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Effects of various concentrations of GA_3 and NAA in cuttings of Hydrangea (*Hydrangea macrophylla*) under open condition

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Abstract

The present investigation entitled "Effect of various concentrations of GA_3 and NAA in cuttings of Hydrangea (*Hydrangea macrophylla*) under open condition" was carried out at V.C.S.G, UUHF Bharsar during rainy season 2015-1016. The experiment was set up in a randomized full block design, with 13 treatments consisting of various concentrations of GA_3 and NAA, as well as their combinations. Secateurs were used for making pencil-sized diameter cuts. During the cutting process, all of the leaves on the shoots were removed. Early in the morning, when the leaves and branches of the stock plants were still turgid, cuttings were taken. A slanting incision was made around 1.5 cm above the node, and the basal section was done slightly below the node without causing any harm to the bud or proximal end. The results showed that T_7 (150 ppm NAA) had the thickest sprout with the largest diameter (14.13 mm), T_4 (200 ppm GA_3) had the most leaves per plant (6.70), and the least number of days required for bud initiation (13.33) was T_7. However, it was discovered that T_{12} (100 ppm GA_3 + 100 ppm NAA) had the highest root metrics, such as the number of main roots (19.96) and the thickest root's diameter (0.53mm), whereas T_{13} (Control) had the lowest. T_5 cuttings treated with 50 ppm NAA showed the highest number of secondary roots (12.36).

Keywords: Hydrangea, GA_3, NAA, Cutting and Root

Introduction

Hydrangeas are great for a variety of garden locations, including pots, shrub borders, and group plantings. Hydrangeas are deciduous landscaping shrubs and potted flowers. Their stunning pink, blue, or white inflorescences are potted plants. The majority of publications claim that germination of seeds in *Hydrangea spp.* is challenging; nonetheless, the resulting seedlings are variable and do not always generate the desired shapes or features (Jacobs *et al.*, 1990). The perennial shrub *Hydrangea macrophylla* has the unusual capacity to blossom again in the spring and summer. It's clear that hydrangeas have long been a mainstay in gardens in the South. Certain hydrangeas, particularly mophead and lacecap, can change colour depending on the pH of the soil, which influences the relative availability of aluminum ions. Generally, flowers cultivated in acidic soils are blue, whereas those planted in alkaline soils are pink. Cuttings are used for the majority of the commercial propagation of *Hydrangea macrophylla* due of the clonal consistency that results from their use.

Consequently, an effort has been made to use napthalene acetic acid (NAA) and gibberellic acid (GA_3) to determine the proper concentration of growth regulators for improved performance in Hydrangea species. A thorough investigation was conducted with the consideration of the aforementioned factors in order to calculate the "Effect of various concentrations of GA_3 and NAA in cuttings of Hydrangea (*Hydrangea macrophylla*) under open conditions".

Materials and Methods

The field experiment was carried out at the Experimental Farm of Department of Floriculture and Landscape Architecture, College of Horticulture VCSG, UUHF Bharsar (Pauri Garhwal) Uttarakhand during rainy-season, 2015. In each treatment and replication, ten plants were randomly tagged, and data

on the number of days it took for the first bud to sprout, the number of buds and shoots, the number of leaves per plant, and the survival percentage were recorded. On the other hand, the root parameters are the diameter of the thickest root (mm), the number of primary and secondary roots, the length of the longest root (cm), and the percentage of rooted cutting (%). There were of 13 treatments T_1 (50 ppm GA_3), T_2 (100 ppm GA_3), T_3 (150 ppm GA_3), T_4 (200 ppm GA_3), T_5 (50 ppm NAA), T_6 (100 ppm NAA), T_7 (150 ppm NAA), T_8 (200 ppm NAA), T_9 (25 ppm GA_3+25 ppm NAA), T_{10} (50 ppm GA_3+50 ppm NAA), T_{11} (75 ppm GA_3+75 ppm NAA), T_{12} (100 ppm GA_3+100 ppm NAA) and T_{13} (Control).

Results and Discussion

3.1 Growth attributes:

An essential characteristic that characterizes the promptness of various therapies is bud initiation. The administration of T_7 (150 ppm NAA) achieved the minimum number of days required for bud sprouting, while the plots that received no growth regulators (absolute control) reported the highest number of days required, which might be the cause of the rising number of days. A synergistic impact of the optimal concentration of the plant growth regulator may be the cause of this early sprouting. The administration of NAA may have increased cell division and elongation, which may have altered the physiological process and started the bud. Similar findings were noted in Bougainvillaea by Mehraj *et al.,* (2013), Thakur (2009), and Sahariya *et al.,* (2013).

