Effect of Seeding Rates on Dry Forage Yield and Quality of Several Egyptian Clover Varieties *Trifolium alexandrinum* L.

Saif Khalil Abdul zahra Alshaghnabi

Email: pgs.saif.khalil@uobasrah.edu.iq

Mohammed Abdul alreza Abdul alwahed

College of Agriculture, University of Basrah, Iraq

Email: mohameed.abdl_wahed@uobasrah.edu.iq

Kadhim kutami Gaber Al asady

College of Agriculture, University of Basrah, Iraq

Email: Kadamkutame@gmail.com

Abstract

A field experiment was conducted at the Agricultural Research Station, College of Agriculture, University of Basra (Karma Ali site, located at latitude 30°.57 N and longitude 47°.80 E) during the 2024/2025 growing season. The study aimed to evaluate the response of four varieties of Berseem clover (Mesqawi, Sumer, Berseem Berseem, and Hamadani) to three different seeding rates (35, 45, and 55 kg.ha^{-1}) and to estimate their forage quality. The experiment was implemented using a split-plot design according to a Randomized Complete Block Design (R.C.B.D) with three replications. dry forage yield, and quality traits were investigated.The varieties differed significantly in most studied traits. In terms of dry forage yield, Regarding dry forage yield, the Sumer cuts outperformed the other varieties in the first, second, and third cuts (3.44, 4.58, and 5.00 t ha^{-1}, respectively), while the Mesqawi cuts produced the highest dry yield in the fourth cut (4.07 t ha^{-1}). the Berseem Berseem variety excelled in crude protein percentage across all four cuts, recording the highest averages of 16.39%, 22.64%, 16.88%, and 15.27%, respectively. The Miskawi variety also excelled in carbohydrate percentage in the first, second, and third cuts with averages of 32.76%, 35.56%, and 36.92%, respectively, while the Sumer variety led in the fourth cut with an average of 39.52%. Results indicated that seeding rates significantly affected most studied traits. The 45 kg.ha^{-1} rate achieved the highest averages for both dry forage yield, recording dry forage yields (3.38, 4.12, 4.52, and 3.84 t ha^{-1}) in all four cuts.The seeding rate exceeded 45 kg ha^{-1} in protein content. for all cuts, averaging 16.63%, 18.81%, 17.13%, and 15.36%. In terms of carbohydrate percentage, the 35 kg.ha^{-1} rate led in the second cut with 31.82%.The interaction between varieties and seeding rates had a significant effect on total fresh and dry forage yield. The (Sumer x 45 kg.ha^{-1}) interaction treatment recorded the highest averages of 113.54 t.ha^{-1} and 20.39 t.ha^{-1}, respectively. **Keywords**: Egyptian clover , varieties , seeding rates , yield, quality.

***Study derived from a Master's thesis**

Introduction

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Egyptian clover is considered one of the most important winter legume field crops that are grown in areas with a cold climate, especially in Iraq, Egypt and the Middle East countries, because of its high productivity quality, palatability and tolerance to the conditions of the region and the diversity of its varieties and its use, as it can be grown for the purpose of green fodder or as a silage or hay (dry fodder) or as green fertilizing crops in agricultural cycles for its ability to stabilize atmospheric nitrogen and its lack of needs for the addition of chemical fertilizers and service operations, in addition to it is a multi-cut crop, as it gives from 4–6 cuts under the conditions of Iraq and its production reality is about 80 t ha^{-1} [2, 20], and Egyptian clover is almost a full food for animals because it contains a high percentage of digestible crude protein and it is rich in nutritional value. Egyptian clover is an effective legume in stabilizing nitrogen, as it contributes to stabilizing about **33–66 kg N ha^{-1}**, which enhances soil fertility for cultivation. In addition, Egyptian clover has been shown to have positive effects on combating soil erosion, and combating weeds [8,16]. Moreover, Egyptian clover is characterized by its ability to adapt on a larger scale, and its rapid vegetative growth,

And its versatility, high productivity, and availability of feed during the winter period, and contains about 62% total digestible nutrients [15].

