ZIBELINE INTERNATIONAL™ PUBLISHING

ISSN: 2521-0858 (Print)
ISSN: 2521-0866 (Online)
CODEN: SHJCAS

Science Heritage Journal (GWS)

DOI: http://doi.org/10.26480/gws.02.2023.76.78

RESEARCH ARTICLE

VARIATION OF GROWTH AND YIELD OF CHILLI WITH DIFFERENT DOSES OF NITROGEN IN LAMJUNG DISTRICT, NEPAL

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ARTICLE DETAILS

Article History:

Received 06 June 2023
Revised 15 July 2023
Accepted 24 August 2023
Available online 28 August 2023

ABSTRACT

The study was undertaken to assess how the growth and yield of the NS-1701 chili variety were impacted by different nitrogen doses in the Lamjung district's Rainas area. The study involved arranging five different treatment combinations within a Randomized Complete Block Design (RCBD), with each combination being replicated four times. The application consisted of doses (0 kilograms per hectare, 30 kilograms per hectare, 60 kilograms per hectare, 90 kilograms per hectare, 120 kilograms per hectare). Various parameters related to plant growth and yield were observed throughout the study timeframe. The data underwent statistical analysis utilizing Microsoft Excel and R-studio software. Duncan's Multiple Range Test (DMRT) was applied to distinguish means at a significance level of 5% for the purpose of separation. Growth characteristics such as plant height and the quantity of branches, along with yield-related attributes like fruit length, number of fruits per plant, individual plant weight, and yield (tons per hectare), displayed noteworthy variations until the point of harvest. Among varying nitrogen quantities, the most pronounced plant height (82.40 cm), branch count (8.38), fruit length (11.41 cm), fruits per plant (116.55), per-plant yield (475.5 gm), and overall yield (31.70 t/ha) were achieved with the application of 120 kilograms of nitrogen per hectare. Across all characteristics studied, the analysis of variance (ANOVA) indicated a noteworthy disparity between the various nitrogen doses concerning both yield and growth parameters. Among the range of nitrogen doses tested, the utilization of 120 kilograms of nitrogen per hectare resulted in enhanced growth and yield characteristics. This outcome could be proposed as a beneficial approach for cultivating chili in both the Lamjung district and comparable agro-ecological circumstances.

KEYWORDS

Chilly variety NS-1701, Nitrogen, Vegetative, Yield parameters

1. INTRODUCTION

Being an agrarian nation, approximately 66% of the country's population engages in agriculture. The agricultural sector holds the most significant share in the GDP, accounting for 27.08% in the fiscal year 2019/2020, a slight rise from 26.98% in the previous year (CBS, 2019/2020). Vegetable cultivation plays a vital role in Nepal's farming system, experiencing rapid growth in recent times. In pursuit of improved returns, numerous farmers are shifting their focus from cereal crops. The cultivation of vegetables is estimated to involve over 3.2 million households, with women heading 17% of these households. Presently, this sector contributes 9.7% to the national GDP, primarily driven by small-scale subsistence farming units. Varieties such as Jwala, Nepa hot, NS-1701, Anna 3, NS-1101, Goli, Akash, and Big mama are among the types of chili being cultivated.

Chili, scientifically known as Capsicum annuum L., holds significant importance as a prized spice crop. The Capsicum genus belongs to the Solanaceae family. The primary hub of variation for the widely cultivated Capsicum annuum pepper is likely situated in Mexico, accompanied by a secondary hub in Guatemala (Bose and Som, 1986).

Chilli holds the third position among spice crops in Nepal, trailing behind cardamom and ginger. Its cultivation spans across various regions including Terai, inner Terai, lower hills, and mid hills. In the year 2021, the total land area dedicated to chili cultivation in Nepal covered 9,195 hectares, resulting in a production of 95,398 metric tons and achieving a productivity rate of 10.37 tons per hectare (measured in fresh weight). Specifically, in Lamjung, the figures for chili cultivation are 80 hectares of area, yielding 725 metric tons, and achieving a productivity of 9.06 tons per hectare (MoALD, 2021).

Chilli peppers thrive in hot climates, yet they struggle to develop fruit effectively when the nighttime temperature exceeds 24°C. The ideal daytime temperature range for promoting chili pepper growth spans from 20 to 30°C. Extended periods of temperatures dropping below 15°C or rising beyond 32°C often result in diminished growth and yield (Berke, 2005). Both temperatures below 16°C and above 32°C hinder the process of fruit setting (Bosland, 1994). The most optimal flower setting takes place when both day and night temperatures fall within the range of 21°C to 16°C. The best yields are achieved when the daily air temperature during the fruit-setting phase falls between 18°C and 32°C (Olarewaju, 1989).

