1.72
$V_2N_4N_3$	34.92	71.00	52.96	12.48	12.16	12.32	1.63	1.18	1.41
CD at 5%									
A x B x C	10.31	16.25	9.28	NS	NS	NS	0.38	NS	0.27
SE(m)±									
A x B x C	3.67	1.33	5.787	0.57	1.33	0.81	0.14	0.14	0.09

highest survival percentage during season I and pooled mean (79.98 % and 79.11%, respectively). The vigorous roots initiated from the hardwood cuttings enabled the cuttings to absorb more nutrients and produce more leaves. Enhanced root quality results in the better absorption of nutrients and water from the media, which in turn increases the survival of cutting (Mishra, 2014).

Minimum days taken to first sprouting were observed in Natal Briar during seasons I and II, and in the pooled mean (10.92, 10.04 and 10.48 days, respectively). Among different nutrient treatments, the minimum days taken to first sprouting was recorded at the nutrient level 400:200:200 kg NPK ha^{-1} year^{-1} during seasons I, II and pooled mean (8.33, 8.61 and 8.47 days, respectively). Among different types of cuttings, hardwood cutting registered the minimum days taken to first sprouting during season I and the pooled mean (10.63 and 10.54 days, respectively). This may be due to the fact that hardwood cuttings contain more food reserves, such as hormones (IAA and/or, cytokinin) that can be used for shoot growth and development. The status of the stored food is an important feature that determines rooting, growth and development capacity of stem cuttings which are more abundant in hardwood than in soft and semi-hardwood cuttings that enable the hardwood cuttings to grow and develop more quickly than other types of cuttings (Hambrick et al., 1991).

Maximum number of sprouts per cutting was recorded in *Rosa multiflora* (1.96 and 1.84, respectively) and 400:200:200 kg NPK ha^{-1} year^{-1} (2.08 and 1.91, respectively) during season I and pooled mean. This may be because nitrogen is a major constituent of several important substances that occur in plants and its application increased number of stems (Nagaraju et al., 2003).

Rosa multiflora recorded the highest thickness of cutting during season I (5.91 mm) compared to Natal Briar (Table 2). Among the different nutrient treatments, the highest thickness of cuttings was observed in the 400:200:200 kg NPK ha^{-1} year^{-1} during season I, season II and the pooled mean (7.81, 11.35 and 9.5 mm, respectively). For different types of cuttings, hardwood cuttings recorded the highest thickness during season I, season II and pooled mean (6.42 mm, 8.83 mm and 7.62 mm, respectively) compared to semi-hardwood and softwood cuttings. Anamika & Lavania (1990) concluded that a combination of macro nutrients, such as N, P, K influenced the best vegetative growth in roses in terms of shoot diameter and plant height. Hardwood cuttings have greater food reserves, providing an advantage to develop more and longer roots from the early stages of root development (Kumar et al., 2011).

Rosa multiflora rootstock (9.65, 9.54 and 9.66, respectively) and application of 400:200:200 kg NPK ha^{-1} year^{-1} (10.31, 10.76 and 10.54, respectively) recorded the maximum number of leaves per cutting during season I, season II and pooled mean compared to Natal Briar (Table 2). The increase in the number of leaves per cutting might be attributed to the plant directing a greater amount of assimilates to the leaf buds since the leaves are one of the significant production sites of natural auxins in them, besides being very important for vital processes like photosynthesis and respiration (Mehmood et al., 2020).

The maximum number of roots per cutting was observed in *Rosa multiflora* during season II and pooled mean (9.56 and 7.83, respectively) (Table 2). Application of 400:200:200 kg NPK ha^{-1} year^{-1} recorded the highest number of roots per cutting during season I, season II and the pooled mean (8.83, 1036 and 9.65, respectively). For different types of cuttings, hardwood cuttings showed the highest number of roots per cutting in the pooled mean (7.67). These results suggest that the hardwood cuttings, having higher nutritive reserves, are better for metabolic support and subsequent development and root growth (Fachinello et al., 2005).

