Libyan Journal of Medical and Applied Sciences LJMAS

Online ISSN: 3006-1113

Volume 3, Issue 2, 2025, Page No: 23-29

Website: https://ljmas.com/index.php/journal/index

The Effect of Foliar and Soil Application of Urea Fertilizer on the Growth of the Vegetative Total of Nalta Jute (*Corchorus Olitorius*)

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Received: April 02, 2025 Accepted: May 02, 2025 Published: May 07, 2025

Cite this article as: A, M, Aebeedat., H, A, Hendi., A, A, Mustafa. (2025). The Effect of Foliar and Soil Application of Urea Fertilizer on the Growth of the Vegetative Total of Nalta Jute (Corchorus Olitorius). Libyan Journal of Medical and Applied Sciences (LJMAS). 2025;1(1):23-29.

Abstract:

The study was conducted in Wadi Ataba region in southwestern Libya during the summer season of 2023 to investigate the growth response of Nalta Jute plants to foliar spraying and ground fertilization. A practical study was carried out according to a complete block design (RCBD) to study the effect of nitrogen fertilization on growth traits (plant height and number of leaves) for the season, where the treatments included four levels of fertilization with (urea 46.4% N) fertilizer (0, 0.5, 1, and 4) g N/254 cm², coded as (N0, N1, N2, N3) respectively by adding it to the soil surface directly, and (0, 0.5, 1, 4) g N/litre (R1, R0, R2, R3) respectively by spraying it on the leaves by dissolving it in 1L of water. The study concluded that there were significant differences between the added concentrations of urea as they affected plant growth traits. It was found that the fertilization level of 1 g/254 cm² and 1 g/L for foliar and ground fertilization had the best effect on plant characteristics. In comparison, the concentration of 4 g/254 cm² and 4 g/L for foliar and ground fertilization affected the plants negatively, resulting in leaf drop and the death of some plants. The study showed significant differences in plant height and number of leaves in foliar fertilizer spraying compared to spreading it on the soil surface, and the study also showed the effect of fertilizer type and concentration on wet and dry weight.

Keywords: Foliar and Soil application, Vegetative growth, Nalta Jute plants, Urea.

دراسة تأثير إضافة سماد اليوريا ورقياً وأرضياً على نمو المجموع الخضري لنبات الملوخية

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الملخص

أُجريت الدراسة في منطقة وادي عتبة في جنوب غرب ليبيا خلال الموسم الصيفي لعام 2023 لدراسة استجابة نمو نباتات الملوخية للرش الورقي والتسميد الأرضي. تم إجراء دراسة عملية وفق تصميم كتلة كاملة (RCBD) لدراسة تأثير التسميد النيتروجيني على صفات النمو (ارتفاع النبات وعدد الأوراق) للموسم، حيث شملت المعالجات أربعة مستويات من التسميد بسماد (يوريا 4. 46%) سماد (0، 0.5، 1، 4) غم ن/ 254 سم²، ورمزت بـN0 ، N1، N2، N3على التوالي بإضافته على سطح التربة مباشرة، و(0، 0.5، 1، 4) غم /لترR1 ، R0، R2، R3على التوالي برشه على الأوراق بإذابته في 1 لتر من الماء. وخلصت الدراسة إلى وجود فروق كبيرة بين التركيزات المضافة من اليوريا حيث أثرت على صفات نمو النبات. وقد وجد أن مستوى التسميد 1 جم/254 سم² و1 جم/لتر للتسميد الورقي والأرضي كان له أفضل تأثير على صفات النبات. وبالمقارنة، فإن تركيز 4 جم/254 سم² و4 جم/لتر للتسميد الورقي والأرضي أثر سلباً على النباتات مما أدى إلى تساقط الأوراق وموت بعض النباتات. كما أظهرت الدراسة وجود فروق معنوية في ارتفاع النبات وعدد الأوراق في رش السماد الورقي مقارنة بنثره على سطح التربة، كذلك تأثير نوع السماد وتركيزه على الوزن الرطب والجاف.

