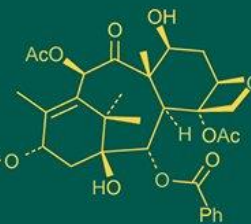
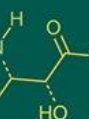
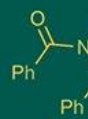
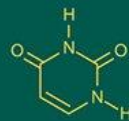
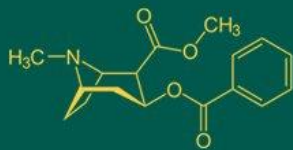


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Effect of pruning levels and gibberellic acid (GA₃) on growth and flowering of rose cv. divine

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Abstract

A field experiment was conducted for two seasons, 2024-25 and 2025-26, at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, to study the effect of pruning levels and gibberellic acid (GA₃) on growth and flowering of Rose cv. Divine. Sixteen treatment combinations - four pruning from ground level (30, 40, 50 cm and no pruning) and four GA₃ levels (150, 200, 250 ppm and a water spray) were tested in a Factorial Randomized Block Design with three replications. Unpruned plants (P₄) grew tallest (188.73 cm at 180 DAP) and flowered earliest, while pruning at 50 cm from ground level (P₃) gave the most secondary (18.58) and tertiary (52.78) branches, the largest leaf area (67.25 cm²) and the widest plant spread (143.39 cm). Among GA₃ levels height was greatest at 250 ppm and all other traits best at 200 ppm (G₂). The interaction was significant for most traits, the maximum plants height noticed in P₄G₃, the strongest canopy was found in P₃G₂ and the earliest flowering was noticed in P₄G₂. Pruning at 50 cm from ground level with foliar application of 200 ppm GA₃ was found most appropriate for suitable growth and flowering of Rose cv. Divine.

Keywords: Rose cv. divine, pruning, growth, gibberellic acid, flowering

Introduction

Floriculture has emerged as one of the most remunerative branches of Indian horticulture and is officially recognised as a sunrise industry with 100 per cent export-oriented status. Being a high-value, low-volume enterprise, it offers substantially greater returns per unit area than conventional field crops and is therefore well suited to small and marginal holdings, generating considerable rural employment and foreign exchange (Singh and Kumar, 2023) [17]. According to the National Horticulture Board data cited by APEDA [2], the area under floriculture in India during 2023-24 was 317 thousand hectares, with a production of 2,659 thousand tonnes of loose flowers and 877 thousand tonnes of cut flowers.

Tamil Nadu, Karnataka, Maharashtra, West Bengal, Andhra Pradesh, Madhya Pradesh, Uttar Pradesh and Gujarat are the leading flower-producing states. Rose, chrysanthemum, marigold, tuberose, jasmine, gladiolus, carnation, gerbera, orchid and anthurium constitute the major commercial crops, of which rose, carnation, chrysanthemum, gerbera, gladiolus, orchid and anthurium dominate the international cut and loose flower trade.

Among ornamental crops, the rose (*Rosa* spp., family Rosaceae) is universally acclaimed as the "Queen of Flowers". The genus comprises more than 300 species and over 30,000 cultivated hybrids exhibiting wide variability in plant habit, flower form, colour and fragrance (Zlesak, 2017) [19], and roses account for more than 65 per cent of the international cut flower trade (Rajput and Kumar, 2024) [13]. In India, Maharashtra, Karnataka, Punjab and Uttar Pradesh are the leading rose-growing states, where the crop is raised both for cut flowers and for value-added products such as rose oil, rose water and perfumes (Meshram *et al.*, 2022) [12].

Pruning is among the most important cultural operations for regulating plant architecture, improving light penetration and stimulating vigorous flowering shoots. Appropriate pruning height breaks apical dominance and redirects assimilates towards productive laterals. Mendhe *et al.* (2011) [11] recorded maximum shoot production in *Rosa indica* pruned at 60 cm above ground level, whereas Porwal *et al.* (2002) reported that severe pruning at 30 cm promoted greater plant height in *Rosa damascena*, and Maske *et al.* (2018) [10] observed

larger flower diameter at an intermediate pruning height of 50 cm. These contrasting results indicate that the optimum pruning level is cultivar- and environment-specific.