Rosa multiflora exhibited longest root during season I and the pooled mean (4.65 cm and 5.19 cm, respectively) compared to Natal briar (Table 2). Application of 400:200:200 kg NPK ha^{-1} year^{-1} resulted in the highest length of longest root during season I, season II and the pooled mean (4.66, 8.00 and 6.33, respectively). Regarding the types of cuttings, hardwood cuttings recorded the greatest length of longest root during season I and the pooled mean (4.13 and 5.85, respectively) compared to semi-hardwood and softwood cuttings. Shenoy (1992) in *Rosa damascena* reported that the increase in root length may be due to the enhanced hydrolysis of carbohydrates, metabolites accumulation and cell division induced by auxin.

Table 2 : Sprouting and rooting parameters of rose rootstocks (*Rosa multiflora* and Natal Briar) as influenced by nutrients and type of cuttings

Treatment	Thickness of cutting (mm)			Leaves/cutting (Nos.)			Roots/cutting (Nos.)			Length of longest root (cm)		
	Season I	Season II	Pooled	Season I	Season II	Pooled	Season I	Season II	Pooled	Season I	Season II	Pooled
Factor A: Type of rootstock												
V_1	5.91	7.88	6.99	9.65	9.54	9.66	6.17	9.56	7.83	4.65	7.33	5.19
V_2	5.71	7.91	6.81	8.56	8.91	8.74	5.60	7.68	6.64	2.55	6.72	4.64
SE(m)±	0.06	0.09	0.05	0.25	0.21	0.15	0.21	0.31	0.18	0.13	0.23	0.13
CD at 5%	0.17	NS	NS	0.71	0.59	0.43	NS	0.88	0.51	0.36	NS	0.38
Factor B: Nutrient dose												
N_1	7.81	11.35	9.58	10.31	10.76	10.54	8.83	10.36	9.65	4.66	8.00	6.33
N_2	6.29	8.83	7.56	8.87	9.56	9.21	5.85	8.57	7.21	3.76	7.15	5.45
N_3	5.04	6.39	5.72	8.76	8.57	8.67	4.52	8.01	6.27	3.21	6.39	4.89
N_4	4.11	5.02	4.57	8.58	8.01	8.25	4.19	7.53	5.86	2.77	6.56	4.66
SE(m)±	0.09	0.12	0.08	0.36	0.37	0.22	0.30	0.44	0.26	0.23	0.32	0.19
CD at 5%	0.24	0.34	0.21	1.03	0.83	0.61	0.86	1.24	0.72	0.51	0.96	0.53
Factor C: Type of cutting												
H_1	6.42	8.83	7.62	9.34	9.64	9.51	6.33	9.02	7.67	4.13	7.58	5.85
H_2	5.70	7.64	6.67	9.19	8.92	9.06	5.41	8.47	6.90	3.47	6.79	5.13
H_3	5.33	7.21	6.27	8.80	9.11	8.95	5.81	8.44	7.12	3.20	6.71	4.96
SE(m)±	0.07	0.10	0.07	0.31	0.26	0.19	0.26	0.38	0.22	0.16	0.28	0.16
CD at 5%	0.21	0.29	0.18	NS	NS	NS	NS	NS	0.62	0.45	NS	0.46
Interaction effect (AXBXC)												
$V_1N_1H_1$	7.87	11.88	9.88	10.17	10.54	10.77	7.53	11.50	9.52	5.36	8.86	7.08
$V_1N_1H_2$	7.30	11.06	9.18	12.53	9.92	11.23	7.17	11.42	9.35	4.06	7.84	5.95
$V_1N_1H_3$	7.70	11.05	9.38	8.87	11.90	10.38	8.53	11.74	10.13	5.12	8.01	6.57
$V_1N_2H_1$	9.03	11.47	10.25	10.89	10.58	10.73	5.88	9.98	7.93	5.05	8.63	6.84
$V_1N_2H_2$	5.42	7.36	6.39	9.89	10.22	10.05	4.73	9.04	6.88	4.59	6.96	5.78
$V_1N_2H_3$	5.19	7.4	6.35	10.32	9.08	9.79	6.70	10.16	8.43	4.26	6.97	5.58