Fruit set and yield experience a sudden decline when temperatures surpass 40°C (Deshpande, 1988). Elevated temperatures lead to a decrease in both the percentage of fruit set (Anand et al., 1992) and the size of the fruits. The primary cause of reduced pepper production lies in the loss of flower buds, flowers, and young fruits, and the chief environmental factor contributing to the shedding of reproductive structures is extreme temperatures, either too low or excessively high

Quick Response Code	Access this article online	
	Website: www.jscienceheritage.com	DOI: 10.26480/gws.02.2023.76.78

Cite The Article: Sabin Bhattarai, Seema Adhikari, Shrisha Shrestha, Sagar Manandhar (2023). Variation of Growth and Yield of Chilli with Different Doses of Nitrogen in Lamjung District, Nepal. *Science Heritage Journal, 7(2): 76-78.*

(Cochran, 1936). Some cultivars fail to initiate fruit set when the temperature exceeds the range of 37 to 40°C (Kriakraun, 1998). Furthermore, an imbalance in nutrients and biotic factors such as diseases and insect pests worsen the situation (Agrios, 1984; Khan and Suryanarayana, 1977). Among diseases, viral infections prevail the most, followed by anthracnose, in the context of hot pepper cultivation.

Chilli pepper, scientifically known as Capsicum annuum, is widely esteemed and holds considerable economic significance on a global scale due to its vibrant color, distinct flavor, spiciness, and nutritional worth, enhancing the appeal of numerous dishes (Berke, 2005). Both freshly harvested and dried chillies find frequent application in culinary endeavors, either in their natural state or following various processing methods, to enhance taste, color, and spiciness. Furthermore, this versatile ingredient serves as a rich source of Vitamins C and A, in addition to its recognized medicinal properties.

1.1 Varietal description about NS-1701

This top-tier hybrid boasts tall and expansive plant growth, with well-developed branching, resulting in abundant yields. The glossy green fruits transition into a gleaming deep red hue as they reach maturity. Measuring between 7 and 12 centimeters in length and with a girth of 0.8 centimeters, the fruits of this hybrid are characterized by their intense spiciness. Additionally, the plants display a notable resistance to viruses. This hybrid variety is perfectly suited for both fresh green chili consumption and the drying process. With its broad adaptability, it thrives even in high-temperature conditions.

- Hybrid type: Dual Purpose Hybrids
- Relative days to maturity (DS) - Green: 75
- Relative days to maturity (DS) - Red: 85
- Wall thickness: thin
- Immature fruit color: light green
- Mature fruit color: dark red
- Pungency SHU: very high 75000 SHU
- Disease tolerance: tolerance to virus
- Length x grith: 8 x 0.8
- Remarks: performs well under high temperature, suitable for round the year

2. Materials and Methodology

The study took place in Harrabot, located within the Rainas Municipality of Province 4, on the land of a forward-thinking farmer registered in PMAMP, Lamjung. Lamjung, positioned within the sub-tropical mid-hills, spans from 28048' North latitude to 84028' East longitude, at an elevation of 600 meters above sea level. The experimental setup employed a Randomized Complete Block Design (RCBD), incorporating five distinct treatment combinations and replicated for four time.

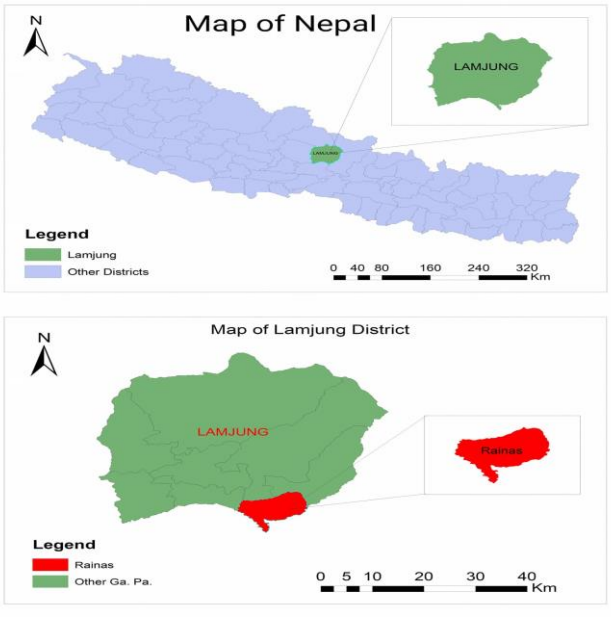

Figure 1: Map showing lamjung district and research site

Study Parameters

Selected plants were subject to the recording of various growth and yield attributes, including plant height, count of flowering branches, fruits per plant, fruit length, individual plant fruit yield, and cumulative fruit yield. Data collection took place at 15-day intervals, beginning 30 days after transplantation and spanning up to 90 days after transplantation.

