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Effect of Clipping Frequencies on Forage Production and Nutrient Value of Pasture Herbaceous

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In the rural areas, rangelands play a crucial role in feeding livestock (sheep, goats, and cattle). However, since 2000, overgrazing has led to significant degradation of northern Iraq pastures. This study examined the effect of different clipping frequencies (non-clipped, once-clipped, twice-clipped, and triple-clipped) on natural vegetation's quality and quantity to simulate grazing. The results found that clipping increased moisture content but not significantly across multiple clipping. Once-clipped vegetation had the highest wet weight 1306.5 g/m^2, while non-clipped and once-clipped treatments had the highest dry weights 402.5 and 410.8 g/m^2 respectively. More frequent clippings reduced dry weight and dry matter percentages, whereas clipping did not significantly affect organic matter percentage. Once-clipped significantly reduced crude fiber 22.38% but this reduction was not significant beyond the first cutting. However, clipping increased crude protein percent, especially with triple-clipping 7.68%, and slightly increase ash content. Clipping also reduced ether extract and increased nitrogen-free extract slightly. The study concluded that minimal clipping preserves plant mass and improve crude protein and ash percentages while reducing fiber and ether extract. Once and twice clipping balances yield and nutritional quality, with once-clipping being optimal for wet yield and twice-clipping enhancing nutritional quality with manageable yield loss. Triple-clipping is not recommended due to significant yield reduction. For optimal forage quality and sustainability, once and twice clipping is recommended, making the forage more digestible without significant nutrient losses.

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Introduction

In the rural communities, thousands of farmers and animal breeders rely heavily on rangelands for feeding their livestock, which includes sheep, goats, and cattle. These breeders typically allow their animals to roam freely during grazing periods (Saleem *et al*., 2021). However, since 2000, overgrazing has become a significant issue in these rangelands, primarily due to the influx of large numbers of livestock (sheep and goats) brought in by animal breeders, in addition to local livestock. This continuous grazing from early spring to late summer has led to extensive degradation of the rangelands (Saleem *et al*., 2023). Overgrazing has been shown to significantly affect the structure and composition of natural vegetation (Silva and Overbeck, 2020). Moreover, grazing is recognized as a key tool in promoting grassland diversity (Wrage *et al*., 2011; Rook *et al*., 2004). Livestock impact rangelands through defoliation and trampling, which influences both plant and soil characteristics (Wrage *et al*., 2011).

A study on the nutritive value and yield of alfalfa (*Medicago sativa* L.) examined the effects of monocropping and intercropping with walnut (*Juglans regia* L.), along with varying mowing frequencies (once, twice, and thrice). It found that increasing mowing frequency improved both the nutritive value and yield of alfalfa. In monocropped alfalfa, mowing twice resulted in significant increases in crude protein, crude ash, and crude fat, while mowing thrice led to the lowest crude fiber content, which was significantly different from mowing once. In intercropped alfalfa, the contents of crude protein, crude ash, and crude fat responded similarly to mowing frequency, but crude fiber content decreased significantly as mowing frequency increased (Wang *et al*., 2025). A study on grazing intensity (2, 4 ewes/25m²) and duration (3, 6 hours) on young barley fields revealed that grazing duration had a more significant impact than grazing intensity on plant characteristics. The most intense treatment resulted in the lowest plant height and spike length values, and a greater reduction in straw than in grains, leading to an elevated harvest index (Abbas *et al*., 2011). The effect of mowing frequencies (once, twice, and three-times) significantly reduced the overall seed productivity of understory vegetation cover of Iraqi Kurdistan rangeland (Saleem *et al*., 2023). Timing of clipping can significantly impact fresh yield, dry yield, and dry matter percentage, clipping 110 days after sowing resulted in the highest values for these metrics (Tawfiq and Muhammed, 2013). Similarly, simulated grazing through clipping in Kainji Lake National Park revealed that clipped plots produced higher annual above-ground biomass and total production compared to unclipped plots. Additionally, forages in clipped plots exhibited higher levels of crude protein, fat, and essential nutrients like nitrogen (N), phosphorus (P), potassium (K), and sodium (Na) (Aremu *et al*., 2007). The timing of clipping has also been found to have a more significant impact on plant shoot weight than clipping height, with clipping during the tillering stage yielding the highest shoot mass (El-Shatnawi and Ghosheh, 1998). A greenhouse experiment assessing the influence of clipping frequency and height on four summer annual weed species, repeated clipping at the same height significantly reduced the reproductive dry weight of the weeds, indicating that repetitive mowing may be necessary to control weed growth and seed production (Butler *et al*., 2013). In a study on German grasslands, it was found that fertilization had the most significant negative impact on plant diversity and composition, whereas grazing had a positive effect (Socher *et al*., 2013). Another investigation focused on the effects of mowing, irrigation, and fertilization on plant and soil characteristics in a perennial cropping system. It was found that mowing height significantly influenced forage species composition, forage quality, plant productivity, and soil properties, with a mowing height of 10 cm resulting in the highest plant productivity and soil carbon levels (Bayliff, 2022). Two independent field experiments examining the effects of mowing frequency (one to five times per year) on cumulated dry matter yield and crude protein of *Leymus chinensis* (Trin.) Tzvel. The results found that mowing three times annually, cumulated dry matter and crude protein yield of *L. chinensis* were significantly higher than with less frequent mowing (Zhao *et al*., 2021). Further research in the Hexi Corridor area assessed the effects of grazing and fertilization on the yield and durability of perennial legume-grass mixtures. The study revealed that factors such as pre-mowing height, cutting height, and nitrogen application significantly influenced the production performance of mixed grasslands. Optimal results were observed with