$V_1N_3H_1$	5.53	7.00	6.27	7.87	9.16	8.52	5.79	10.74	8.26	5.11	7.43	6.27
$V_1N_3H_2$	6.01	7.07	6.54	9.24	9.18	9.21	5.56	8.93	7.24	4.46	5.99	5.23
$V_1N_3H_3$	4.28	5.08	4.68	9.09	8.17	8.63	4.41	6.45	5.43	4.29	6.68	5.45
$V_1N_4H_1$	4.01	4.84	4.42	9.74	8.06	8.90	6.08	7.04	6.56	4.72	6.86	5.79
$V_1N_4H_2$	4.33	5.26	4.84	7.16	8.80	7.98	5.16	8.12	6.64	4.85	6.48	5.67
$V_1N_4H_3$	4.30	5.116	4.71	9.26	8.84	9.05	5.64	9.58	7.61	3.95	7.39	5.67
$V_2N_1H_1$	8.04	11.19	9.61	8.30	9.72	9.01	8.48	9.22	8.85	5.66	8.09	6.88
$V_2N_1H_2$	7.96	11.22	9.59	8.85	10.24	9.55	8.87	8.32	8.56	4.19	7.84	6.02
$V_2N_1H_3$	7.96	11.68	9.82	12.30	12.26	12.28	12.49	9.94	11.21	3.57	7.44	5.50
$V_2N_2H_1$	7.48	12.48	9.98	7.82	12.60	10.21	10.08	9.00	9.54	4.04	8.03	6.04
$V_2N_2H_2$	5.28	7.02	6.15	6.78	7.18	6.98	3.98	6.68	5.33	2.64	5.50	4.07
$V_2N_2H_3$	5.35	7.26	6.30	7.50	7.68	7.59	3.74	6.56	5.15	2.05	6.79	4.42
$V_2N_3H_1$	5.27	6.98	6.12	11.84	9.22	10.53	4.36	8.38	6.37	1.74	6.51	4.13
$V_2N_3H_2$	5.20	7.14	6.17	8.34	8.50	8.42	4.45	7.08	5.76	2.06	6.57	4.31
$V_2N_3H_3$	3.98	5.06	4.52	6.27	7.20	6.78	2.58	6.48	4.53	1.62	5.28	3.41
$V_2N_4H_1$	4.09	4.84	4.46	7.24	7.28	7.26	2.45	6.26	4.35	1.34	6.30	3.82
$V_2N_4H_2$	4.10	4.99	4.54	10.73	7.34	9.03	3.45	7.58	5.51	0.90	7.08	3.99
$V_2N_4N_3$	3.85	5.06	4.46	6.86	7.74	7.39	2.36	6.60	4.48	0.82	5.25	3.04
CD at 5%												
A x B x C	0.66	NS	NS	2.46	NS	1.49	2.16	NS	1.76	NS	NS	NS
SE(m)±												
A x B x C	0.21	0.298	0.19	0.87	0.73	0.53	0.75	1.08	0.63	0.45	0.78	0.46

Factor A: Type of rootstocks (V_1-*Rosa multiflora* & V_2-Natal Briar), Factor B: Nutrient dose (N_1-400:200:200 kg, N_2-600:200:700 kg, N_3-450:150:525 kg and N_4-300:100:350 kg NPK ha^{-1} $year^{-1}$) and Factor C: Type of cuttings (hardwood, semi hardwood and soft wood). Observations were recorded for newly emerged leaves; Roots emerged were adventitious from nodes

CONCLUSION

The study clearly demonstrated that nutrient management of the rootstock mother plants had a significant influence on the subsequent rooting and growth performance of stem cuttings. Hardwood cuttings (10–15 cm) obtained from *Rosa multiflora* mother plants supplied with 400:200:200 kg NPK ha^{-1} $year^{-1}$ and planted in six-inch polybags filled with red soil exhibited the highest survival percentage, earliest sprouting, and superior rooting and shoot growth parameters, including number of sprouts, leaves, and roots per cutting, as well as longest root length. These findings emphasize that appropriate nutrient dosing of the rootstock mother block is crucial for producing physiologically vigorous cuttings and can be effectively utilized for large-scale production of high-quality rose rootstock planting material.

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