الكلمات المفتاحية: التسميد الورقي والأرضي، نبات الملوخية، النمو الخضري، سماد اليوريا

Introduction

Nalta jute (Corchorus olitorius L.), also known as Tossa jute, Egyptian spinach, or molokhia, is an annual herbaceous plant belonging to Tiliaceae family with a growth height of 2 to 4 meters [1]. It is abundantly grown and consumed as a vegetable in many countries of the world. Nalta jute possesses tender and flavorful younger leaves while older leaves turn fibrous and woody making them chewy and less palatable [2]. Jute is widely regarded as a nutrient-dense vegetable because, along with other nutraceuticals, it contains abundance of B1, B2, A, C, E, folic acid, and minerls, including beta carotene, calcium, and iron. This plant is often used to make a well-known leafy soup [3]. One of the reasons why these vegetables are consumed in greater numbers is due to the high amounts of phenolic compounds quercetin and caffeoylquinic acid, which suggest certain antioxidant properties. These properties do indicate some form of protection against chronic diseases such as diabetes, cancer, heart disease, and hypertension [4]. Most of the people that these vegetables are critical to the health of populations that are economically dependent on cereals for their diet due to Nalta jute's unique nutritional profile revolving around abundant supply of essential vitamins, minerals, and proteins. Research has focused on plant growth and yield in relation to the application of foliar and ground fertilizers [5]. Johnson et al. (2001) studied productivity and fruit growth in Early Maycrest, an early-maturing peach cultivar, using low-biuret urea as a foliar fertilizer. Their analysis indicated that nitrogen applied to the soil may be necessary to support root growth and other related activities. Similarly, Amiri et al. (2008) examined apple tree yield and fruit quality in relation to mineral nutrient concentrations in soil, leaves, and fruits after foliar and ground fertilization [6]. Their results highlighted the significance of fertilization methods on both fruit quality and the quantity of nutrients absorbed [7]. El-Kady et al. (2010) reported on the impact of nitrogen fertilizer rates and nitrogen foliar application on the development, yield, and yield components of sunflowers. According to their findings, both nitrogen fertilizer and foliar fertilization significantly enhanced plant development and output. Additionally, Geries et al. (2011) investigated the growth, yield, and storage of onions in relation to the timing of potassium and urea foliar sprays [8]. The study suggested that the right timing and method of fertilization are effective ways to improve crop production and quality. Currently, a significant number of farmers fail to adhere to the appropriate conditions when applying a variety of fertilizers. Some farmers indiscriminately apply chemical fertilizers, which can result in harm to the soil, plants, and humans. To rationalize the use of urea fertilizer and to determine the optimal method and ratio of fertilization, Al-Juthery et al. (2020) studied the influence of urea and nano-nitrogen fertigation, as well as the foliar application of nano-boron and molybdenum, on potato growth and yield metrics [9]. Their research emphasized the potential benefits of novel fertilizer application strategies in improving crop performance and output. Overall, the research indicates that the use of foliar and ground fertilizers can significantly impact plant growth, productivity, and nutrient utilization. The timing and method of fertilizer application are essential for optimizing crop productivity and quality. Further research into the influence of foliar and ground urea fertilizer treatments on the growth of Nalta jute is needed to discover the best fertilization strategies for this crop. The Nalta jute plant (Corchorus olitorius) was selected due to its rapid growth as a leafy vegetable to investigate the impact of nitrogen fertilizer through foliar and soil application, given its status as a consumable leafy vegetable.

Methods

An experiment was conducted in southwestern Libya to study the growth response of Nalta Jute plants to foliar spraying and ground fertilization. A complete block design was used to examine the effects of nitrogen fertilization on various growth traits. Four levels of fertilizer were applied either to the soil surface or as a foliar spray dissolved in water. Growth traits were analyzed using ANOVA with three replicates, and means were compared using the least significant difference (LSD). Fertilization levels were administered in two doses, with the first dose applied 35 to 55 days after germination. This experiment aimed to determine the impact of nitrogen fertilization on the growth of Nalta Jute plants and identify the most effective application method.

Nalta Jute plants were grown in pots measuring 21 cm in height and 18 cm in diameter, each containing 3 kg of soil with a pH of 7.4.