Treatment and their combination

1. Number of treatments: 5
2. Number of replications: 4
3. Total number of plots: 20
4. Size of plots: 1.5m×2m
5. Plant to plant distance: 30 cm
6. Row to row distance: 50 cm
7. Design: RCBD
8. Crop: Chilli
9. Variety: NS-1701
10. Date of planting: 21st Falgun
11. Total area of field: 110.5m2

Table 1: Treatment combinations

Treatment Number	Nitrogen Doses (Kg/Ha)
1	0(only FYM)
2	30
3	60
4	90
5	120

3. Result and Discussion

3.1 Plant Height

The utilization of varying nitrogen levels influenced the growth of plant height, as an augmentation in nitrogen dosage corresponded to an elevation in height. By the 75th day after transplanting (DAT), the highest plant height of 82.40 cm was observed with the application of 120 kg nitrogen per hectare, whereas the lowest height of 55.25 cm was recorded in the absence of nitrogen application (0 kg/ha). Similar outcomes were replicated at the 30th, 45th, and 60th DAT. Statistical analysis using Duncan's Multiple Range Test (DMRT) at a significance level of $p<0.05$ revealed parallels between nitrogen doses of 90 kg/ha and 120 kg/ha.

The elevated plant height resulting from the escalation of nitrogen dosage could potentially be attributed to the heightened concentration of nitrogen fertilizer. This increase in concentration might lead to an augmentation in nitrogen uptake, thereby positively influencing chlorophyll concentration, photosynthetic rates, and ultimately contributing to increased plant height (Lal and Pundrik, 1971). The increased plant height associated with the use of inorganic fertilizer might stem from more efficient metabolic activities carried out by the crops under optimal fertility conditions (Rajanna et al., 1987).

Based on above facts a conclusion can be made that with increasing dose of nitrogen the height of plants increases proportionately

Table 2: Effect of different dose of nitrogen on plant height at different days after planting

Treatment	Plant Height			
	30 DAT	45 DAT	60 DAT	75 DAT
Nitrogen level				
0 kg/ha	19.50^{d}	41.65^{d}	51^{e}	55.25^{d}
30 kg/ha	19.90^{d}	47.55^{c}	56.25^{d}	62.5^{c}
60 kg/ha	23.45^{c}	50.85^{bc}	59.9^{c}	64.25^{c}
90 kg/ha	26.90^{b}	53.78^{ab}	68.3^{b}	75.15^{b}
120 kg/ha	29.25^{a}	55.65^{a}	74.9^{a}	82.40^{a}
Mean	23.8	49.89	62.07	67.91
LSD	0.74	3.98	2.20	2.95
SEm	0.24	1.31	0.76	0.97
C.V%	2.05	5.27	2.34	2.86
F- test	***	***	***	***

3.2 Number of Flowering Branches

The quantity of flowering branches experienced an impact due to the application of nitrogen doses, where an elevated nitrogen level resulted in an increase in the number of flowering branches. The highest count of flowering branches, 8.38, was noted with the application of 120 kg nitrogen per hectare, while the lowest count, 4.35, was observed with the absence of nitrogen application (0 kg/ha).

The presence of nitrogen exerts a notable influence on the quantity of flowering branches per plant, primarily by triggering vegetative growth. These findings are consistent with the observations made who established that there is a positive correlation between the rate of nitrogen application and the increase in the number of flowering branches per plant by (Manchanda and Singh, 1988).

