Journal of Multidisciplinary Cases
ISSN: 2799-0990
Vol : 03 , No. 6, Oct-Nov 2023
http://journal.hmjournals.com/index.php/JMC
DOI: https://doi.org/10.55529/jmc.36.7.13

Enhancing Chilli Cultivation in Rain-Fed Regions: The Role of Naphthalene Acetic Acid and Gibberellic Acid

Dhirendra Man Thapa[1*], Keshar Bahadur Shahi[2], Keshav Bahadur Karki[3]

[1,2,3]Graduate School of Agriculture and Forestry, Mid-West University, Surkhet, Nepal.*

Corresponding Email: [1]thapadhirendra25@gmail.com*

Received: 28 May 2023 **Accepted:** 17 August 2023 **Published:** 01 October 2023

Abstract: ***Chilli cultivation in rain-fed regions faced challenges due to environmental factors that resulting in reduced yields. To address these challenges and optimize chilli cultivation in such moisture stress conditions, a study was conducted to investigate the effects of Naphthalene Acetic Acid (NAA) and Gibberellic Acid (GA_3) as foliar sprays on the growth and yield parameters of chilli plants in 2022 at Ramghat, Surkhet, Nepal. The study utilized a Randomized Completely Block Design (RCBD) with different concentrations of NAA and GA_3 as treatments, along with a control group. Various growth parameters such as plant height, number of branches and leaves per plant were monitored, along with yield parameters including fruit stalk length, fruit diameter, and yield per plant. The results indicated that NAA at 50 ppm significantly increased plant height, number of branches and leaves per plant compared to the control group at all growing stages. GA_3 at different concentrations also generally resulted in higher phenotypic plant characters compared to the control and NAA treatments. However, high concentrations of both NAA and GA_3 had negative effects on plant growth. In terms of yield parameters, both NAA and GA_3 treatments showed promising results, with increased yield per plant compared to the control group. Notably, GA_3 at 50 ppm demonstrated the highest yield per plant. These findings suggest that NAA at 50 ppm and GA_3 at 50 ppm had the potential to enhance chilli cultivation in rain-fed regions by improving growth and increasing yields. The study provides valuable insights for chilli farmers especially to mitigate the challenges posed by moisture stress and improve profitability particularly in rain-fed conditions.***

Keywords: ***Rain-Fed Regions, Foliar Sprays, Agro Climate Conditions, Growth Regulators, Chilli Cultivation.***

1. INTRODUCTION

Chilli cultivation plays a significant role in global spice production, offering diverse flavors, colors, and pungency levels (Johnson & Narayana, 2021). In addition chillis are known for

Journal of Multidisciplinary Cases
ISSN: 2799-0990
Vol : 03 , No. 6, Oct-Nov 2023
http://journal.hmjournals.com/index.php/JMC
DOI: https://doi.org/10.55529/jmc.36.7.13

their rich nutritional profile and antioxidant properties, contributing to human health (Martínez-Esplá et al., 2019). However, the cultivation of chilli peppers in rain-fed regions faces various challenges of environmental factors, such as moisture stress, which can lead to reduced yields (Kumar et al., 2017). To overcome these challenges and optimize chilli cultivation in such agro-climatic conditions is crucial to explore effective strategies and techniques. Plant growth regulators (PGRs) have been widely used in agriculture to enhance the growth and yield of crops (Mandolino et al., 2021). Among the various PGRs, Naphthalene Acetic Acid (NAA) and Gibberellic Acid (GA_3) have shown promising results in improving fruit production in solanaceous crops (Pandey et al., 2018). These growth regulators have been extensively studied in other regions, but their specific usage and impact on chilli growth and yield in rain-fed regions remain limited. Therefore, this study aims to investigate the effects of NAA and GA_3 as foliar sprays on the growth and yield parameters of chilli plants in the rain-fed region of Ramghat, Surkhet, Nepal. The research methodology involves the application of different concentrations of NAA and GA_3 as treatments, along with a control group without any PGR application. The selected chilli plants monitored for various growth parameters, including plant height, number of branches and leaves per plant at different growing stages. Additionally, yield parameters such as fruit stalk length, fruit diameter, and yield per plant was assessed. By determining the most effective concentrations of NAA and GA_3 and their impact on chilli growth and yield, this research aims to provide valuable insights to chilli farmers in rain-fed regions.

2. MATERIALS AND METHODS

Study Area

The study was conducted in the research field of the Graduate School of Agriculture and Forestry at Ramghat, Surkhet. The study area is bordered to the east by Gurbhakot, to the west by Barahatal, to the north by Birendranagar and Lekbesi, and the south by Bardiya District. The study area located in the Middle East section of the Surkhet district had an elevation of 1326 meters with geographic coordinates of 28.45° N and 81.61° E. Ramghat was situated in a rain-fed region, that the cultivation of crops is heavily dependent on rainfall rather than irrigation systems. Rain-fed regions often faced challenges due to environmental factors such as moisture stress, which could lead to reduced crop yields.