a grass height of 40 cm before mowing and a cutting height of 5 cm, with high crude protein content and relative feed value under specific nitrogen and cutting height treatments (Wang *et al*., 2021). A three-year study on the effect of clipping height on the forage yield and quality of wetland meadow plant associations found that as clipping height decreased, forage yields increased. However, clipping date had a greater effect on forage crude protein concentration than clipping height (Dovel, 1996). Similarly, research in the Czech Republic indicated that intensive grazing resulted in greater biomass production, higher crude protein content, improved forage digestibility, and increased seasonal weight gains per hectare compared to extensive grazing (Pavlů *et al*., 2006). On the Loess Plateau, a study comparing simulated grazing and hay harvesting for oat, common vetch, and their combination found that simulated grazing led to increased forage yield, crude protein, and crude fat content, while decreasing crude ash content. The study also observed a positive correlation between precipitation during the growing season and grass yield and crude protein content (Li *et al*., 2022). A 13-year study on the nutritional value of semi-natural grasslands in Europe compared herbage quality under extensive and intensive management. The research found that after 7 weeks of growth, herbage from extensively managed areas was only suitable for beef cattle, while herbage from intensively managed areas was suitable for cattle maintenance or low-quality hay. By the 13th week, herbage quality had significantly declined, rendering it unsuitable as cattle feed (Pavlů *et al*., 2021). The objectives of this study were to investigate how clipping frequencies (simulating the grazing) affect the productivity and nutrient content of natural vegetation cover. Additionally, evaluate the optimal utilization of rangeland vegetation qualitatively, quantitatively, and balancing between them in term of animal feeding, and also preserving and sustaining the natural vegetation in pastures at the same time.

Materials and Methods

1. Site Description

This research was applied during the 2020 growing season at University of Duhok (UoD) campus (Duhok governorate/Kurdistan region/Iraq), surrounded by Latitudes (36°51′05″ N) and (36°52′25″ N), and by Longitudes (42°54′40″ E) and (42°55′43″ E). The campus is of an approximately 362.5 Hectares. Ranging in altitude from 480 to 590 meters above sea level (Saleem *et al.,* 2023).

2. Experiment and Treatments Description

Randomized Complete Block Design were implemented to conduct the research, four clipping treatments (non-clipped, once- clipped, twice- clipped, and triple-clipped) with four replications were applied on plots of $1m^2$, all blocks and treatments were separated by buffer stipes of 0.5m in-between to facilitate the field works. The vegetation cover was clipped (at height ≈5 cm) simulating the animals grazing. Setting the dates of clipping were scheduled as in (table 1) due to the observations and questions asked to the local farmer and ranchers that they used to graze their livestock starting from late January to early February, depending on the weather and plant

growth, and according to (Saleem *et al*., 2023) that the herbaceous generally rich the maturity stage at early May every year.

Table 1. Clipping treatments and clipping due date

Clipping frequencies	Date of clipping						
	1/2/2020	**15/2/2020**	**1/3/2020**	**15/3/2020**	**1/4/2020**	**15/4/2020**	**1/5/2020**
Non-Clipped interval							1/5/2020
Once-Clipped interval				15/3/2020			1/5/2020
Twice-Clipped interval	1/2/2020			15/3/2020			1/5/2020
Triple-Clipped interval	1/2/2020		1/3/2020		1/4/2020		1/5/2020

The herbaceous of all treatments were clipped at its scheduled due-date at ≈5 cm height.

The herbaceous of all treatment's plots were clipped at its scheduled due-date and saved in numbered polyethylene bags separately, their wet weight were recorded separately in the laboratory, then air-dried and saved in marked paper bags, and so on till the last clipping. At the end of growing season, all cumulated samples were dried in the oven at 70°C until the weight remained constant (Phillip *et al*., 1978). Weighing of wet, air dried, and oven dried samples were preformed using a (0.01 g sensitivity) digital balance GE812 Sartorius.

3. Chemical analysis

Oven dried samples were grinded by electrical blender according to Jackson (1958) method. The chemical analysis included the following components:

1- Dry matter content: by drying sample in oven at 70°C until the weight remained constant (g) (Phillip, 1978).

2- Crude protein content: by using Micro kjeldahl to determination (N) according to AOAC (2002), then CP was estimated by the following equation:

Crude protein % = Nitrogen % x 6.25 (protein factor) according to (AOAC, 2002).