Plant growth regulators, particularly gibberellic acid (GA₃), complement canopy management by stimulating cell division, internodal elongation and biomass accumulation. Hashemabadi and Zarchini (2010) [7] obtained improved stem length in *Rosa hybrida* cv., with 300 ppm GA₃, while Chaudhari and Patil (2018) [5] recorded earlier bud initiation and maximum stalk length at 250 mg L⁻¹. Excessive GA₃ in overcrowded canopies, however, may produce weak, elongated stems of poor structural strength (Nair *et al.*, 2002).

Materials and Methods

The experiment was conducted the Department of Floriculture and Landscaping, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola for two consecutive seasons (June-December of 2024 and 2025). Uniform one-year-old plants of rose cv. Divine on raised beds spaced at 1.5 m × 1.0 m were used. Treatments were arranged in a Factorial Randomized Block Design with three replications and sixteen treatment combinations: four pruning levels - P₁ (pruning at 30 cm from ground level), P₂ (pruning at 40 cm from ground level), P₃ (pruning at 50 cm from ground level) and P₄ (no pruning)- and four GA₃ levels- G₁ (GA₃.150 ppm), G₂ (GA₃.200 ppm), G₃ (GA₃.250 ppm) and G₄ (water spray). Pruning was done on 15th June in each year with a sharp secateur, the slanting cut half a centimetre above an outward-facing bud, sealed with copper oxychloride paste. Four GA₃ sprays were applied, the first spraying right after pruning and three more at fortnightly intervals. Fertilizer was 200:200:100 kg NPK ha⁻¹ with 10 t ha⁻¹ farmyard manure. Five plants per treatment were tagged for observations, and data were analysed by ANOVA for the design with means compared at 5% (CD). All values reported below are pooled over the two seasons.

Results and Discussion

Vegetative Parameters

Plant height

Among the pruning levels, the treatment P₄ (no pruning) recorded maximum plant height at 30 DAP (115.71 cm), 60 DAP (131.69 cm), 90 DAP (149.58 cm), 120 DAP (156.28 cm), 150 DAP (175.37 cm) and 180 DAP (188.73 cm), which was significantly superior than rest of all the treatments and was followed by the treatment P₃ (pruning at 50 cm) with 96.47, 119.95, 140.48, 144.43, 155.53 and 162.93 cm, respectively. Whereas, significantly minimum plant height was recorded with the treatment P₁ (pruning at 30 cm) i.e. 58.49, 85.45, 96.79, 102.78, 122.67 and 136.29 cm at 30, 60, 90, 120, 150 and 180 DAP, respectively. It was observed that the plant height decreased progressively with increasing severity of pruning at all the stages.

Thus, from the above results it is seen that the rose plants left unpruned (P₄) showed maximum plant height at every stage of crop growth. This might be due to retention of the maximum vegetative framework and preservation of apical dominance, whereby the terminal growing points continued to sustain the auxin gradient driving uninterrupted vertical elongation, whereas progressively more severe pruning removed a greater proportion of this framework and diverted resources toward regeneration of new basal shoots rather than height. Similar findings have also been reported by

Kumar *et al.* (2018), Meena *et al.* (2020), Ahmad *et al.* (2019), Reddy *et al.* (2017) and Sharma *et al.* (2016) in rose. In case of GA₃ levels, the treatment G₃ (GA₃ 250 ppm) recorded maximum plant height at 30 DAP (92.57 cm), 60 DAP (114.26 cm), 90 DAP (131.19 cm), 120 DAP (141.50 cm), 150 DAP (155.91 cm) and 180 DAP (165.49 cm), which was significantly superior than rest of all the treatments and was followed by the treatment G₂ (GA₃ 200 ppm) with 86.76, 110.47, 124.91, 135.94, 151.40 and 163.32 cm, respectively. Whereas, significantly minimum plant height was recorded with the treatment G₄ i.e. control (80.15, 99.18, 118.79, 126.88, 145.15 and 158.58 cm at 30, 60, 90, 120, 150 and 180 DAP, respectively).

GA₃ at 250 ppm (G₃) recorded significantly the tallest plants at every stage, in clear contrast to the 200 ppm optimum identified for most other vegetative and yield characters in this study. This may be attributed to the promotion of cell division and elongation in the sub-apical meristem by GA₃, an action most fully expressed at the highest concentration tested and favouring continued internodal extension throughout the growing season. Similar results were reported by Gaur *et al.* (2016) [6], Hazarika and Ansari (2017) [8], Sunitha *et al.* (2018) [18], Ahmad *et al.* (2019) [1], Bhattarai *et al.* (2020) [3] and Singh and Sharma (2020) [16] in rose and other ornamentals.