Seeds were planted in pots on August 28, 2023. Seven experimental units were established, with 30 seeds planted per pot and 3 seeds per hole after irrigation. Seeds appeared 3 days after sowing, and the number of plants was reduced to 10 per pot after 9 days.

Measurements of plant height and leaf number were recorded after germination to monitor growth prior to fertilization, specifically at 15 to 20 days.

After 35 days of germination, plant measurements were taken, and the first dose of fertilizer was applied. Urea fertilizer levels were weighed using a sensitive scale, and measurements were recorded 4 and 10 days after the

first fertilization.
After 55 days, measurements were again taken, followed by the application of the second dose of urea fertilizer. Measurements were recorded 4 and 10 days after the second fertilization.
The cultivation continued for 71 days, after which the plants were harvested above the soil surface. The wet weight was measured, and the plants were dried under sunlight in well-ventilated conditions for 4 days, after which the dry weight was measured.

Results

The results in Figure 1 show the measurements of plants 1, 2, and 3 before ground and foliar fertilization. The measurements indicated that the plant lengths and the number of leaves were similar.

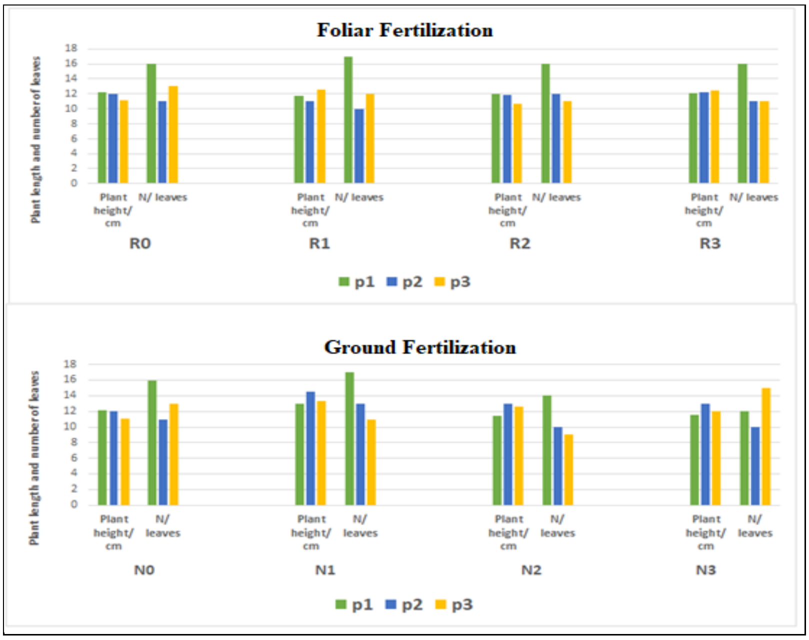

Figure 1. Plant's Measurements before Folair and Ground Fertilization

After recording these measurements, the first dose of urea fertilizer was added at different concentrations for the treatments.
The results are presented in Figure 2, which illustrates the effects of foliar fertilization on plants ten days after the first dose of urea. The data indicate significant differences between treatments in terms of plant height and the number of leaves.

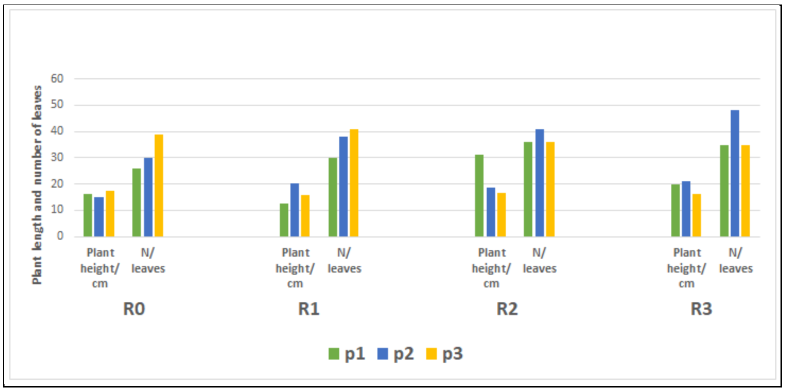

Figure 2. Plant's Measurements of Foliar Fertilization 10Days after the first Round