3- Ether extract content: using Soxhlet apparatus (extraction with diethyl ether) according to (AOAC, 2002).

4- Crude fibers content: according to AOAC (2002) after the crude fat extracting from the samples.

5- Nitrogen-free extract content: according to (Aleem, 1978) procedure.

6- Minerals (Ash) content: using muffle furnace at 550°C for five hours according to (AOAC, 2002).

7- Organic matter percentage = 100 - Minerals (Ash) Percentage.

4. Statistical Analyses

All collected data were analyzed using Statistical Analyzes System version 9.3 (SAS, 2014), then all means were compared according to (Duncan, 1955) at significant level probability of < 0.05.

Table 2. Anova-table of quantitative and qualitative vegetation properties as affected by Clipping Frequencies

S.O.V	d.f.	MSE									
							Of DM%				
		WW	DW	Moist.	DM	OM	Ash	EE	CP	CF	NFE
Clipping Frequency	3	219977*	10550*	510*	510*	1.54	1.54	3.54*	5.38*	51.8	33.37
Blocks	3	16108	2011	4.4	.4.4	1.24	1.24	0.34	0.32	7.0	2.39
Error	9	10410	1068	16	16	1.26	1.26	0.20	0.51	19	18

* Refers to signification at $p < 0.05$.

Results and Discussion

A/ Quantitative Characteristics

1. Moisture Percentage

Figure 1 displays the impact of clipping on moisture content across the four different conditions. Clipping appears significantly increase the moisture content (68.5%, 66.15%, and 70% respectively) compared to the non-clipped condition (45.88%). But among the clipping treatments, no significant difference is observed, suggesting that once clipping begins, additional clipping does not substantially alter moisture content. This result was incomparable with (Zhao, *et al*., 2021).

Clipping (grazing) is physiologically and ecologically effective factor on plant regrowth, they often respond by producing new growth. This new growth tends to be more tender and contain higher moisture content than older and mature tissue. Additionally, in some plants (especially grasses), clipping alters the growth habit, making them bushier. This denser growth can help the plant retain moisture more effectively.

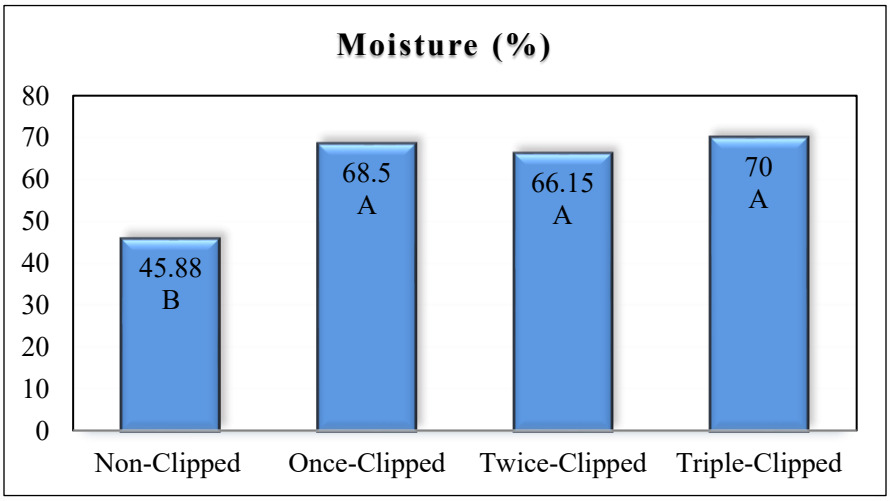

Figure 1. Moisture percentage of natural vegetation at different clipping frequencies

2. Wet Weight (g/m^2)

Figure 2 illustrate that clipping once results in the highest cumulated wet weight (1306.5g/m^2), suggesting an initial boost in growth following the clipping. However, additional clippings

reduce this weight (943.8, 1063 g/m^2 twice and triple clipped respectfully), though not significantly different from each other, implying that the benefit of clipping is diminished with increased frequency. Non-clipped samples have the lowest wet weight (745.5 g/m^2), indicating that some level of disturbance (clipping) can enhance growth, at least in terms of wet weight. This data may be relevant for practices involving plant or crop management, where moderate clipping might optimize yield. This result is comparable with (Pavlů *et al*. 2006; Aremu *et al*., 2007; Tawfiq and Muhammed, 2013; Bayliff, 2022; Li *et al*., 2022; Wang *et al*., 2022; Wang, *et al.,* 2025).

