Effect of Planting Dates and Seeding Rates on Silage Production and Quality of Egyptian Berseem (*Trifolium alexandrinum* L.)

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Abstract

A field experiment was conducted in Karbala city during the 2025–2026 season to study the effect of four planting dates for Egyptian Berseem (*Trifolium alexandrinum* L.) specifically September 25, October 10, October 25, and November 10 and three seeding rates (20, 30, and 40 kg.ha^{-1}) on green forage yield and silage quality. The experiment was laid out as a factorial trial using a Randomized Complete Block Design (RCBD) with three replicates. The results showed that the November 10 planting date excelled on the others, producing the highest total green forage yield (74.11 ton.ha^{-1}). The first planting date (September 25) gave the highest crude protein percentage in the silage (12.48%).and the first planting date excelled in terms of soluble carbohydrate percentage in the silage, with an average of 39.34%, and produced the optimal pH for silage making (3.90). The seeding rate of 40 kg.ha^{-1} resulted in the highest total green forage yield (62.72 ton.ha^{-1}); however, seeding rates did not show a significant effect on silage protein percentage or pH.

Keywords: Egyptian Berseem, silage, protein percentage, soluble carbohydrate percentage.

Introduction

Livestock wealth holds a significant place and serves as a fundamental pillar of a stable agricultural system; it is also a key component of the national economy due to its vital role in achieving food security.However, low forage productivity, limited feed resources which fail to meet the animals' essential needs along with high prices and rising demand, constitute major obstacles hindering the development of this sector and preventing the bridging of the current supply-demand gap for animal products.Egyptian Berseem (*Trifolium alexandrinum* L.) is one of the most important green forage crops cultivated in Iraq's irrigated regions. It is distinguished by its high productivity and nutritional value, as well as its role in improving soil fertility and its successful integration into crop rotation systems. Yet, the volume of green forage produced falls short of meeting the growing needs of the livestock sector; this deficit is primarily due to the limited area dedicated to forage crops.In fact, the total area cultivated with forage crops in Iraq does not exceed 2% of the country's total arable land. Consequently, it is essential to increase the yield per unit area specifically regarding green forage, dry matter, and nutrient content. This can be achieved through various means, such as breeding and genetic improvement programs and the advancement of agricultural technologies including the optimization of planting dates and seeding rates. These two factors are crucial in determining the plant's physiological processes, thereby influencing yield traits in terms of both quantity and quality.Thus, determining the optimal planting date for the forage crop is of paramount importance. Seeding rates for forage crops influence the degree of competition among plants for growth requirements such as light, water, and nutrients. This impact is positive, leading to abundant forage production and high nutritional value by increasing plant density, suppressing weeds (some of which may be toxic or unsuitable for animal feed), and reducing fiber content. Consequently, the resulting forage is more palatable [11] highlighting the importance of determining the optimal seeding rate for the crop. Given the scarcity of research on this subject, this study was conducted to determine the most suitable planting date and seeding rate for Egyptian Berseem under the conditions of Karbala

province , aiming to maximize green forage yield for silage production and improve forage quality.

Materials and Methods

This experiment was conducted in the city of Karbala at a farmer's field during the 2025–2026 winter season. The objective was to study the effect of four planting dates and three seeding rates on green forage yield and silage quality, involving four harvests throughout the growing season. Table (1) presents some physical and chemical properties of the field soil.

The study involved three factors:

First: Planting dates:

(September 25; October 10 and 25; and November 10), designated as D1, D2, D3, and D4, respectively.

Second: Seeding rates:

(20, 30, and 40 kg.ha^{-1}), designated as S1, S2, and S3, respectively.

Third: Harvesting:

The crop was harvested four times:

The harvests from the first to the fourth were designated as C1, C2, C3, and C4, respectively.

Table (1): Some physical and chemical properties of the soil and water at the study loation prior to planting.

traits	**values**
Soil pH	**7.5**
Soil Electrical Conductivity (dS/m)	**4.3**
Available Phosphorus (mg/kg)	**4.52**
Available Potassium (mg/kg)	**2.4**
Total Available Nitrogen (%)	**0.450**
Organic Matter (g/kg)	**22.69**
Sand (g/kg)	**550**
Silt (g/kg)	**300**
Clay (g/kg)	**150**
Soil Texture	**loamy**
Water pH	**7.6**
Water Electrical Conductivity (dS/m)	**1.98**

Note: Analyses were conducted at the Field Crops Laboratory, College of Agriculture, University of Karbala.

The experiment was carried out as a factorial experiment using a Randomized Complete Block Design (RCBD) with three replicates, in which the various treatments were randomly distributed.The land was thoroughly plowed; the soil was pulverized and then leveled using a land-leveling machine. Based on the experimental design, the land was divided into plots measuring 3 meters in length and 2 meters in width, with a spacing of 25 cm between rows. Phosphate fertilizer was applied at a rate of 100 kg P_2O_5/ha using triple

superphosphate (46% P_2O_5) in a single dose prior to planting. Nitrogen fertilizer was applied at a rate of 20 kg N/ha using urea (46% N) two weeks after planting to promote growth [1]. Seeds were sown within the rows and covered with soil. Immediately after planting, the plots were irrigated gently to prevent seed displacement; subsequent irrigations were applied according to the plants' needs.The plants were harvested whenever they reached an average height of approximately 40 cm across the experiment; harvesting was performed manually at a height of 5 to 8 cm above the soil surface [1]. A total of four harvests were obtained during the season.