N2, with a concentration of 1 g, achieved the highest plant heights (21.3 cm, 18.7 cm, and 16.5 cm) and the greatest number of leaves (36, 41, and 39) respectively. followed by N1, with a concentration of 0.5 g, which resulted in plant heights of 12.5 cm, 20.1 cm, and 16 cm, and leaf counts of 30, 38, and 41 respectively. In contrast, N3 with a concentration of 4 g, showed no significant differences in plant height and leaf count compared to N0, with measurements of 20 cm, 21.1 cm, and 16.2 cm for height, and 35, 48, and 35 for the number of leaves. Additionally, a negative effect was observed in N3 (4 g), leading to yellowing of leaf edges and leaf drop.

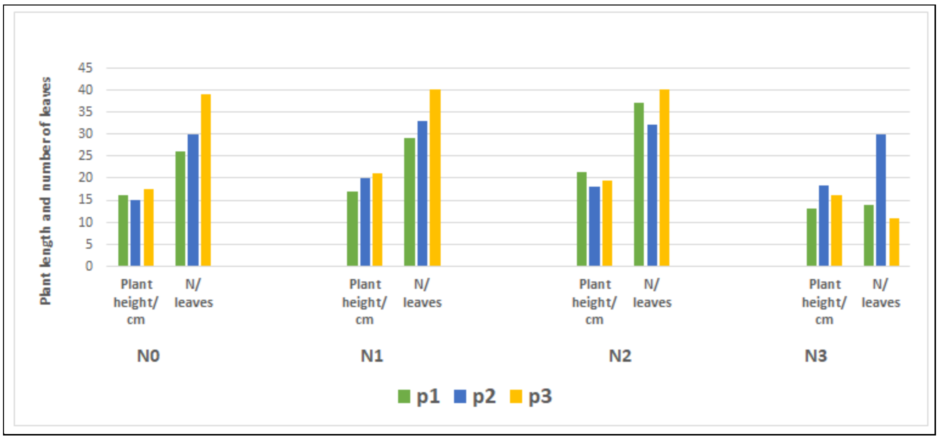

Figure 3. Plant's Measurements of Ground Fertilization 10Days after the first Round

As for the measurements of plants for ground fertilization ten days after the first dose of urea was applied. The findings in figure 3 above, indicate that spreading urea on the soil surface significantly impacted plant height and the number of leaves. Specifically, R2 which achieved the highest height among the plants, measuring 21.4 cm, 18 cm, and 19.5 cm, with corresponding leaf counts of 37, 32, and 40. No significant differences were observed between R0 and R1 at a concentration of 0.5 g/L. The measurements for the heights and number of leaves for the R1 and R0 treatments were 16.2 cm, 15 cm, and 17.5 cm in height, and 26, 30, and 39 leaves respectively. Again, no significant differences were noted between R0 and R1 at a concentration of 0.5g/L. Furthermore, the R3 fertilizer treatment at a concentration of 4 g/L had a noticeable negative effect, causing leaf burn and loss, with plant heights recorded as 13 cm, 18.4 cm, and 16 cm, and leaf counts of 14, 30, and 11. The results suggest that applying urea to the soil surface had a more detrimental effect than foliar application.

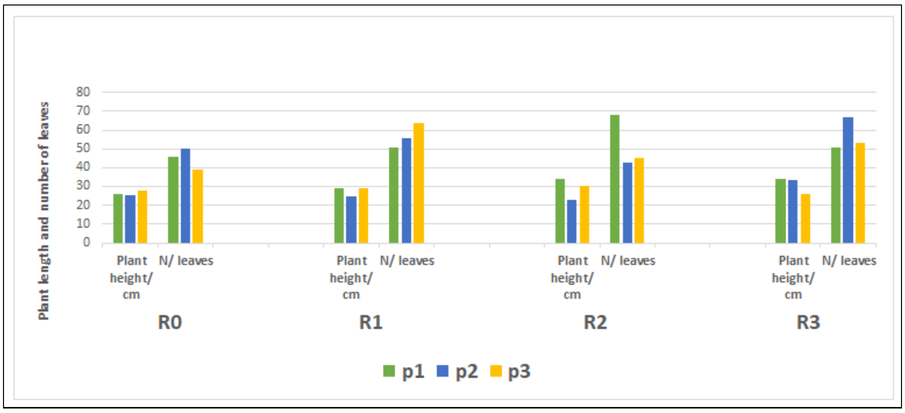

Figure 4. Plant's Measurements of Foliar Fertilization 10Days after the Second Round