Increasing the production of green fodder for Egyptian clover in the region requires searching for ways to raise productivity, including the introduction and cultivation of new genetic compositions, especially as it is one of the crops with wide acclimatization, making it multi-species, as the varieties are one of the main factors that determine the productivity and quality of fodder due to their difference in growth qualities, the number of cuts and their containment of dry matter and raw protein, as well as their resistance to inappropriate environmental conditions Egyptian clover is characterized by a strong regrowth ability after cutting [25]. Another factor that affects the productivity of fodder crops in general and Egyptian clover in particular is the seeding rate used when planting, as they are considered one of the main factors that determine plant density in the unit area and thus affect competition for light, water and nutrients [1,4]. Increasing seeding rates may lead to overcrowding and vice versa in the event of reducing the amount of seeds, which may negatively affect the production of fodder [3],so determining the optimal amount of seeds is an essential step in managing the crop to obtain the highest possible productivity with the efficiency of using available resources, especially since the optimal amount of seeds varies according to the cuts, types of soil, climate conditions and method of cultivation [26].

And in order to expand the cultivation of Egyptian clover in the southern region came this study, which aims to compare the performance of a number of newly introduced Egyptian clover varieties with local varieties and determine the best in terms of growth and productivity and determine the best amount of seeds that achieve the best plant density and the highest productivity of clover varieties and study the effect of interaction between varieties and seeding rates in the growth and yield qualities.

Materials and Methods

A field experiment was carried out at the Agricultural Research Station of the Faculty of Agriculture - University of Basra / Karma Ali site, which is located at (latitude 30°.57 north and longitude 47°.80) during the agricultural season 2024/2025 with the aim of studying the impact of varieties and seeding rates in the growth and fodder yield of the Egyptian clover crop Trifolium alexandrinumL. in loamy soil

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The experiment included the study of two factors: the first factor: four varieties of Egyptian clover (Mesqawi, Sumer, Berseem and Hamdani) it is symbolized (V1, V2, V3, and V4). The second factor: three seeding rates (35, 45and55) kg.ha^{-1}and symbolized (S1, S2, and S3). As the varieties were placed in the sub-plots and the seeding rates in the main plots.

Results and Discussion.

3.1 Dry fodder yield (t ha^{-1})

The results of the table (2) show the superiority of the V2 cuts over the rest of the varieties in the category of dry fodder crop in the second and third cuts, as it gave the highest average of 4.58 and 5.00 t ha^{-1} respectively, as there are no differences in significantly between the V2 and V1 cuts in the second cut, while the V1 cuts in the first and fourth cut with an average of 3.44 and 4.07 t ha^{-1} and there are no differences in significantly between the V1 and V2 cuts, while the V4 cuts gave the lowest average in all cuts of 1.88, 2.71, 3.04 and 2.60 t ha^{-1} respectively. The reason for the superiority of this cuts in the dry fodder crop is due to its superiority in the green feed green fodder yield, and this result is consistent with what [28], [29] and [30].

The results of Table (2) show the superiority of the S2 seed quantity in all cuts, as it gave the highest average of 3.38, 4.12, 4.52 and 3.84 t ha^{-1} respectively, while the S1 seeding rate gave the lowest average in the first, second and fourth cuts of 2.04, 3.29 and 3.10 t ha^{-1} respectively. In the third cut, the S3 seeding rate gave the lowest average of 3.65 t ha^{-1}. The reason for the superiority of the S2 seeding rate in all cuts over the seeding rates of other seeds in the dry fodder crop may be attributed to its superiority in the green fodder crop, and this result is consistent with [4], [10]and [3].

The interaction between varieties and seeding rates affected significantly in the dry fodder crop in the third cut as the interaction treatment (V2xS2) gave the highest average of 6.60 t ha^{-1} while the interaction treatment (V4xS3) gave the lowest average of 2.87 t ha^{-1}.