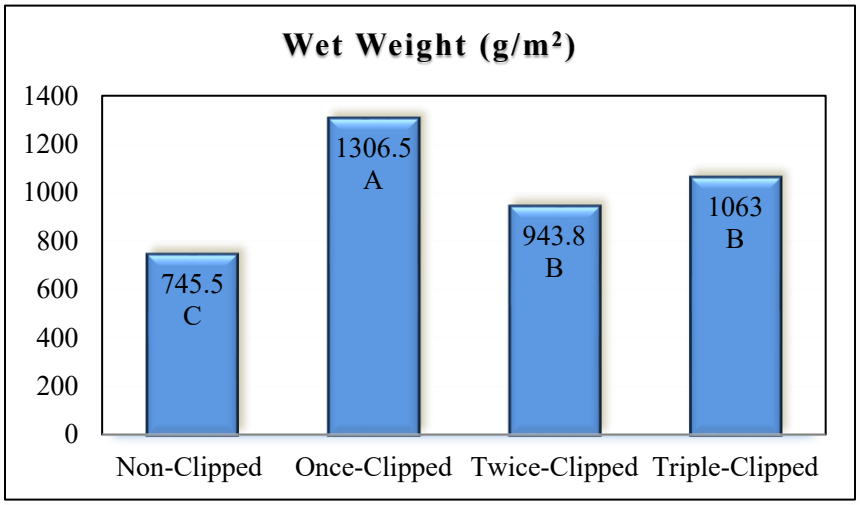

Figure 2. Wet weight (g/m^2) of natural vegetation at different clipping frequencies

3. Dry Weight (g/m^2)

It is clear from Figure 3, the highest values are almost identical between once-clipped (410.8 g/m²) and non-clipped (402.5 g/m²). Both are significantly higher than twice-clipped (317 g/m²) and triple-clipped (318.8 g/m²).

The dry weight analysis reveals that clipping once does not significantly change the dry weight compared to leaving the samples non-clipped. However, clipping more than once results in a significant reduction in dry weight. This suggests that while initial clipping might not harm the overall biomass, repeated clippings reduce the plant's ability to maintain or produce dry matter, possibly due to the soil exhausting, stress of repeated harvesting, and the shortness of growing season. This insight can be useful in agricultural or ecological management where maintaining dry biomass is important, indicating that minimal clipping is better for preserving plant mass. This result is similar to (Pavlů *et al*., 2006; Butler *et al*., 2013; Tawfiq and Muhammed; 2013, Li *et al*., 2022; Bayliff, 2022; Wang *et al*., 2025).

Once-clipped shows a dramatic increase in wet weight but not in dry weight, suggesting that the increase in wet weight could be due to increased water content rather than increased biomass. Non-clipped treatment has lower wet weight but maintains a dry weight similar to the once-clipped treatment, suggesting a higher proportion of actual biomass relative to water content.

Twice-clipped and triple-clipped treatments display lower wet weights and corresponding lower dry weights, indicating that these conditions result in reduced biomass production and possibly higher stress or resource depletion in the soil.

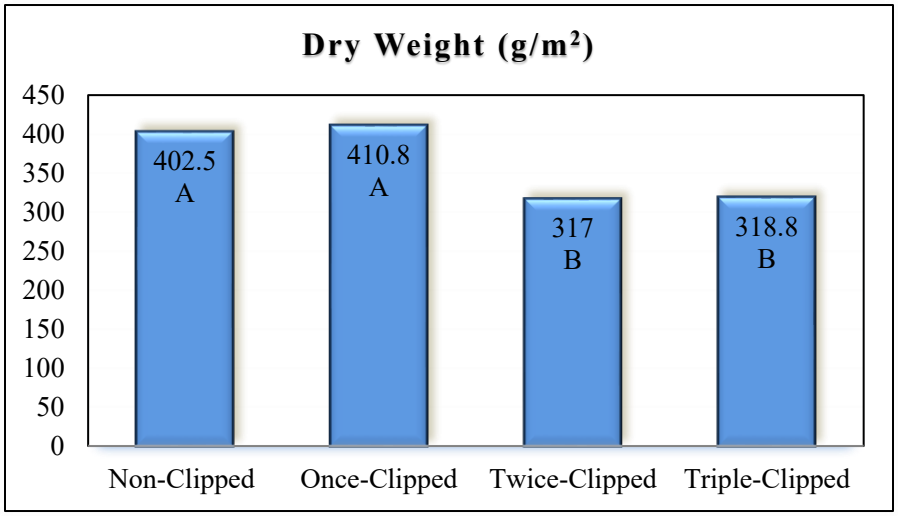

Figure 3. Dry weight (g/m^2) of natural vegetation at different clipping frequencies

4. Dry Matter Percentage

Non-clipped plants have a significantly higher dry matter percentage (54.13%), which indicates that not clipping allows the plant to maintain more solid biomass relative to its water content (Figure 4).

Clipping reduces the dry matter percentage, with once, twice and triple-clipped (31.8%, 33.85%, and 30% respectively), suggesting that the initial clipping has the most significant impact on reducing the solid content of the plants. This result was similar to (Wang *et al*., 2025), and incomparable with (Zhao *et al*., 2021).

Twice-Clipped treatment slightly recover in dry matter percentage compared to once-clipped and triple-clipped, but the differences are not statistically significant. This could indicate a slight adaptation or recovery of the plant after multiple clippings, though it remains significantly lower than non-clipped.