The results presented in Figure 4 illustrate the effect of foliar fertilization measurements taken ten days after the second dose was applied. The data indicate that the highest growth rate was achieved with N2, which recorded plant heights of 34 cm, 23.5 cm, and 31.5 cm, and leaf counts of 68, 43, and 45. The addition of two sprays of urea positively influenced plant traits compared to a single spray.

In the N1 treatment, both plant height and leaf count exceeded those of N0, although the differences were minor and not statistically significant. However, N3 at 4 g showed a negative effect on leaf count, resulting in some leaf loss, while plant height increased slightly to 34.2 cm, 33.5 cm, and 26.1 cm, with leaf counts of 51, 67, and 53. The findings confirm that two sprays of urea positively affected plant traits.

Figure 5 shows the impact of ground fertilization on plants ten days after the second dose of urea fertilizer was added. The results indicate that R2 treatment led to the highest increases in both height and leaf count, measuring 29.9 cm, 26 cm, and 26 cm in height, and 60, 42, and 47 in leaf count, respectively. Significant differences were noted between the effects of N2 treatment in foliar fertilization and R2 treatment in ground fertilization regarding the tested plant traits.

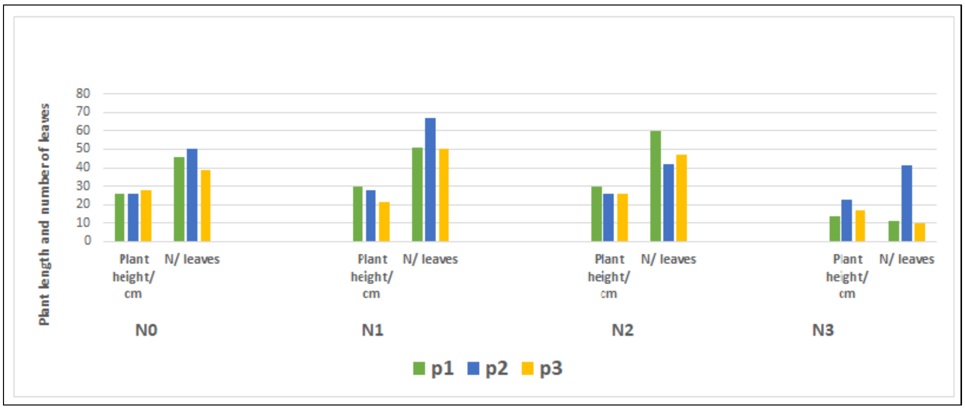

Figure 5. Plant's Measurements of Ground Fertilization 10Days after the Second Round

These results (Figures 4 and 5) suggest that appropriate rates of fertilizer applied to leaves yield a quicker response in plant height and leaf count.

In Figure 5, the results for R1 treatment show no significant differences between the N1 (foliar) and R1 (ground) treatments in terms of stem height and leaf count, although the N1 treatment performed better in both metrics. Additionally, the results indicate that the R3 treatment, applied in two doses to the soil surface, had a significant negative effect on the plants, resulting in the death of some and the loss of their leaves.

After recording the initial measurements and applying the first dose of urea fertilizer at varying concentrations on the soil surface, we observed increases in both height and leaf count after the first ten days. Specifically, R1 (0.5 g/L) resulted in a height increase of 17 cm and an additional 29 leaves, while N1 foliar fertilization led to a height increase of 12.5 cm and 35 new leaves. This indicated that foliar fertilization produced a greater increase in leaf numbers compared to ground application.