A bud is an immature or embryonic sprout that often develops at the tip of a stem or in the leaf axil. The current study demonstrates notable variations in the quantity of buds across different treatments. The plant treated with 75 ppm GA_3 + 75 ppm NAA, or T_{11}, had the most buds, whereas the control group had the fewest. Different plant types, seasonal variations, and the thickness of the stem cuttings might all be contributing factors to this rise in the number of buds. This is consistent with the results of the 2008 study by Kochhar *et al.,* on *Jatropha curcas*. Another explanation might be the quick mobilization and accumulation of metabolites, as well as the increase in cell elongation, which likely affected floral morphogenesis and produced the most buds per plant. The study of Singh *et al.,* (2014) in Duranta golden and Singh, 2004 in tuberose, as well as Ali Torkashvanda and Shadparvar, 2012 in *Hibiscus rosa-sinensis*, supports these findings.

The buds in T_{10} (50 ppm GA_3 + 50 ppm NAA) were the longest. Auxins stimulated shoot development, which may have led to stem elongation and sprout length through cell division, resulting in more sprouts and the longest sprout. This is consistent with research conducted on *Jasminum sambac* by Husen and Mishra (2001) in *Vitex negundo*, Singh *et al.,* (2003) in *Piper longum*, and Singh (1979). The lengthening of the sprout is undoubtedly a result of auxins and gibberelic acid concentration stimulating both cell division and cell expansion (Ranjan *et al.,* 2003). Mehraj *et al.,* (2013) observed similar findings in Bougainvillaea, while Singh *et al.,* (2013) reported similar findings in *Cestrum nocturnum*.

3.2 Root Characters:

The plant's nutritional state has a significant role on a stem's ability to root. The hardwood's strong roots allowed the cuttings to take up more nutrients. The highest proportion of rooted cutting was seen in (150 ppm GA_3). By preventing carbohydrates and other root-promoting elements from moving downward, gibberellin may have raised the proportion of rooted cuttings. This is consistent with the findings of Hartmann and Kester (1968). Stoltz and Hess (1966) found similar outcomes with hibiscus cuttings.

The longest root's maximum length was noted in T_7 (150 ppm NAA). The administration of NAA, which is crucial for adventitious root formation, root quality enhancement, and root biomass growth, may be the cause of this (Husen and Pal 2007). The use of auxin may have promoted cell division, expansion, metabolite accumulation, hydrolysis of carbohydrates, and the creation of new proteins. The results of Shenoy (1992) in Rosa damascena, Babashpour *et al.,* (2012) in *Bougainvillaea sp.,* and Singh *et al.,* (2013) in *Cestrum nocturnum* are consistent with this.

The plant that received T_{12} treatment (100 ppm GA_3 and 100 ppm NAA) had the thickest root with the largest diameter. Increased metabolic activity and optimal use of sugar and starch following hydrolysis from the stem may be the cause of these phenomena. This is consistent with *Citrus auriantifolia* research by Bhatt and Tomar (2010). Gibberellins support a variety of favorable outcomes, such as stem elongation, root length, and root diameter, and are engaged in several root development processes. *Babashpour et al.,* (2012) in *Bougainvillaea species*, Mehraj *et al.,* (2013) in *Bougainvillaea spectabilis*, and Khassawneh *et al.,* (2006) in Black iris also observed similar findings.

The cuttings treated with 100 ppm GA_3 + 100 ppm NAA had the highest number of primary roots. It could have been brought on by auxin's activity, which hydrolysed and moved nitrogenous and carbohydrate materials near the base of cuttings, accelerating cell division and elongation in the right conditions. Gibberellin application and Hartmann *et al.,* (2007) may have enhanced cell elongation and division in the meristematic area, leading to the greatest number of primary roots. The results of Rai *et al.,* (2006) in Tomato and Shamet and Sharma (2004) in Red Cedar both corroborate this conclusion.

T_5 (50 ppm NAA) had the highest secondary root (12.36). Basipetal (downward) buildup of vital internal chemicals and a hormone that promotes quicker callusing may be the likely cause of the increase in primary and secondary root numbers in cuttings (Table 2). The results of Mesen *et al.,* 2001 study on *Albizia guacapale* stem cutting support this.

Conclusion

The present study demonstrates that the application of growth regulators GA_3 and NAA significantly influences the rooting and sprouting behavior of Hydrangea macrophylla cuttings under open conditions. Among all treatments, 150 ppm NAA (T7) was most effective in promoting early bud initiation and produced the thickest sprouts, while 200 ppm GA_3 (T4) led to the highest leaf production. Root development was notably enhanced with combined treatment of 100 ppm GA_3 + 100 ppm NAA (T12), which yielded the greatest number of primary roots and the thickest root diameter. Additionally, 50 ppm NAA (T5) resulted in the highest number of secondary roots. These findings suggest that optimal concentrations and combinations of GA_3 and NAA can significantly improve vegetative propagation of Hydrangea macrophylla, offering practical applications for commercial floriculture and landscape use.