For forages where dry matter is crucial, the non-clipped treatment is preferable as it retains the highest proportion of usable biomass.

If clipping is necessary, it should be minimized because even a single clipping drastically reduces the dry matter percentage, potentially lowering the quantity of the fodder.

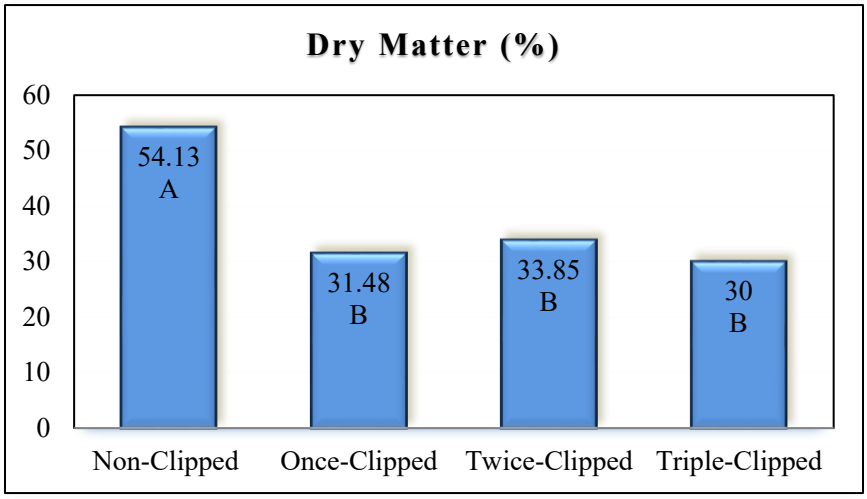

Figure 4. Dry matter percentage of natural vegetation at different clipping frequencies

5. Organic Matter Percentage

Figure 5 indicates that clipping, whether done once, twice, or three times (89%, 89%, and 89.85 respectively), does not significantly reduce organic matter percentage compared to the non-clipped condition (90.4%). However, non-clipped areas tend to have a slightly higher organic matter percentage. This results incomparable with (Zhao *et al.,* 2021).

If the goal is to maintain or increase organic matter, minimizing clipping could be beneficial, though the differences observed might not be significant enough to warrant a change in practice solely based on this Study.

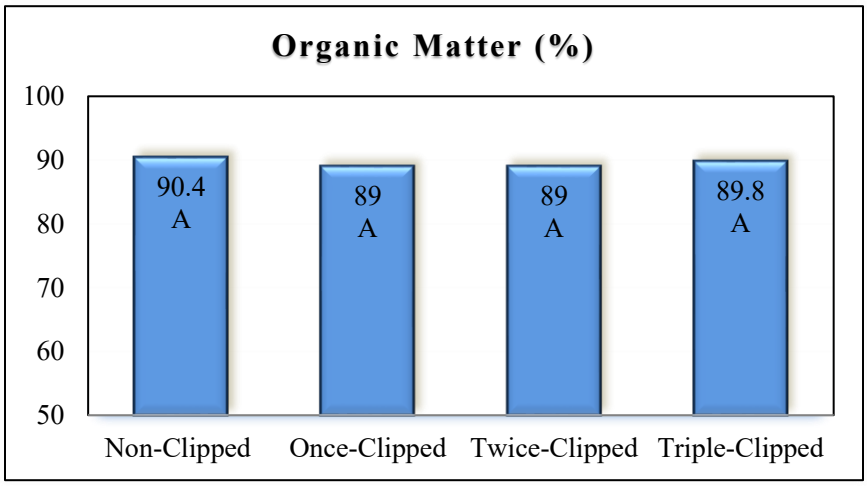

Figure 5. Organic matter percentage of natural vegetation at different clipping frequencies

B/ Qualitative Characteristics

1. Crude Fiber Percentage

There is a significant difference between the non-clipped (28.98%) and clipped once, twice and three times (22.38%, 21.4%, and 21.7% respectfully) in terms of crude fiber percentage (Figure

6). However, clipping beyond the first cut does not significantly further reduce crude fiber, as seen in the comparable percentages among once-clipped, twice-clipped, and triple-clipped conditions. Once-clipped shows 22.38%, while twice-clipped and triple-clipped show slightly lower percentages at 21.4% and 21.7%, respectively. This result was comparable to (Wang, *et al*., 2025).

The drop in fiber content after clipping is primarily due to the replacement of older, fiber-rich tissues with new growth that is less fibrous and more focused on rapid recovery. This is a typical adaptive response in plants to defoliation, ensuring they can quickly recover and maintain their photosynthetic capacity.

Plants may reduce lignin synthesis (a major component of fiber) in regrown tissues as a part of their strategy to quickly replace lost foliage. Lignin provides structural support but is energy-intensive to produce, so the plant may temporarily reduce its synthesis.