As for R1 (0.5 g/L), 10 days after the second fertilization, the plant height reached 30 cm with 51 leaves, while foliar fertilization N1 (5 g) resulted in a height of 29.3 cm and the same leaf count of 51. The results suggested that 0.5 g of nitrate applied to the ground was more effective than foliar spraying. Ten days after applying 1 g/L fertilizer on the leaves, the plants achieved a height of 21.3 cm with 38 leaves, while nitrate applied to the soil resulted in a height of 21.4 cm and 37 leaves, demonstrating superior plant height and leaf count compared to ground fertilization.

Overall, the experiment revealed that spraying fertilizer on the leaves was more effective than applying it to the soil surface. However, increasing the urea concentration to 4 grams in the ground (R3) caused some plants to die. When this concentration was dissolved in one liter of water and sprayed on the leaves (N3), it resulted in wilting and leaf drop.

The results shown in Figures 6 and 7 compare foliar and ground fertilization regarding plant height and the number of leaves at N2 and R2 concentrations for plant N1 over different time periods. It was observed that there is a convergence in plant stages during the early growth period, with a slight increase in plant height for foliar fertilization after the first dose of fertilizer. However, a clear increase in plant height was noted between foliar and ground fertilization after the second dose of fertilizer, with foliar fertilization demonstrating superiority.

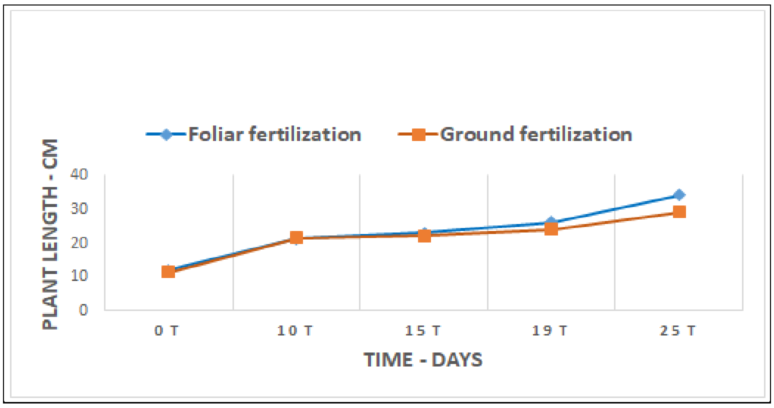

Figure 6. The Difference between Foliar and Ground Fertilization for Plant's Length at a Concentration of 1gm Urea

Figure 6 indicates that during the initial growth phases, there was a strong convergence in the number of leaves. Ten days after the first fertilization, foliar fertilization showed an accelerated increase in the number of leaves compared to ground fertilization. Following the addition of the second dose of fertilizer, significant differences emerged between the two methods, again favoring foliar fertilization.

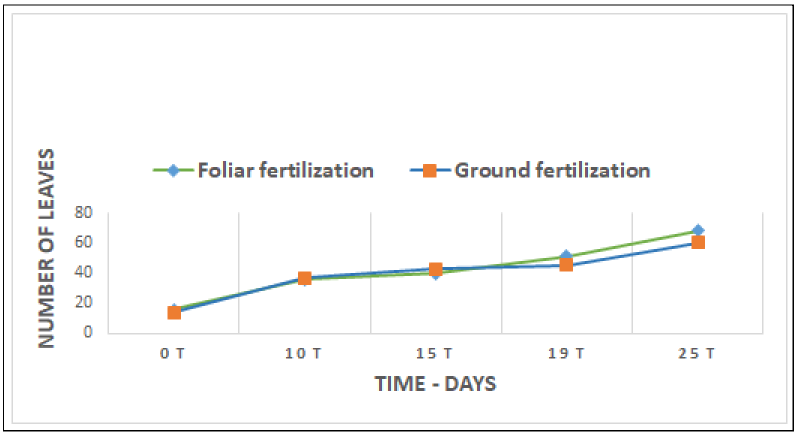

Figure 7. The Difference between Foliar and Ground Fertilization for Number of Leaves at a Concentration of 1gm Urea

The results presented in Table 1 demonstrate that foliar fertilization with N2 at a concentration of 1g produced superior outcomes compared to other fertilization levels when applied to the leaves. The N2 treatment resulted in the highest wet weight, with plants (N1, N2, N3) averaging 10.1g, 9.9g, and 6.6g, respectively. Similarly, N2 treatment also yielded the highest dry weight, with values of 3.3g, 3.6g, and 2.0g for plants (N1, N2, N3), respectively. These results can be attributed to the optimal amounts of nitrogen fertilizer used, consistent with previous findings by Hamza (2004) [10].