Based on above facts a conclusion can be made that with increasing dose of nitrogen the number of flowering branches increases proportionately

Table 3: Effect of different dose of nitrogen on number of branches at different days after planting

Treatment	Number of Flowering Branches
Nitrogen level	
0 kg/ha	4.35^{e}
30 kg/ha	5.48^{d}
60 kg/ha	6.5^{c}
90 kg/ha	7.6^{b}
120 kg/ha	8.38^{a}
GM	6.46
LSD	0.55
SEm	0.18
C.V%	5.59
F-test	***

3.3 Number of Fruits Per Plant

The application of different nitrogen doses had a notable impact on the quantity of fruits per plant, as an escalation in nitrogen levels corresponded to an augmentation in the number of fruits per plant. The highest count of fruits per plant, reaching 116.55, was noted with the utilization of 120 kg nitrogen per hectare, while the lowest count, at 69.15, was observed when no nitrogen was applied per hectare (0 kg/ha).

The quantity of fruits per plant demonstrated a gradual rise in tandem with the augmentation of nitrogen dosage. These findings align with the observations made who similarly documented that elevating the nitrogen fertilizer rate leads to an increase in the average weight of fruits by (Bar-Tal et al., 2001; Villa-Castorena et al., 2003).

Based on above facts a conclusion can be made that with increasing dose of nitrogen the number of fruits per plant increases proportionately

Table 4: Effect of different dose of nitrogen on number of fruits per at different days after planting

Treatment	Number of fruits per plant		
	60 days	75 days	90 days
Nitrogen level			
0 kg/ha	11.65^{c}	32.50^{d}	25.0^{e}
30 kg/ha	15.00^{c}	38.05^{c}	27.5^{d}
60 kg/ha	21.80^{b}	41.50^{b}	32.0^{c}
90 kg/ha	24.90^{ab}	43.75^{b}	36.5^{b}
120 kg/ha	28.25^{a}	48.80^{a}	39.5^{a}
GM	20.32	40.92	32.1
LSD	5.21	2.71	2.09
SEm	1.71	0.89	0.67
C.V%	16.90	4.36	4.29
F-test	**	***	***

3.4 Fruit Length

The length of the fruit experienced changes due to the application of different nitrogen doses, with a rise in nitrogen levels correlating to an increase in fruit length. The most considerable fruit length, measuring 11.41 cm, was noted with the application of 120 kg nitrogen per hectare, followed by 90 kg nitrogen per hectare at 10.34 cm. Conversely, the shortest fruit length was documented in the absence of nitrogen application (0 kg/ha), measuring 8.24 cm.

The outcome could potentially be attributed to heightened cell division resulting from the augmentation of nitrogen doses. This observation aligns to some extent with the findings of who similarly noted an enhancement in fruit size corresponding to the increase in nitrogen application (Lal and Pundrik, 1971).

Based on above facts a conclusion can be made that with increasing dose of nitrogen the fruit length increases proportionately

Table 5: Effect of different dose of nitrogen on fruit length

Treatment	Fruit Length (cm)
Nitrogen level	
0 kg/ha	8.24^{d}
30 kg/ha	8.68^{cd}
60 kg/ha	9.19^{c}
90 kg/ha	10.34^{b}
120 kg/ha	11.41^{a}
GM	9.56
LSD	0.56
SEm	0.18
C.V%	3.92
F-test	***

3.5 Yield Of Chilli Per Plant

The application of nitrogen doses had a discernible impact on the chili yield per plant, with an elevated nitrogen level corresponding to an augmentation in the yield of chili per plant. The highest chili yield per plant, amounting to 475.5 grams, was recorded with the utilization of 120 kg nitrogen per hectare, followed by 90 kg nitrogen per hectare at 418.88 grams. Conversely, the lowest chili yield per plant was observed in the absence of nitrogen application (0 kg/ha), measuring 237.35 grams.

Substantial differences were observed in the chili yield per plant across various nitrogen treatment doses. As the nitrogen doses increased gradually, both the fruit weight and the number of fruits per plant exhibited a corresponding gradual increase. The data indicated that the lowest fruit weight was recorded with the application of lower doses (T1 treatment). However, the highest yield of chili per plant was achieved with the implementation of T3 treatment (120 kg N ha-1). These outcomes are consistent with the findings of who similarly noted that escalating nitrogen fertilizer rates lead to an augmentation in the average fruit weight and volume of chili (Akanbi et al., 2007).