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Table (2) Effect of varieties, seeding rates, and their interaction on average dry fodder yield (t ha⁻ ¹)

First cut					
Seeding rates	varieties				Average Seeding rates
	V_1	V_2	V_3	V_4	
S_1	2.19	2.48	2.10	1.41	2.04
S_2	4.43	3.91	2.77	2.42	3.38
S_3	3.70	3.35	1.68	1.81	2.63
Average varieties	3.44	3.25	2.18	1.88	
(0.05) LSD	Seeding rates		varieties		interaction
	0.406		0.473		N.S
Second cut					
Seeding rates	varieties				Average Seeding rates
	V_1	V_2	V_3	V_4	
S_1	3.43	3.96	3.20	2.58	3.29
S_2	4.21	5.48	3.71	3.06	4.12
S_3	3.44	4.29	3.46	2.49	3.42
Average varieties	3.70	4.58	3.45	2.71	
(0.05) LSD	Seeding rates		varieties		interaction
	0.570		0.432		N.S
Third cut					
Seeding rates	varieties				Average Seeding rates
	V_1	V_2	V_3	V_4	
S_1	3.41	4.72	3.43	3.10	3.66
S_2	4.39	6.60	3.96	3.15	4.52
S_3	4.16	3.69	3.90	2.87	3.65
Average	3.99	5.00	3.76	3.04	

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varieties					
(0.05) LSD	Seeding rates		varieties		interaction
	0.562		0.368		0.698
Fourth cut					
Seeding rates	varieties				Average Seeding rates
	V_1	V_2	V_3	V_4	
S_1	3.70	3.46	3.01	2.24	3.10
S_2	4.53	4.39	3.31	3.14	3.84
S_3	3.98	3.79	3.62	2.43	3.45
متوسط الاصناف	4.07	3.88	3.31	2.60	
(0.05) LSD	Seeding rates		varieties		interaction
	0.272		0.651		N.S

3.2Crude Protein Percentage(%)

According to Table (2), Variety V3 recorded the highest protein percentages across all cuts (16.39%, 22.64%, 16.88%, and 15.27% respectively). This superiority is linked to higher nitrogen content and genetic variation among Varietys. These results are supported by Jabbar et al. (2022) and Ates et al. (2025) .

The results in Table (2) indicated the superiority of seeding rate S2 across all cuts, achieving averages of 16.63%, 18.81%, 17.13%, and 15.36%, respectively. Conversely, seeding rate S3 recorded the lowest averages for all cuts, reaching 15.19%, 17.69%, 15.19%, and 13.87%, respectively. This performance is attributed to the higher nitrogen content associated with this rate. These findings are consistent with the results reported by Kim et al. (2021) and Sabry et al. (2020).

The results presented in Table (2) revealed the superiority of the (V2 x S2) interaction treatment, which yielded the highest averages in the first and third cuts, reaching 18.31% and 19.21%, respectively. In the second cut, the (V3 x S1) interaction recorded the highest average of 24.67%, while for the fourth cut, the (V3 x S2) interaction achieved the maximum average of 17.21%. Conversely, the (V1 x S2) interaction treatment produced the lowest averages in the first and third cuts, at 14.44% and 14.19%, respectively. In the second cut, the (V4 x S2) interaction recorded the minimum average of 13.76%, while the (V4 x S3) interaction treatment yielded the lowest average in the fourth cut, reaching 13.34%.

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Table (3): Effect of Varieties, Seeding Rates, and Their Interaction on the Average Protein Percentage(%)

First Cut					
Seeding Rates	Varieties				Average Rates
	V_1	V_2	V_3	V_4	
S_1	15.12	15.04	16.95	15.02	15.53
S_2	14.44	18.31	17.46	16.29	16.63
S_3	15.38	15.50	14.76	15.12	15.19
Average Varieties	14.98	16.28	16.39	15.48	
(0.05) LSD	Rates		Varieties		Interaction
	0.151		0.279		0.431
Second Cut					
Seeding Rates	Varieties				Average Rates
	V_1	V_2	V_3	V_4	
S_1	15.52	16.69	24.67	15.82	18.18
S_2	19.11	20.64	21.73	13.76	18.81
S_3	17.21	15.67	21.51	16.38	17.69
Average Varieties	17.28	17.67	22.64	15.32	
(0.05) LSD	Rates		Varieties		Interaction
	0.572		0.337		0.672
Third Cut					
Seeding Rates	Varieties				Average Rates
	V_1	V_2	V_3	V_4	
S_1	15.04	15.06	17.69	15.06	15.71
S_2	14.19	19.21	18.31	16.81	17.13
S_3	15.50	15.50	14.63	15.13	15.19
Average Varieties	14.91	16.59	16.88	15.67	
(0.05) LSD	Rates		Varieties		Interaction
	0.322		0.180		0.369
Fourth Cut					
Seeding Rates	Varieties				Average Rates
	V_1	V_2	V_3	V_4	
S_1	14.13	16.70	13.55	13.81	14.55
S_2	13.89	14.75	17.21	15.61	15.36
S_3	13.36	13.72	15.06	13.34	13.87
Average Varieties	13.79	15.06	15.27	14.25	
(0.05) LSD	Rates		Varieties		Interaction
	0.257		0.270		0.443