Table:1

Treatment	Number of Days taken for the first bud sprout ± SE(m)	Number of buds ± SE(m)	Number of shoots ± SE(m)	Average diameter of thickest sprout (mm) ± SE(m)	Number of leaves per plant ± SE(m)	Survival % ± SE(m)
T1	14.73*±0.12	1.26*±0.09	0.90±0.45	12.47*±0.27	5.93±2.97	28.00 (4.70±1.85)
T2	14.56*±0.28	1.42*±0.06	0.90 ±0.45	12.53*±0.03	5.93±2.97	26.66 (4.60±1.80)
T3	15.03*±0.86	1.26*±0.10	0.86 ±0.43	12.03 ±0.62	5.13±2.59	29.33 (4.80±1.90)
T4	15.03*±1.40	1.23*±0.07	1.03 ±0.51	12.63* ±0.26	6.70±3.36	30.66 (4.90±1.95)
T5	14.23*±0.52	1.20*±0.11	0.86 ±0.43	12.67* ±0.54	6.03±3.03	32.00 (4.90±2.00)
T6	13.83*±1.56	1.22*±0.10	0.86 ±0.43	12.63* ±0.37	6.00±3.00	30.66 (4.90±1.95)
T7	13.33*±0.40	1.34*±0.07	0.90 ±0.45	14.13* ±0.28	6.00±3.00	36.00 (5.27±2.14)
T8	15.83*±0.80	1.46*±0.13	0.83 ±0.41	12.77* ±0.51	5.90±2.95	25.33 (4.49±1.75)
T9	14.70* ±0.98	1.24* ±0.12	0.90 ±0.45	14.03* ±0.12	6.10±3.05	30.66 (4.9±1.95)
T10	14.33*±0.49	1.21* ±0.10	0.90 ±0.45	12.33* ±0.08	5.93±2.97	30.66 (4.9±1.95)
T11	14.53*±0.66	1.50* ±0.03	0.90 ±0.45	12.37* ±0.17	5.83±2.91	30.66 (4.9±1.95)
T12	14.60*±0.17	1.35* ±0.14	0.90 ±0.45	12.10 ±0.23	5.83±0.91	30.66 (4.9±1.95)
T13	19.16 ±0.78	0.96 ±0.03	0.80 ±0.40	11.30 ±0.12	5.90±2.95	30.66 (4.9±1.95)
SE(d)	1.02	0.07	0.05	0.47	0.38	2.52
C.D.(0.05)	2.13	0.15	0.12	0.97	0.79	5.21

Table 2

Treatment	Percentage of rooted cutting (%) ± SE(m)	Number of primary root ± SE(m)	Secondary root ± SE(m)	Length of longest root (cm) ± SE(m)	Diameter of thickest root (mm) ± SE(m)
T1	54.66* (7.45±0.17)	23.50* ±0.60	13.96* ±0.48	3.22* ±0.02	0.40* ±0.01
T2	58.66* (7.72±0.17)	22.23* ±1.21	13.63* ±0.66	3.31* ±0.09	0.42* ±0.03
T3	53.33* (7.37±0.09)	20.50* ±0.29	12.50* ±0.56	3.38* ±0.18	0.38 ±0.01
T4	58.66* (7.71±0.23)	22.53* ±1.68	13.93* ±0.17	3.63* ±0.11	0.47* ±0.03
T5	61.33* (7.89±0.08)	25.13* ±0.52	17.63* ±1.32	3.47* ±0.46	0.46* ±0.02
T6	53.33* (7.36±0.18)	22.33* ±0.64	13.16* ±0.69	3.64* ±0.46	0.45* ±0.01
T7	52.00* (7.28±0.00)	23.53* ±0.52	13.43* ±0.32	3.54* ±0.42	0.42* ±0.01
T8	66.66* (8.22±0.16)	23.16* ±1.10	12.10* ±0.57	3.05* ±0.99	0.55* ±0.01
T9	53.33* (7.36±0.18)	29.76* ±1.14	14.70* ±0.77	3.36* ±0.08	0.43* ±0.01
T10	52.00* (7.28±0.00)	21.03* ±0.37	12.83* ±0.84	3.88* ±0.45	0.47* ±0.01
T11	54.66* (7.46±0.09)	22.96* ±0.57	13.40* ±0.74	4.13* ±0.12	0.42* ±0.06
T12	56.00* (7.54±0.15)	22.13* ±0.89	14.53* ±1.18	3.33* ±0.21	0.43* ±0.07
T13	44.00 (6.70±0.17)	16.33 ±0.61	7.46 ±1.16	2.38 ±0.08	0.32 ±0.00
SE(d)	3.19	1.98	1.27	0.26	0.03
C.D.(0.05)	6.64	4.11	2.64	0.54	0.07

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