Based on above facts a conclusion can be made that with increasing dose of nitrogen the yield of chilli per plant increases proportionately

Table 61: Effect of different dose of nitrogen on yield per plant at different days after planting

Treatment	Yield of chilli per Plant (gm)		
	60 days	75 days	90 days
Nitrogen level			
0 kg/ha	53.85^{c}	101.5^{d}	82.0^{c}
30 kg/ha	64.13^{c}	151.0^{c}	110.0^{b}
60 kg/ha	97.13^{b}	152.0^{c}	135.0^{a}
90 kg/ha	113.88^{ab}	161.0^{b}	144.0^{a}
120 kg/ha	138.5^{a}	185.5^{a}	151.5^{a}
GM	93.49	150.2	124.5
LSD	24.86	6.78	18.05
SEm	8.19	2.24	5.952
C.V%	17.53	2.97	9.56
F-Test	**	***	**

3.6 Yield Of Chilli (T/Ha)

The chili yield experienced an impact due to the application of varying nitrogen doses, with higher nitrogen levels correlating to an increase in chili yield. The highest chili yield, amounting to 31.7 tons per hectare, was recorded with the utilization of 120 kg nitrogen per hectare, followed by

90 kg nitrogen per hectare at 27.9 tons per hectare. Conversely, the lowest chili yield was observed in the absence of nitrogen application (0 kg/ha), measuring 15.82 tons per hectare.

The data indicated that the application of 120 kg of nitrogen per hectare resulted in the highest quantity of fruits per plant, consequently leading to a substantial increase in the overall yield per hectare. This finding aligns with the observations made who similarly concluded that the optimal nitrogen fertilizer level led to the highest yield per plant by (Ahmed et al., 2007). reported similar outcomes in pea cultivation Similarly, (Bahuguna et al., 2014).

Based on above facts a conclusion can be made that with increasing dose of nitrogen the yield of chilli increases proportionately

Table7: Effect of different dose of nitrogen on yield of NS-1701 variety of chilli

Treatment	Yield (Ton/Ha)			
	60 days	75 days	90 days	Total yield
Nitrogen level				
0 kg/ha	3.59^{c}	6.76^{d}	5.47^{c}	15.82^{d}
30 kg/ha	4.27^{c}	10.07^{c}	7.3^{b}	21.67^{c}
60 kg/ha	6.47^{b}	10.13^{c}	9.0^{a}	25.60^{b}
90 kg/ha	7.59^{ab}	10.73^{b}	9.6^{a}	27.92^{b}
120 kg/ha	9.23^{a}	12.37^{a}	10.1^{a}	31.70^{a}
GM	6.23	10.01	8.29	24.54
LSD	1.65	0.45	1.20	2.49
SEm	0.54	0.15	0.39	0.82
C.V%	17.53	2.97	9.56	6.71
F-test	**	***	**	***

4. Conclusion

Plant height exhibited significant variation based on nitrogen doses, with greater nitrogen levels resulting in increased height. The utmost plant height was observed with the application of 120 kg nitrogen per hectare, while the minimum plant height was recorded in the absence of nitrogen (0 kg/ha). The 120 kg nitrogen per hectare treatment exhibited superior performance in terms of flowering branch count, whereas the lowest branch count was noted with no nitrogen application. The number of fruits per plant displayed a positive correlation with nitrogen dosage, with higher doses leading to increased fruit yield. Conversely, the lowest number of fruits per plant was observed with the lowest nitrogen dose of 0 kg/ha. Among the treatments, the greatest fruit length was observed with 120 kg nitrogen per hectare, followed by 90 kg nitrogen per hectare and 60 kg nitrogen per hectare, while the lowest fruit length was noted without nitrogen application. The yield of chili per plant reached its pinnacle with the application of 120 kg nitrogen per hectare, while the least yield was observed in the absence of nitrogen. These findings align with ANOVA results, which indicated significant disparities among nitrogen doses in both yield and growth parameters.

The research findings distinctly demonstrated that the employment of 120 kg nitrogen per hectare outperformed other treatments in terms of both growth and yield parameters. Among the various nitrogen doses tested, 120 kg per hectare exhibited enhanced growth and yield indicators. The utilization of 120 kg nitrogen per hectare resulted in the highest chili yield (31.7 t/ha). To sum up, cultivating chili with an application of 120 kg nitrogen per hectare proved to be a productive approach in the Lamjung region.

Authors' Contribution

S. Bhattarai designed the research plan; S. Bhattarai, S. Adhikari, S. Shrestha and S. Manandhar performed experimental works and collected the required data. S. Bhattarai and S. Adhikari analyzed the data; S. Bhattarai prepared the manuscript. S. Shrestha and S. Manandhar critical revised and finalized the manuscript. Final form of manuscript was approved by all authors.

Conflict of Interest

The authors declare that there is no conflict of interest with the present publication.

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