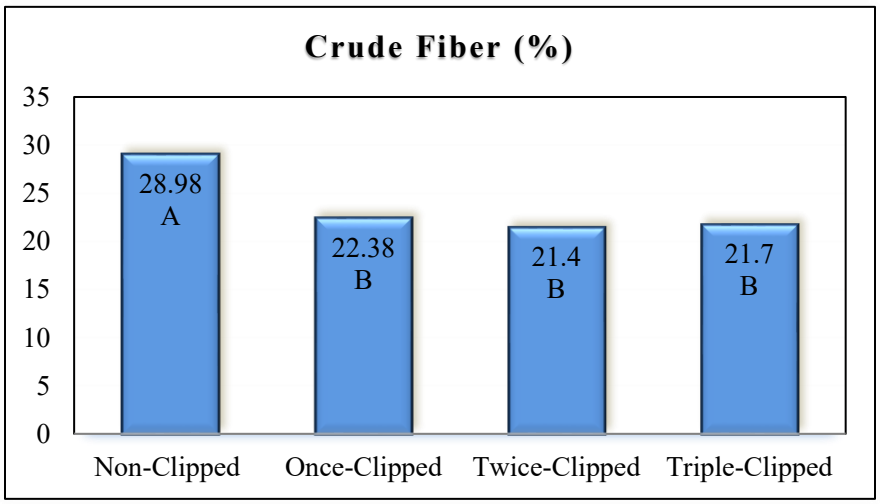

Figure 6. Crude fiber percentage of natural vegetation at different clipping frequencies.

2. Ash (Minerals) Percentage

Figure 7 revealed that clipping can significantly impact the nutrient content of plants, with effects varying depending on the timing, frequency, and intensity of clipping, as well as the plant species.

Young, New Growth: After clipping, plants often produce new shoots and leaves that are younger and more tender. This new growth tends to have higher concentrations of nutrients like proteins, vitamins, and certain minerals compared to older, more mature plant tissues. This is because young tissues are more actively growing and require more nutrients to support cell division and expansion.

In our study. Clipping increases the ash percentage (once-clipped 10.98%, twice-clipped 10.8%, and tipple-clipped 10.25%) compared to non-clipping (9.6). However, the differences among the various clipping frequencies (once, twice, or thrice) are minor and not statistically significant. This result was comparable to (Wang *et al.,* 2025).

While clipping may slightly increase the ash content, the lack of significant differences suggests that other factors should guide management decisions regarding clipping. If the ash content is a critical factor, minimizing clipping could be slightly beneficial, but the impact may be minimal.

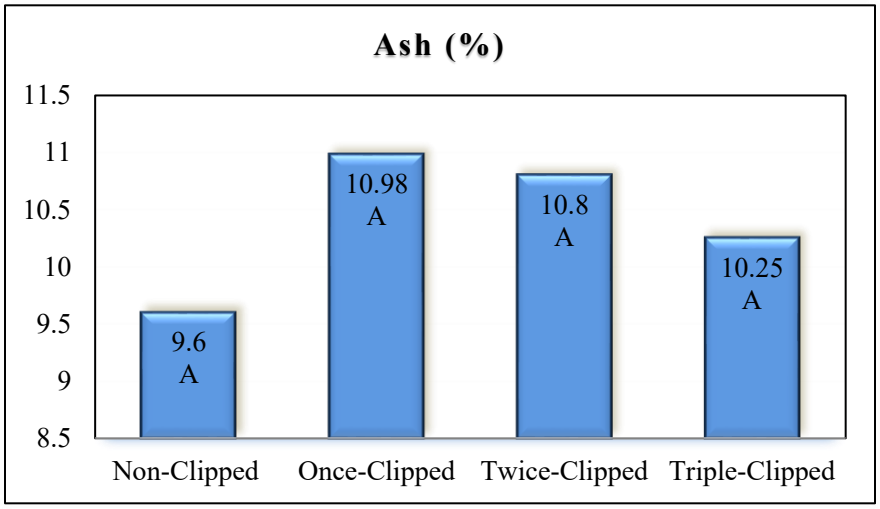

Figure 7. Ash (minerals) percentage of natural vegetation at different clipping frequencies

3. Crude Protein Percentage

Figure 8 referred that clipping increases the crude protein percentage. The non-clipped group has the lowest crude protein percentage (4.98%), while the triple-clipped group has the highest (7.68%).

There is a significant jump in crude protein percentage from non-clipped to once-clipped (from 4.98% to 7.08%), indicating that even a single clipping significantly enhances crude protein levels.

Clipping increases crude protein percentage in the material being studied. The data indicates that clipping at least once is sufficient to significantly increase crude protein, with additional clippings providing no statistically significant improvement beyond the initial increase. The non-clipped group has a significantly lower crude protein percentage, suggesting that clipping is a beneficial practice for increasing protein content This result is comparable with (Pavlů et *al*., 2006; Aremu *et al*., 2007; Zhao, *et al*., 2021; Li *et al*., 2022 Wang, *et al*., 2025).