Table 1. Effect of Foliar Fertilisation on Wet and Dry Weight of Nalta jute**.**

	Wet weight/gm			Dry weight/gm		
	N1	**N2**	**N3**	**N1**	**N2**	**N3**
N0	5.6	8.2	6.5	1.9	3.1	2.1
N1	8.2	4.6	7.4	2.2	1.8	2.6
N2	10.1	9.9	6.6	3.3	3.6	2.0
N3	6.6	5.7	5.9	1.8	1.5	1.6

In contrast, the results indicate that N3 had the lowest wet weight, with values of 3.9g, 4.6g, and 3.3g for plants (N1, N2, N3), respectively. Additionally, N3 exhibited the lowest dry weight, reaching values of 1.0g, 1.6g, and 1.4g for plants (N1, N2, N3), respectively. This may be due to the negative effects of increased nitrogen levels on plant growth, highlighting the importance of using appropriate amounts of nitrogen fertilizers.

Table 2. Effect of Ground Fertilisation on Wet and Dry Weight of Nalta jute**.**

	Wet weight/gm			Dry weight/gm		
	N1	**N2**	**N3**	**N1**	**N2**	**N3**
R0	5.6	8.2	6.5	1.9	3.1	2.1
R1	6.2	10.1	4.3	2.3	1.8	1.7
R2	6.1	8.3	10.1	1.8	2.4	2.1
R3	3.9	4.6	3.3	1.0	1.6	1.4

The results in Table 2 for ground fertilization indicated that R2 outperformed the others in terms of wet and dry weight. The average wet weight for plants N1, N2, and N3 was 6.1 g, 8.3 g, and 10.1 g, respectively, while the average dry weight was 2.8 g, 2.4 g, and 2.2 g, respectively. The lowest wet and dry weights among the fertilization treatments were observed for R3, which had average wet weights of 3.9 g, 4.6 g, and 3.3 g for plants N1, N2, and N3, respectively, and average dry weights of 1.0 g, 1.6 g, and 1.4 g, respectively. This drop in weight was attributed to over-fertilization, which negatively affected the plants.

Conclusion

The study revealed significant differences in plant growth traits based on varying concentrations of urea. It was determined that fertilization levels of 1 g/254 cm² and 1 g/l for foliar and ground applications had the most positive effect on plant characteristics. In contrast, concentrations of 4 g/254 cm² and 4 g/l for foliar and ground applications negatively impacted the plants, leading to leaf drop and the death of some specimens. Additionally, the study demonstrated significant differences in plant height and leaf count when comparing foliar spraying of the fertilizer to soil surface application. The amount of nitrogen fertilizer applied influenced the development of the vegetative group, with the 1 g concentration yielding better results than the other concentrations via foliar spraying, which also affected wet and dry weight. Among the tested concentrations (0, 0.5, 1, and 4 g), the 1 g and 0.5 g treatments showed no significant differences in the wet and dry weight of the mallow crop.

Recommendations

- Raise awareness among farmers about the importance of using the appropriate amount of urea fertilizer, balancing economic returns with health effects.
- Develop diverse fertilization methods instead of relying on a single approach.
- Advise farmers against overusing urea fertilizer, as it can lead to crop spoilage as well as reduced productivity and quality.
- Conduct more studies on the residual nitrogen in crops, particularly in the form of nitrate, and evaluate its potential dangers to human health, animals, and the environment.
- Encourage farmers to apply fertilizer during the early stages of plant growth to enhance quality.
- Educate farmers on the best weather conditions for fertilizer application and advise against using it under direct sunlight.
- When using granular fertilizer, ensure that the appropriate amounts are added before irrigation to improve fertilization efficiency.
- Urge fertilizer manufacturers and companies to clarify safety procedures and methods of use.

Disclaimer

The article has not been previously presented or published, and is not part of a thesis project.

Conflict of Interest

There are no financial, personal, or professional conflicts of interest to declare.

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