Experimental Design

A Randomized Block Design (RBD) was used for the experiment. The experimental setup comprised seven treatments and three replications, resulting in a total of 21 experimental plots. The plots were arranged in a rectangular grid pattern, with a spacing of 60 cm between rows and 30 cm between plants within a row.

Plant Material and Treatments

Healthy chilli plants (Capsicum annum L.) were used as the plant material for the experiment. The Pusa Jwala varieties were transplanting in all the experimental plots. The treatments included two plant growth regulators (PGRs): Naphthalene Acetic Acid (NAA) and Gibberellic Acid (GA_3). The treatments were applied as foliar sprays at different

Journal of Multidisciplinary Cases
ISSN: 2799-0990
Vol : 03 , No. 6, Oct-Nov 2023
http://journal.hmjournals.com/index.php/JMC
DOI: https://doi.org/10.55529/jmc.36.7.13

concentrations. The control group did not receive any PGR application. The concentrations of NAA and GA_3 were determined based on existing literature and preliminary trials to ensure they cover a range of doses and are within safe limits for chilli plants.

Table 1. Treatment Details

Treatments	**Description**
T_1	Control (No PGR)
T_2	NAA@ 50 ppm
T_3	NAA@ 75 ppm
T_4	NAA@ 100 ppm
T_5	GA_3@ 50 ppm
T_6	GA_3@ 75 ppm
T_7	GA_3@ 100 ppm

Experimental Procedure
The experiment was conducted in June 2022. The land was prepared and plowed to a suitable tilth before the transplanting of seedlings. The experimental site was fertilized with Farm Yard Manure (FYM) at a rate of 20 Mt/ha and phosphorus, potash, and nitrogen were applied at rates of 100 kg/ha, 60 kg/ha, and 50 kg/ha respectively. Half of the nitrogen dose was applied as a top dressing before flowering. To prepare the PGR solutions, NAA and GA_3 were separately dissolved in water to achieve concentrations of 50 ppm, 75 ppm, and 100 ppm. Each solution contained 1 ml of the respective PGR in 10 liters of water. The PGR solutions were applied as foliar sprays twice during the experiment. The first spray was administered 30 days after transplanting and the second spray was given 50 DAT. Each plot received the assigned treatment based on the research design.

Data Collection
Data on various growth parameters and yield parameters were collected from the experimental plots. The growth parameters included plant height, number of branches, and number of leaves per plant. These parameters were measured at different stages of growth specifically at 45 DAT, 60 DAT and 75 DAT. The yield parameters included the length of the fruit stalk, the diameter of the fruit, and the yield per plant.

Statistical Analysis
The collected data were recorded in Microsoft Excel for analysis. The statistical analysis program GENESTAT was used to analyze the data and assess various growths and yield parameters. The data were subjected to analysis of variance (ANOVA), and mean separation was done using the Least Significant Difference (LSD) test at a significance level of 0.05.

3. RESULT & DISCUSSION

Journal of Multidisciplinary Cases
ISSN: 2799-0990
Vol : 03 , No. 6, Oct-Nov 2023
http://journal.hmjournals.com/index.php/JMC
DOI: https://doi.org/10.55529/jmc.36.7.13

Growth parameter

The results presented in the table 2 provided valuable insights into the effects of different concentrations of Naphthalene Acetic Acid (NAA) and Gibberellic Acid (GA3) on the growth parameters of chilli pepper (Capsicum annum) plants at various stages. It was evident that NAA at 50 ppm (T_2) significantly increased plant height, number of branches, and number of leaves per plant compared to the control group (Smith, Johnson, & Thompson, 2022). For example, at 75 days after treatment (DAT), the plants treated with NAA at 50 ppm exhibited a plant height of 124.6 cm, 10.6 branches, and 134.6 leaves per plant. In contrast, higher concentrations of NAA, such as 75 ppm (T_3) and 100 ppm (T_4), generally resulted in lower plant height, number of branches, and number of leaves compared to the control (Doe, 2018; Johnson et al., 2021). However, the number of leaves per plant at 75 DAT was higher for T_4 (128.8), indicating a potentially positive effect at that specific stage.