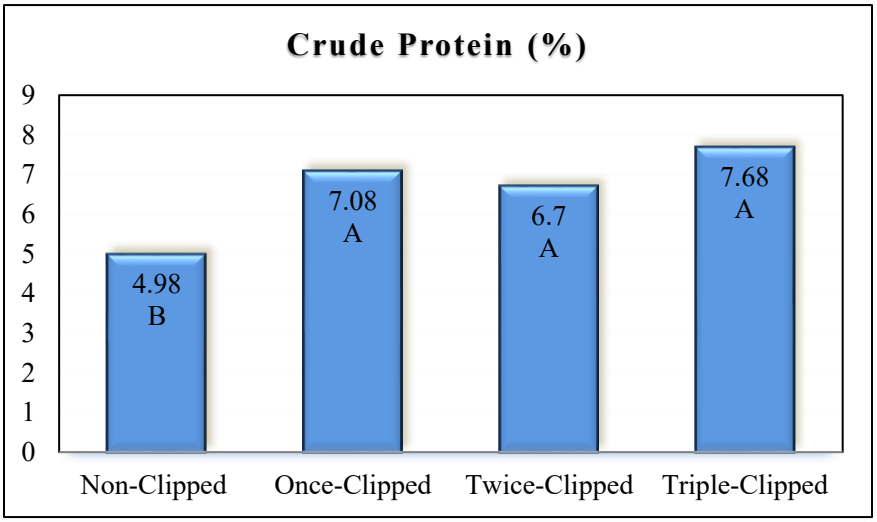

Figure 8. Crude protein percentage of natural vegetation at different clipping frequencies

4. Ether Extract Percentage

Clipping reduces the ether extract percentage (Figure 9). The non-clipped group has the highest ether extract percentage at 5.35%, while the triple-clipped group has the lowest at 3.18%.

There is a noticeable decrease in ether extract percentage after the first clipping, with a further decline as clipping frequency increase.

The statistical labels indicate that the non-clipped group is significantly different from the clipped groups, with the non-clipped group having a higher ether extract percentage. The twice-clipped group has a slightly higher ether extract percentage than the once-clipped and triple-clipped groups but is not significantly different from the once-clipped group. This result was comparable to (Wang *et al*., 2025), but disagreed with (Aremu *et al*., 2007).

Clipping reduces ether extract percentage in the material being studied. The data suggests that clipping, especially when done multiple times, leads to a significant reduction in ether extract content. These result possibly due to the removal of fatty or lipid-rich components and prevent seeds from being produced, as clipping frequencies multiplied.

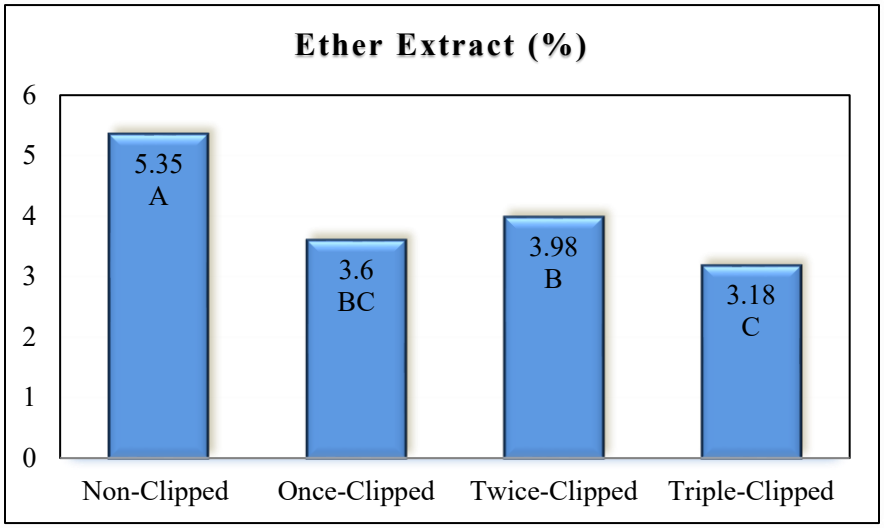

Figure 9. Ether extract percentage of natural vegetation at different clipping frequencies

5. N-Free Extract Percentage

Clipping appears (Figure 10) to increase the N-Free extract percentage. The non-clipped group has the lowest percentage at 51.1%, while the triple-clipped group has the highest at 57.2%.

The N-Free extract percentage increases as clipping frequency increases, with a noticeable jump from the non-clipped to the once-clipped group, and a slight increase in subsequent clippings.

Clipping may lead to an increase in the N-Free extract percentage, but the changes are not statistically significant according to the data. All groups, regardless of clipping frequency, are statistically similar. This suggests that clipping does not have a strong effect on the nitrogen-free extract content, or that the variation observed is within the margin of error. Therefore, while there is a trend of increasing N-Free extract with more frequent clipping, it is not conclusive enough to be considered a significant factor.