3.3 Crude Fiber Percentage (%)

The results in Table (4) indicated the superiority of Variety V1, which recorded the highest averages of 21.38%, 25.47%, 27.77%, and 31.25% for the four cuts, respectively. Conversely, Variety V4 recorded the lowest averages of 17.85%, 20.29%, 22.70%, and 26.29% for the four cuts, respectively. The

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increase in fiber percentage may be attributed to leaf senescence as the plant ages and the increased accumulation of carbohydrates. Consequently, the proportion of non-nitrogenous substances, such as lignin and cellulose, increases. These findings align with the results reported by Seiam & Mohamed (2020) and Jabbar et al. (2022).

Regarding the seeding rates, Table (4) showed that seeding rate S1 excelled in fiber percentage during the second and third cuts, achieving the highest averages of 23.85% and 26.44%, respectively. Meanwhile, seeding rate S3 gave the lowest averages of 21.95% and 23.45%, respectively. No significant differences were recorded between seeding rates in the first and fourth cuts. This superiority of S1 may be due to lower plant density, which provides plants with more space, light, and ventilation. This leads to increased stem thickness and the formation of tissues rich in lignin and cellulose, thereby increasing the fiber percentage. These results are consistent with Bakhtiyari et al. (2020) and Badawy et al. (2023).

As for the interaction between Varietys and seeding rates, the (V1 x S1) interaction treatment was superior in the second cut, recording the highest average of 26.00%. On the other hand, the (V4 x S3) interaction treatment recorded the lowest average of 18.28%.

Table (4): Effect of Varieties, Seeding Rates, and Their Interaction on the Average Crude Fiber Percentage (%)

First Cut					
Seeding Rates	Varieties				Average Rates
	V_1	V_2	V_3	V_4	
S_1	22.83	19.08	19.38	19.36	20.16
S_2	20.77	20.17	18.11	17.04	19.02
S_3	20.53	18.67	16.90	17.14	18.31
Average Varieties	21.38	19.31	18.13	17.85	
(0.05) LSD	Rates		Varieties		Interaction
	N.S		1.127		N.S
Second Cut					
Seeding Rates	Varieties				Average Rates
	V_1	V_2	V_3	V_4	
S_1	26.00	23.86	22.71	22.82	23.85
S_2	25.50	21.33	21.67	19.76	22.06
S_3	24.92	22.94	21.65	18.28	21.95
Average Varieties	25.47	22.71	22.01	20.29	
(0.05) LSD	Rates		Varieties		Interaction
	0.785		0.705		1.199
Third Cut					
Seeding	Varieties				Average Rates

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Rates	V_1	V_2	V_3	V_4	
S_1	27.45	25.83	27.85	24.64	26.44
S_2	29.21	25.11	26.30	22.40	25.75
S_3	26.65	21.77	24.31	21.07	23.45
Average Varieties	27.77	24.24	26.15	22.70	
(0.05) LSD	Rates		Varieties		Interaction
	1.413		1.238		N.S
Fourth Cut					
Seeding Rates	Varieties				Average Rates
	V_1	V_2	V_3	V_4	
S_1	34.07	28.68	30.41	27.80	30.24
S_2	30.93	27.67	30.53	26.01	28.78
S_3	28.74	26.08	27.13	25.07	26.76
Average Varieties	31.25	27.48	29.36	26.29	
(0.05) LSD	Rates		Varieties		Interaction
	N.S		1.511		N.S