The interaction for the treatment P₄ (no pruning) and the treatment G₃ (GA₃ 250 ppm) were found significantly superior for plant height at all the stages of observation. The increase in plant height with increasing concentration of GA₃ upto 250 ppm may be attributed to the role of gibberellic acid in cell elongation and cell division, whereas the reduction in plant height under severe pruning was mainly due to removal of the apical portion of the shoots.

Primary branches, secondary branches, tertiary branches, leaf area and plant spread

The data pertaining to growth parameters of rose as influenced by pruning levels and GA₃ are presented in Table 2.

Among the pruning levels, the number of primary branches was non significant, Whereas, the treatment P₃ (pruning at 50 cm) recorded maximum number of secondary branches per plant (18.58), tertiary branches per plant (52.78), leaf area (67.25 cm²) and plant spread (143.39 cm), which was significantly superior than rest of all the treatments and was followed by the treatment P₂ (pruning at 40 cm) with 16.44, 43.25, 61.21 cm² and 141.18 cm, respectively. Whereas, significantly minimum number of secondary branches per plant (11.72), tertiary branches per plant (32.26) and leaf area (53.63 cm²) were recorded with the treatment P₄ - no pruning, while significantly minimum plant spread was recorded with the treatment P₁ - pruning at 30 cm (122.24 cm).

Moderate pruning at 50 cm (P₃) was consistently superior for branching and foliar characters, recording significantly more secondary branches at all stages. Removal of the dominant terminal shoot releases correlative inhibition on retained lateral buds while leaving sufficient reserves to sustain the resulting flush. Unpruned plants (P₄) retained intact apical dominance, whereas severe pruning (P₁) left too few nodes and reserves for extensive branching, so the two extremes remained at par. The advantage widened for tertiary branches, all four levels being clearly separable, as successive branching orders compound the gain under P₃.

Leaf area followed the same trend, P3 producing the largest leaves throughout. Plant spread departed from the pattern of plant height, being minimum under P1 and only third under P4, since spread depends on outward extension of new laterals rather than retained framework height. Similar findings were reported by Sharma *et al.* (2016), Reddy *et al.* (2017), Kumar *et al.* (2018), Meena *et al.* (2020) and Patel *et al.* (2021) in rose.

In case of GA₃ levels, the number of primary branches was non significant. Whereas, the treatment G₂ (GA₃ 200 ppm) recorded maximum number of secondary branches per plant (15.81), tertiary branches per plant (44.75), leaf area (63.52 cm²) and plant spread (139.69 cm), which was significantly superior than rest of all the treatments and was followed by the treatment G₁ (GA₃ 150 ppm) with 15.03, 42.77, 61.10 cm² and 135.57 cm, respectively. Whereas, significantly minimum values for all these characters were recorded with the treatment G₄ - control (13.85, 38.56, 56.93 cm² and 128.88 cm, respectively).

However, in respect of number of primary branches per plant, the treatment P₃ (5.66) and the treatment G₂ (5.83) recorded maximum values, while minimum values were recorded with the treatment P₁ (4.67) and the treatment G₄ i.e. control (4.80), but the differences due to both pruning levels and GA₃ levels were found non-significant, indicating that the production of primary branches was governed mainly by the inherent framework of the plant.

GA₃ at 150-200 ppm (G₁ and G₂) supported the outgrowth of newly released axillary buds without the elongation-dominant, branch-limiting effect of the higher dose, whereas 250 ppm (G₃) did not differ from the control. The superiority of 200 ppm, statistically indistinct in 2024-25, became clearly expressed by 2025-26 and in the pooled data as branching advanced to the tertiary order. Leaf area also peaked at 200 ppm and declined at 250 ppm, indicating that at the highest dose assimilates were preferentially diverted to the rapidly elongating internodal sink at some cost to lamina expansion. Plant spread declined symmetrically at both lower and higher concentrations, G₁ and G₃ remaining at par, suggesting a physiological optimum at 200 ppm. Similar results were reported by Gaur *et al.* (2016) [6], Hazarika and Ansari (2017) [8], Sunitha *et al.* (2018) [18], Ahmad *et al.* (2019) [1] and Singh and Sharma (2020) [16] in rose.