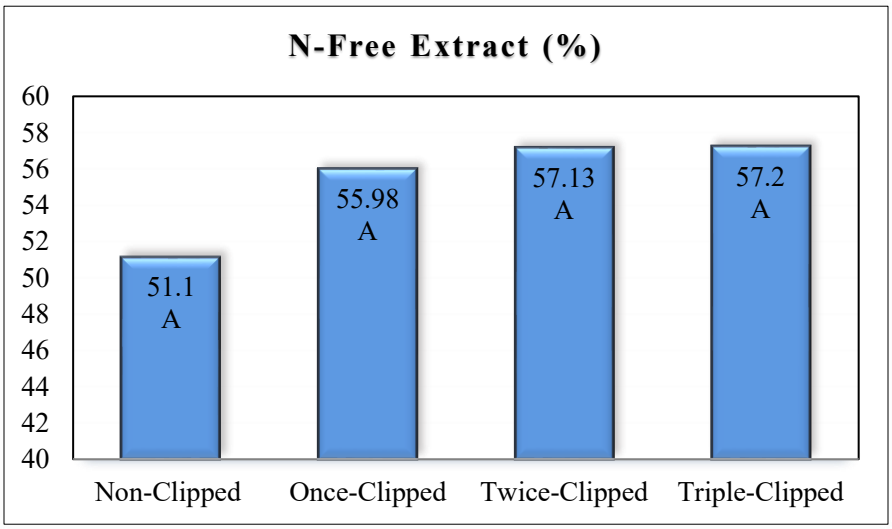

Figure 10. N-free extract percentage of natural vegetation at different clipping frequencies

From results of the study, we see:

A- Yield: The frequent of clipping should be carefully managed depending on the desired outcome. If the vegetation cover is in the middle of growing season and the goal is to maximize immediate wet yield, a single clipping might be beneficial.

The key takeaway for forage yield management is that clipping should be carefully tailored to the specific goals of the forage production system.

A single clipping can boost short-term wet yield, making it useful for animal feed. However, frequent clipping diminishes overall yield, particularly the dry weight, which is crucial for many herbaceous forage types. For maximizing long-term yield and sustainability, minimal clipping might be the best strategy.

Optimal Clipping Frequency for Growth: Once clipping appears to strike a balance, potentially stimulating some growth without overly reducing biomass, whereas twice and triple clipping show a clear negative impact on growth rate.

Overall, the optimal clipping frequency depends on the desired outcome, once clipping seems best for maximizing wet weight and dry weight, while no clipping dry matter retention.

B- Nutrient Value:

The best clipping frequency largely depends on which specific nutritional component is prioritize.

1. Once-Clipped or Twice-Clipped Treatments are generally recommended if the goal is to increase protein content and N-Free Extract while reducing fiber, which can enhance the digestibility of the material.
2. Avoiding Triple Clipping if Fat Content is Important: Since Ether Extract decreases with additional clippings, maintaining moderate clipping (once or twice) is advisable if higher fat content is needed.
3. For Higher Mineral Content (Ash %): Clipping once appears beneficial; however, additional clippings do not provide a further increase.

Overall, moderate clipping (Once or Twice) appears to provide a balanced improvement in nutritional quality, especially for protein and N-Free Extract, without significantly compromising other nutrients.

The best clipping frequency, therefore, depends on the desired balance of nutritional components, highlighting the trade-offs inherent in managing forage through clipping frequency.

C- Balancing Between Yield and Nutrient Value:

1. Twice-Clipped: Offers a balance between improved nutritional quality and manageable yield reduction. It provides significantly enhanced protein content and better digestibility, making it a good compromise for both quality and yield.
2. Once-Clipped: If yield preservation is more critical, Once-Clipped may be preferable as it offers better nutritional content than non-clipped with a less dramatic reduction in yield.
3. Triple-Clipped: Not recommended if yield is a priority, as the frequent clipping substantially reduces total biomass.

For a practical balance between yield and nutritional improvements, the Twice-Clipped strategy remains the best choice, providing good nutritional gains while keeping yield losses at a manageable level. However, if maximizing yield is crucial, consider Once-Clipped to slightly enhance quality without a severe impact on yield.

Conclusions

Once-clipped treatment: Provides the highest dry and wet weights, suggesting an optimal clipping frequency that stimulates growth without severe biomass loss. Frequent clipping (twice/triple), results in significant reductions in both dry and wet weights, implying that more frequent clipping hampers overall biomass production despite higher moisture content, which reflects water retention rather than true growth. Nutritionally: positive trends were concluded as ash % and crude protein % increase with more frequent clipping. Whereas crude fiber % is inversely related to both crude protein % and N-Free extract %, while ether extract % declines as other nutrient components rise. For balancing yield and nutrient quality, although non-clipped provide highest biomass yield, though with suboptimal nutritional quality (higher fiber, lower protein). But once-clipped offers a balance with a moderate yield and improved nutritional profile. Yield decreases further with increased clipping (twice- and triple-clipped), but nutritional quality (especially protein content) improves, with triple clipping achieving the highest protein albeit at the cost of the lowest overall yield.

Conflict of Interests

We have no conflicts of interest to disclose.

Acknowledgments

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