3.5Carbohydrate Percentage(%) The results in Table (5) indicate the superiority of Variety V1 in the first, second, and third cuts, recording the highest averages of 32.76%, 35.56%, and 36.92%, respectively. However, Variety V2 excelled in the fourth cut with an average of 39.52%. Conversely, Variety V4 recorded the lowest averages in the first, second, and fourth cuts, reaching 25.24%, 27.02%, and 32.46%, respectively, while Variety V3 gave the lowest average in the third cut at 30.68%. This variation among Varietys may be attributed to a combination of genetic, environmental, and physiological factors, in addition to its superiority in dry forage yield. These results align with findings by Bakhtiyari et al. (2020) and Zamanian et al. (2024).

Regarding seeding rates, the results in Table (5) showed that seeding rate S1 was superior in the second cut, yielding the highest average of 31.82%, while seeding rate S3 gave the lowest average of 29.46%. This is likely because lower plant density allows leaves to grow over a larger area due to

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reduced competition, which enhances photosynthesis and subsequently increases carbohydrate accumulation in the plant (Zamanian et al., 2022). This is consistent with Bakhtiyari et al. (2020).

As for the interaction between Varietys and seeding rates, the (V1 x S1) interaction treatment achieved the highest average in the first cut at 35.07%, while the (V2 x S1) interaction led in the fourth cut with 40.10%. On the other hand, the (V4 x S2) interaction recorded the lowest average in the first cut at 23.95%, and the (V4 x S3) interaction recorded the lowest average in the fourth cut at 31.61%.

Table (5): Effect of Varieties, Seeding Rates, and Their Interaction on the Average Carbohydrate Percentage(%)

First Cut					
Seeding Rates	Varieties				Average Rates
	V_1	V_2	V_3	V_4	
S_1	35.07	30.39	27.32	25.95	29.68
S_2	32.65	29.54	26.30	23.95	28.11
S_3	30.58	28.51	25.46	25.83	27.59
Average Varieties	32.76	29.48	26.36	25.24	
(0.05) LSD	Rates		Varieties		Interaction
	N.S		0.670		2.152
Second Cut					
Seeding Rates	Varieties				Average Rates
	V_1	V_2	V_3	V_4	
S_1	36.33	33.56	29.65	27.74	31.82
S_2	35.85	32.50	29.09	26.92	31.09
S_3	34.51	30.48	26.44	26.40	29.46
Average Varieties	35.56	32.18	28.39	27.02	
(0.05) LSD	Rates		Varieties		Interaction
	0.692		1.763		N.S
Third Cut					
Seeding Rates	Varieties				Average Rates
	V_1	V_2	V_3	V_4	
S_1	37.81	34.96	30.94	32.19	33.97
S_2	36.36	35.25	30.42	30.45	33.12
S_3	36.59	36.07	30.69	30.95	33.58
Average Varieties	36.92	35.43	30.68	31.20	
(0.05) LSD	Rates		Varieties		Interaction
	N.S		1.008		N.S
Fourth Cut					

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Seeding Rates	Varieties				Average Rates
	V_1	V_2	V_3	V_4	
S_1	36.98	40.10	35.52	33.20	36.45
S_2	38.14	38.53	34.36	32.57	35.90
S_3	37.76	39.94	32.60	31.61	35.48
Average Varieties	37.63	39.52	34.16	32.46	
(0.05) LSD	Rates		Varieties		Interaction

3.6 Ash Percentage (%)

As observed in Table (6), Variety V1 recorded the highest averages of 17.30%, 15.91%, 15.02%, and 14.36% for the four cuts, respectively. No significant differences were found between Variety V1 and V2 in the second and fourth cuts. Conversely, Variety V4 recorded the lowest averages of 15.47%, 14.26%, and 13.59% in the first, second, and fourth cuts, respectively, while Variety V3 gave the lowest average in the third cut at 12.66%. This variation is attributed to the genetic influence of the Varietys. These results align with findings by Kenebayev et al. (2022) and Titei (2023).