The interaction for the treatment P₃ (pruning at 50 cm) and the treatment G₂ (GA₃ 200 ppm) were found significantly superior for all the growth parameters under study, except number of primary branches per plant. It was further observed that the response to GA₃ increased upto 200 ppm and thereafter declined at 250 ppm, indicating a supra-optimal effect at the higher concentration.

Flowering Parameters

Among the pruning levels, the treatment P₄ (no pruning) recorded significantly minimum number of days to sprouting (4.79), days to first flower bud initiation (8.26), days to opening of first flower (21.84) and days to harvesting (23.89), which was significantly superior than rest of all the treatments and was followed by the treatment P₃ (pruning at 50 cm) with 8.73, 13.99, 27.83 and 30.20 days, respectively. Whereas, maximum number of days for

all these characters were recorded with the treatment P₁ - pruning at 30 cm (9.94, 17.16, 32.30 and 34.55 days, respectively). It was observed that the number of days required for sprouting, flower bud initiation, flower opening and harvesting increased progressively with increasing severity of pruning, thereby delaying the flowering.

Unpruned plants (P₄) recorded minimum days to sprouting at all stages, as they resume extension from already-active growing points, whereas pruned plants must first activate dormant axillary buds lower on the stem, the more severe the cut the deeper and more dormant the buds forced into growth. The same ranking held for first flower bud initiation, consistent with the vegetative-to-reproductive phase transition requiring a threshold of vegetative growth, which unpruned plants attained with little additional growth while severely pruned plants had to rebuild from a low base. This ordering persisted through flower opening and harvesting, indicating that the delay imposed by pruning accumulated rather than being overtaken, the entire reproductive timeline shifting in proportion to the vegetative rebuilding required. Similar observations were reported by Sharma *et al.* (2016), Kumar *et al.* (2018), Meena *et al.* (2020) and Patel *et al.* (2021) in rose.

In case of GA₃ levels, the treatment G₂ (GA₃ 200 ppm) recorded minimum number of days to sprouting (8.03), days to first flower bud initiation (13.43), days to opening of first flower (27.59) and days to harvesting (29.66), whereas, maximum number of days were recorded with the treatment G₄ - control (8.36, 14.56, 28.35 and 30.92 days, respectively). However, in respect of days to sprouting, days to first flower bud initiation and days to opening of first flower, the treatment G₂ was found at par with the treatments G₁ (150 ppm) and G₃ (250 ppm), while in respect of days to harvesting the treatment G₂ was found significantly superior than rest of all the treatments.

GA₃ at 200 ppm (G₂) recorded minimum days to sprouting at all stages, though the effect was considerably smaller than that of pruning, consistent with the known role of gibberellins in bud dormancy release, which involves a coordinated shift among several hormones rather than gibberellin alone. Flower bud initiation and flower opening were advanced over the control largely irrespective of concentration, indicating dependence on the presence rather than the precise dose of applied GA₃. Days to harvesting showed a sharper concentration-specific response, minimum values occurring at 200 ppm, suggesting the advantage of the moderate dose became progressively more distinguishable as the crop advanced into reproductive development. Similar results were reported by Chaudhary *et al.* (2017) [4], Hazarika and Ansari (2017) [8], Ahmad *et al.* (2019) [1] and Singh and Sharma (2020) [16] in rose.

The interaction for the treatment P₄ (no pruning) and the treatment G₂ (GA₃ 200 ppm) required minimum number of days for sprouting, flower bud initiation, flower opening and harvesting, thereby resulting in earliness in flowering. The delay in flowering under severe pruning may be attributed to the time required by the plant for regeneration of new shoots after removal of the apical portion, whereas the earliness recorded due to GA₃ application may be ascribed to its role in early mobilization of metabolites towards the developing floral buds.

Table 1: Effect of pruning levels and GA₃ on plant height (cm) at 30, 60, 90, 120, 150 and 180 DAP of rose cv. Divine (pooled data)