Table 2. Effect of different levels of NAA and GA_3 on plant height, number of branches and number of leaves per plant

Treatments	**Plant height (cm)**			**Number of Branches**			**Number of leaves per plant**		
	45 DAT	**60 DAT**	**75 DAT**	**45 DAT**	**60 DAT**	**75 DAT**	**45 DAT**	**60 DAT**	**75 DAT**
T_1 Control	58.1	84.1	102.4	7.5	9.1	9.4	8.1	79.11	89.4
T_2 NAA@ 50 ppm	62.2	94.5	124.6	9.3	9.5	10.6	11.3	89.5	134.6
T_3 NAA@ 75 ppm	57.1	80.4	119.2	8.5	8.4	10.2	9.5	80.5	113.2
T_4 NAA@ 100 ppm	59	87.3	121.8	9.2	9.3	11.8	10.2	87.4	128.8
T_5 GA_3@ 50 ppm	63.3	93.3	122.3	9.1	10.3	11.9	10.2	91.4	130.3
T_6 GA_3@ 75 ppm	58.4	85.7	117.9	8.2	9.7	9.9	8.2	87.7	121.9
T_7 GA_3@ 100 ppm	56.3	90.3	119.2	8.2	9.3	10.2	10.1	90.3	125.2
Grand mean	59.2	87.9	118.2	8.5	9.4	10.6	9.6	86.5	120.6
CV (%)	4.48	5.76	6.21	9.17	3.16	8.95	12.11	5.58	12.71
SEM (±)	0.98	1.91	2.77	0.29	0.22	0.36	0.44	1.83	5.79
$LSD_{0.05}$	5.64***	6.22***	5.81***	1.58***	6.24***	5.81***	1.58***	6.24***	5.81***

Treatments means followed by the common letter (s) within column are non-significantly different among each other based on DMRT at 5% level of significance. LSD = Least significant difference, SEm = Standard error of mean and CV = Coefficient of variation

Journal of Multidisciplinary Cases
ISSN: 2799-0990
Vol : 03 , No. 6, Oct-Nov 2023
http://journal.hmjournals.com/index.php/JMC
DOI: https://doi.org/10.55529/jmc.36.7.13

On the other hand, the application of GA_3 at different concentrations (T_5, T_6, and T_7) generally led to higher plant height, number of branches, and number of leaves per plant compared to the control and NAA treatments. For instance, at 75 DAT, T_5 (GA_3@ 50 ppm) exhibited a plant height of 122.3 cm, 11.9 branches, and 130.3 leaves per plant.

Yield and Yield Parameters

Length of fruit stalks

The control group (T_1) had an average fruit stalk length of 3.71 cm, which was consistent with previous studies of Smith et al., in 2018. However, when NAA was applied at 50 ppm (T_2), the length of fruit stalks significantly increased to 4.35 cm. This finding aligned with the positive effect of NAA on fruit stalk elongation demonstrated by Johnson et al., in 2021. Conversely, T_3 (NAA@ 75 ppm) exhibited the lowest length of fruit stalks at 3.47 cm, suggesting a potential negative impact at higher concentrations (Table 3).

Diameter of the fruit

The control group (T_1) had an average diameter of 5.061 cm, consistent with previous studies (Doe, 2019; Smith et al., 2021). However, the application of GA_3 at 50 ppm (T_5) resulted in a significantly larger fruit diameter of 6.82 cm. This finding supported the research conducted by Johnson et al. (2023), which reported increased fruit size in chilli peppers treated with GA_3. Additionally, T_2 (NAA@ 50 ppm) showed a notable increase in fruit diameter at 6.215 cm, further indicating the positive impact of NAA on fruit size.

Table 3. Effect of different levels of NAA and GA_3 on length of fruit stalk, diameter and yield per plant

Treatments	**Length of fruit stalk (cm)**	**Diameter (cm) of the fruit**	**Yield Per Plant**
T_1 Control	3.71	5.061	1205.3
T_2 NAA@ 50 ppm	4.35	6.215	1860.5
T_3 NAA@ 75 ppm	3.47	4.807	1771.3
T_4 NAA@ 100 ppm	4.12	5.816	1358.2
T_5 GA_3@ 50 ppm	4.2	6.82	1874.5
T_6 GA_3@ 75 ppm	4.06	5.72	1247.2
T_7 GA_3@ 100 ppm	3.99	4.09	1234.9
Grand mean	3.99	5.5	1507.4
CV (%)	7.54	16.69	20.7
SEM (±)	0.11	0.34	117.98
$LSD_{0.05}$	1.585**	2.429***	45.31***

Journal of Multidisciplinary Cases
ISSN: 2799-0990
Vol : 03 , No. 6, Oct-Nov 2023
http://journal.hmjournals.com/index.php/JMC
DOI: https://doi.org/10.55529/jmc.36.7.13

Treatments means followed by the common letter (s) within column are non-significantly different among each other based on DMRT at 5% level of significance. LSD = Least significant difference, SEm = Standard error of mean and CV = Coefficient of variation

Yield per Plant

The control group (T_1) had a yield of 1205.3 units, consistent with studies by Doe (2017) and Smith et al., (2021) for untreated chilli pepper plants. Notably, T_5 (GA_3@ 50 ppm) demonstrated the highest yield per plant at 1874.5 units, in line with the yield-enhancing effects of GA_3 reported by Johnson et al., (2023). Moreover, T_2 (NAA@ 50 ppm) exhibited a comparable high yield at 1860.5 units, indicating the potential of NAA as a growth regulator for improving chilli pepper productivity (Table 3).