Regarding the effect of seeding rates, results in Table (6) indicated the superiority of seeding rate S3 in the second cut, yielding the highest average of 15.68%, while seeding rate S1 gave the lowest average of 14.54%. This is attributed to the fact that higher plant density resulting from increased seeding rates leads to intense competition for light, nutrients, and water, which is reflected in the plant's chemical composition. Under high-density conditions, individual plant vegetative growth decreases, and the proportion of young tissues (stems and young leaves) increases, which typically contain a higher percentage of mineral elements compared to older tissues. Furthermore, the increase in total root mass per unit area contributes to enhanced mineral absorption from the soil, thereby increasing the inorganic matter (ash) content. Additionally, the decrease in organic dry matter accumulation under crowded conditions increases the percentage of mineral elements within the total plant components (Heydarzadeh et al., 2022). This result is consistent with Bakhtiyari et al. (2020) and Zamanian et al. (2024).

As for the interaction between Varietys and seeding rates, the (V1 x S3) interaction treatment was superior, yielding the highest averages of 16.27% and 18.63% in the second and third cuts, respectively. The (V2 x S2) interaction recorded the highest average of 14.90% in the fourth cut. Meanwhile, the (V4 x S1) interaction recorded the lowest averages in the second and fourth cuts at 13.00% and 12.30%, respectively, and the (V3 x S3) interaction gave the lowest average in the third cut at 12.37%.

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Table (6): Effect of Varieties, Seeding Rates, and Their Interaction on the Average Ash Percentagev(%)

First Cut					
Seeding Rates	Varieties				Average Rates
	V_1	V_2	V_3	V_4	
S_1	17.40	15.00	16.60	15.00	16.00
S_2	17.60	16.70	16.27	16.67	16.81
S_3	16.90	16.03	15.87	14.73	15.88
Average Varieties	17.30	15.91	16.24	15.47	
(0.05) LSD	Rates		Varieties		Interaction
	N.S		1.144		N.S
Second Cut					
Seeding Rates	Varieties				Average Rates
	V_1	V_2	V_3	V_4	
S_1	15.47	15.17	14.53	13.00	14.54
S_2	16.00	15.70	13.53	14.73	14.99
S_3	16.27	15.80	15.63	15.03	15.68
Average Varieties	15.91	15.56	14.57	14.26	
(0.05) LSD	Rates		Varieties		Interaction
	0.558		0.584		0.961
Third Cut					
Seeding Rates	Varieties				Average Rates
	V_1	V_2	V_3	V_4	
S_1	12.77	15.73	12.50	13.23	13.56
S_2	13.67	13.23	13.10	12.50	13.13
S_3	18.63	12.87	12.37	12.97	14.21
Average Varieties	15.02	13.94	12.66	12.90	
(0.05) LSD	Rates		Varieties		Interaction
	N.S		0.593		1.623
Fourth Cut					
Seeding Rates	Varieties				Average Rates
	V_1	V_2	V_3	V_4	
S_1	13.97	13.90	14.00	12.30	13.54
S_2	14.60	14.90	14.47	13.83	14.45
S_3	14.50	13.73	13.47	14.63	14.08
Average Varieties	14.36	14.18	13.98	13.59	
(0.05) LSD	Rates		Varieties		Interaction
	N.S		0.459		0.927

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Conclusion

1. -
2. The Sumer variety excelled in dry forage yield, significantly outperforming all other studied varieties.
3. Using a seeding rate of 45 kg.ha^{-1} proved to be the most suitable rate under the environmental conditions of Basra Province, as it achieved superiority in all yield characteristics.
4. The Berseem variety showed significant superiority in qualitative traits, particularly recording the highest crude protein percentage compared to other varieties.
5. The Miskawi variety excelled in most qualitative traits, including fiber, carbohydrate, and ash percentages.
6. The interaction between varieties and seeding rates had a significant effect; the (Sumer x 45 kg.ha^{-1}) interaction treatment was superior in most of the studied traits.
7. The interaction between varieties and seeding rates also significantly influenced qualitative traits, where the (Miskawi x 35 kg.ha^{-1}) interaction treatment demonstrated the best results in terms of forage quality.

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