Treatment	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP	180 DAP
Factor A - Pruning levels						
P ₁ - Pruning (30 cm)	58.49	85.45	96.79	102.78	122.67	136.29
P ₂ - Pruning (40 cm)	71.89	92.95	113.83	133.53	148.82	159.61
P ₃ - Pruning (50 cm)	96.47	119.95	140.48	144.43	155.53	162.93
P ₄ - (No pruning)	115.71	131.69	149.58	156.28	175.37	188.73
'F' test	Sig	Sig	Sig	Sig	Sig	Sig
S.Em.+/-	0.78	0.70	0.74	0.68	0.66	0.51
CD at 5% (P)	2.26	2.05	2.15	1.98	1.93	1.58
Factor B - GA₃						
G ₁ -GA ₃ (150 ppm)	83.08	106.13	125.78	132.71	149.93	160.17
G ₂ -GA ₃ (200 ppm)	86.76	110.47	124.91	135.94	151.40	163.32
G ₃ -GA ₃ (250 ppm)	92.57	114.26	131.19	141.50	155.91	165.49
G ₄ (Control)	80.15	99.18	118.79	126.88	145.15	158.58
'F' test	Sig	Sig	Sig	Sig	Sig	Sig
S.Em.+/-	0.78	0.70	0.74	0.68	0.66	0.51
CD at 5% (G)	2.26	2.05	2.15	1.98	1.93	1.58
Treatment combinations	Interaction effect (P x G)					
P ₁ G ₁	63.02	86.77	99.71	109.15	124.49	137.07
P ₁ G ₂	65.18	90.01	103.63	110.47	129.12	138.57
P ₁ G ₃	56.72	83.74	96.23	100.92	123.53	136.12
P ₁ G ₄	49.04	81.28	87.62	90.61	113.54	133.41
P ₂ G ₁	72.43	95.39	114.58	135.30	150.52	161.36
P ₂ G ₂	75.30	96.00	118.36	139.58	151.25	162.55
P ₂ G ₃	69.78	90.67	111.86	131.79	146.45	160.13
P ₂ G ₄	70.03	89.74	110.52	127.43	147.05	154.40
P ₃ G ₁	96.19	120.24	141.18	142.71	154.37	156.10
P ₃ G ₂	95.44	123.29	141.65	143.19	154.62	164.56
P ₃ G ₃	100.45	129.52	145.17	151.04	159.42	167.05
P ₃ G ₄	93.81	106.77	133.92	140.79	153.69	164.02
P ₄ G ₁	109.63	129.87	153.87	155.42	175.37	188.34
P ₄ G ₂	116.16	136.42	143.71	156.10	175.95	190.30
P ₄ G ₃	129.35	141.52	157.63	164.92	183.84	193.78
P ₄ G ₄	107.72	118.94	143.13	148.67	166.31	182.51
'F' test	Sig	Sig	Sig	Sig	Sig	Sig
S.Em.+/-	1.57	1.42	1.40	1.37	1.34	1.09
CD (P×G) 5%	4.54	4.11	4.06	3.97	3.88	2.98

Table 2: Effect of pruning levels and GA₃ on primary, secondary and tertiary branches, leaf area and plant spread of rose cv. Divine (pooled data)

Treatment	Primary branches	Secondary branches	Tertiary branches	Leaf area (cm ²)	Plant spread (cm)
Factor A - Pruning levels					
P ₁ - Pruning (30 cm)	4.67	12.29	38.24	58.71	122.24
P ₂ - Pruning (40 cm)	5.36	16.44	43.25	61.21	141.18
P ₃ - Pruning (50 cm)	5.66	18.58	52.78	67.25	143.39
P ₄ - (No pruning)	5.00	11.72	32.26	53.63	132.58
'F' test	NS	Sig	Sig	Sig	Sig
S.Em.+/-	0.22	0.39	0.50	0.14	0.72
CD at 5% (P)	-	1.14	1.45	0.41	2.08
Factor B - GA₃					
G ₁ -GA ₃ (150 ppm)	5.72	15.03	42.77	61.10	135.57
G ₂ -GA ₃ (200 ppm)	5.83	15.81	44.75	63.52	139.69
G ₃ -GA ₃ (250 ppm)	5.35	14.34	40.45	59.24	135.26
G ₄ (Control)	4.80	13.85	38.56	56.93	128.88
'F' test	NS	Sig	Sig	Sig	Sig
S.Em.+/-	0.22	0.39	0.50	0.14	0.72
CD at 5% (G)	-	1.14	1.45	0.41	2.08
Treatment combinations	Interaction effect (P x G)				
P ₁ G ₁	4.77	12.49	39.00	59.40	121.55
P ₁ G ₂	5.56	12.57	39.92	60.79	125.72
P ₁ G ₃	4.17	12.10	37.20	59.11	123.66
P ₁ G ₄	4.19	12.04	36.86	55.55	118.04
P ₂ G ₁	5.26	16.74	45.52	61.48	142.17
P ₂ G ₂	5.31	17.53	45.43	63.68	145.22
P ₂ G ₃	4.92	16.01	41.40	60.22	139.32
P ₂ G ₄	3.96	15.46	40.65	59.45	138.02