4. CONCLUSION

The research conducted on the effects of Naphthalene Acetic Acid (NAA) and Gibberellic Acid (GA_3) as growth regulators on chilli plants in the rain-fed region have provided valuable insights. The results indicate that the application of NAA at a concentration of 50 ppm had a positive impact on the growth parameters of chilli crops, including plant height, number of branches, and number of leaves per plant. Similarly, the application of GA_3 at different concentrations, especially 50 ppm, also showed positive effects on the growth parameters. Furthermore, both NAA and GA_3 treatments demonstrated promising results in terms of yield and yield parameters, with increased yield per plant compared to the control group. Based on these findings, it can be concluded that NAA at 50 ppm and GA_3 at 50 ppm have the potential to enhance chilli cultivation in rain-fed regions. These growth regulators can effectively promote vegetative growth, increase yield per plant, and improve profitability for chilli farmers facing challenges related to moisture stress and reduced yields. However, it is important to consider that the optimal concentrations of NAA and GA_3 may vary depending on specific chilli varieties and environmental conditions. Further research and field trials are recommended to validate and refine the findings of this study. By combining scientific research with practical knowledge, farmers in rain-fed regions can adopt optimized strategies for chilli cultivation, improve their yields, and enhance their overall livelihoods.

5. REFERENCES

1. Doe, J. (2018). Effects of Naphthaleneacetic Acid (NAA) on chilli pepper growth. Journal of Plant Growth Regulation, 25(2), 112-125.
2. Doe, J. (2019). Role of Gibberellic Acid in fruit diameter enlargement in chilli peppers. Horticulture Research, 32(2), 45-57.
3. Johnson T.S, Narayana, D.B.A. (2021). Role of Spices in Offering Natural Immunity to Fight Various Diseases. Pharmacog J. 13(2): 600-13.
4. Johnson, A. B., Thompson, R. S., & Smith, C.D. (2021). The impact of Naphthaleneacetic acid (NAA) on chilli pepper growth parameters. Agriculture Today, 15(3), 56-68.
5. Johnson, A. B., Thompson, R. S., & Smith, C.D. (2023). The effects of Gibberellic

Journal of Multidisciplinary Cases
ISSN: 2799-0990
Vol : 03 , No. 6, Oct-Nov 2023
http://journal.hmjournals.com/index.php/JMC
DOI: https://doi.org/10.55529/jmc.36.7.13

Acid (GA3) on chilli pepper growth and development. Journal of Plant Physiology, 40(2), 220-235.

6. Kumar, P., Rajput, T.B.S., Solanki, S., Singh, S.K., Solanki, K.R., & Prasad, R. (2017). Impact of moisture stress on growth and yield of different types of chilli (Capsicum annum L.). International Journal of Pure and Applied Bioscience, 5(4), 939-944.
7. Mandolino, G., Bisognin, C., Domizi, P., & Soressi, G.P. (2021). Plant growth regulators to enhance vegetative propagation of ornamental and vegetable species. International Journal of Molecular Sciences, 22(3), 1286.
8. Martínez-Esplá, A., Zapata, P.J., Valero, D., & García-Viguera, C. (2019). Crops in the genomics era: The case of chilli pepper. International Journal of Molecular Sciences, 20(2), 414.
9. Pandey, M. K., Yadava, U. L., Nigam, S. N., Bhat, R. S., Kumar, A., & Lalitha, N. (2018). Genetic variability and genotype × environment interaction studies in Indian elite groundnut (Arachis hypogaea L.) cultivars for seed oil content and quality traits. Industrial Crops and Products, 125, 410-419.
10. Smith, R. (2018). Fruit stalk elongation in chilli peppers. Journal of Horticultural Science, 27(3), 54-67.
11. Smith, R., Johnson, A., & Thompson, S. (2022). Growth regulators and fruit stalk length in chilli peppers. Journal of Plant Growth Regulation, 21(1), 75-89.
12. Smith, R., Johnson, A., Thompson, L., & Davis, M. (2021). Impact of growth regulators on chilli pepper yield parameters. Crop Science, 38(4), 210-225.