P ₃ G ₁	5.68	19.03	54.69	69.27	146.33
P ₃ G ₂	5.83	21.06	58.53	73.34	149.93
P ₃ G ₃	5.31	17.53	51.95	65.04	145.08
P ₃ G ₄	5.83	16.70	45.96	61.36	132.22
P ₄ G ₁	5.18	11.86	31.93	54.27	132.21
P ₄ G ₂	5.60	12.08	35.11	56.26	137.90
P ₄ G ₃	4.99	11.72	31.24	52.62	132.99
P ₄ G ₄	4.23	11.22	30.79	51.36	127.22
'F' test	NS	Sig	Sig	Sig	Sig
S.Em.+/-	0.49	0.79	1.00	0.28	1.44
CD (P×G) 5%	-	2.29	2.93	0.82	4.16

Table 3: Effect of pruning levels and GA₃ on flowering parameters (days) of rose cv. Divine (pooled data)

Treatment	Days to sprouting	Days to first flower bud initiation	Days to opening of first flower	Days to harvesting
Factor A - Pruning levels				
P ₁ - Pruning (30 cm)	9.94	17.16	32.30	34.55
P ₂ - Pruning (40 cm)	9.54	15.81	30.33	33.20
P ₃ - Pruning (50 cm)	8.73	13.99	27.83	30.20
P ₄ - (No pruning)	4.79	8.26	21.84	23.89
'F' test	Sig	Sig	Sig	Sig
S.Em.+/-	0.25	0.29	0.28	0.23
CD at 5% (P)	0.72	0.84	0.80	0.67
Factor B - GA₃				
G ₁ -GA ₃ (150 ppm)	8.30	13.46	27.85	30.50
G ₂ -GA ₃ (200 ppm)	8.03	13.43	27.59	29.66
G ₃ -GA ₃ (250 ppm)	8.30	13.78	28.02	30.76
G ₄ (Control)	8.36	14.56	28.35	30.92
'F' test	Sig	Sig	Sig	Sig
S.Em.+/-	0.25	0.29	0.28	0.23
CD at 5% (G)	0.72	0.84	0.80	0.67
Treatment combinations	Interaction effect (P X G)			
P ₁ G ₁	9.92	16.71	32.30	34.55
P ₁ G ₂	9.76	17.53	31.83	33.59
P ₁ G ₃	9.99	17.15	32.77	34.32
P ₁ G ₄	10.10	17.24	32.95	35.60
P ₂ G ₁	9.82	15.47	30.13	33.05
P ₂ G ₂	9.83	15.42	29.94	32.26
P ₂ G ₃	9.34	16.07	30.29	34.75
P ₂ G ₄	9.16	16.29	30.94	32.77
P ₃ G ₁	8.71	13.94	28.25	30.37
P ₃ G ₂	8.17	13.34	28.02	30.46
P ₃ G ₃	8.94	14.04	27.47	30.01
P ₃ G ₄	9.09	14.66	27.58	29.95
P ₄ G ₁	4.76	7.58	21.37	23.91
P ₄ G ₂	4.38	7.55	20.57	22.33
P ₄ G ₃	4.94	7.86	21.56	23.97
P ₄ G ₄	5.08	10.06	23.86	25.35
'F' test	Sig	NS	Sig	Sig
S.Em.+/-	0.50	0.58	0.56	0.47
CD (P×G) 5%	1.44	-	1.61	1.35

Conclusion

Across the two seasons, pruning height and GA₃ each shaped the growth and flowering of rose cv. Divine consistently. Unpruned plants (P₄) grew tallest at every stage and flowered earliest; pruning at 50 cm (P₃) built the fullest canopy, most secondary and tertiary branches, largest leaf area and widest spread. Height rose with GA₃ up to 250 ppm, but all other traits were best at 200 ppm (G₂); primary branch number responded to neither factor. The interactions confirm the pattern: the tallest plants came from P₄G₃, the strongest canopy from P₃G₂ and the earliest flowering from P₄G₂. For a productive, well-branched plant, pruning at 50 cm with 200 ppm GA₃ is recommended; where height and early bloom matter more, unpruned plants with GA₃ at 200-250 ppm are preferable, under the conditions of the Vidarbha region of Maharashtra.

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