Table 2. Analysis of Variance represented by Mean Squares (MS)

Source of Variation	d.f	Fresh yield ton.ha^{-1}	Protein% in silage	Percentage of soluble carbohydrates (%) in silage	pH In silage
Replication	**2**	**76,451**	**5,587**	**39,469**	**0,029**
D	**3**	**2946,900**	**4,198**	**98,100**	**0,286**
S	**2**	**1986,800**	**2,762**	**5,265**	**0,173**
DS	**6**	**105,100**	**1,545**	**8,341**	**0,159**
Error	**22**	**467,654**	**1,115**	**30,405**	**0,092**

D:Planting dates,S: seeding average. significantly different at *P*=0.05

Studied traits:

1- Total green forage yield (ton.ha^{-1}):

Represents the sum of green forage yields from four cuttings.

2- Crude protein percentage in the produced silage (%):

Determined after measuring nitrogen content in plant samples via ammonia distillation using the Kjeldahl apparatus (at the Horticulture and Landscape Architecture Graduate Studies Laboratory). Crude protein percentage was then calculated according to the method of [2] using the following equation:

Crude protein % = Nitrogen % × 6.25

3- Soluble carbohydrate percentage in the produced silage (%):

Estimated according to the method of [7] using a spectrophotometer (at the Animal Production Department Graduate Studies Laboratory).

4- Silage pH determination:

Measured using a pH meter. Measurements were performed on samples taken from the preserved silage batches immediately after opening, following the method described by [8] This involved soaking a 30 g portion of each silage sample in 100 ml of distilled water for 24 hours prior to reading, followed by measuring the pH of the filtered liquid.

Statistical analysis:

Data for the studied traits were statistically analyzed using the analysis of variance (ANOVA) method via the SPSS software package. Means were compared using the Least Significant Difference (L.S.D.) test at a probability level of 0.05 [15] Table 2).

Results and Discussion:

Total Green Forage Yield (ton.ha^{-1})

The statistical analysis results presented in Table (2) indicate a significant effect of planting dates and seeding rates on the total green forage yield.

The results in Table (3) show that planting date D4 (November 10) excelled on the others, producing the highest total green forage yield (74.11 ton.ha^{-1}); this did not differ significantly from date D3 (October 25), which gave 57.54 ton.ha^{-1}., the early planting dates (D1 and D2) produced the lowest total green forage yields with no significant difference between them recording 29.94 and 30.12 ton.ha^{-1}, respectively. The higher green forage yield observed at the later planting date may be due to relatively lower temperatures and higher relative humidity, creating more favorable conditions. Temperature plays a crucial role in biochemical reactions, CO_2 uptake, enzyme activity, chloroplast production, leaf emergence and expansion, and the synthesis of essential growth compounds; all these factors are directly linked to photosynthesis, which drives the production of dry matter the primary component of forage [12].These findings align with the observations of[3,13] who noted that early planting dates resulted in lower green forage yields compared to later dates. This may be attributed to the fact that the harvest times for early planting dates coincided with lower temperatures, which negatively affected the plants' regrowth capacity and the reactivation of axillary buds. This was due to the reduced leaf area remaining after cutting and depleted nutrient reserves in the roots. Additionally, late planting dates resulted in higher green forage yields per cut compared to early planting dates. These findings align with those of [3,4]who observed increased green forage yields when planting Egyptian Berseem during October and November.Furthermore, the results in Table (3) indicate that the third seeding rate (S3) produced the highest value for this trait, reaching 62.72 ton.ha^{-1}. This differed significantly from the S1 and S2 seeding rates, which did not differ significantly from each other, yielding total green forage of 37.95 ton.ha^{-1} and 43.12 ton.ha^{-1}, respectively. This can be attributed to higher yields per cut associated with high seeding rates, resulting from increased plant density per unit area and a greater number of branches (unpublished data). These results are consistent with the findings of [3,16] who observed that green forage yield in Egyptian Berseem increases with higher seeding rates.

Regarding the interaction between planting dates and seeding rates, the effect on total green forage yield was not significant.

Table (3) Effect of planting dates, seeding rates and their interaction on the mean total green forage yield (ton.ha^{-1}).

planting dates	seeding rates			average D
	S1	S2	S3	
D1	23.26	29.10	37.46	29.94
D2	25.53	29.01	35.83	30.12
D3	41.81	41.59	89.23	57.54
D4	61.20	72.78	88.35	74.11
average S	37.95	43.12	62.72	
LSD 0.05	dates	seeding	interaction	
	21.038	18.220	LSD	

Crude protein percentage in the produced silage (%)

Statistical analysis results demonstrate a significant effect of planting dates on the crude protein percentage in the produced silage. This trait is considered the most critical aspect of preserving Egyptian clover (Berseem) as silage, as values may fluctuate during the preservation process. Results in Table (4) indicate that silage produced from the earliest planting dates gave a higher protein percentage compared to other dates; although the percentage dropped for intermediate dates, it rose again with the final planting date (D4), which also produced a higher protein percentage than the intermediate date (D3). Consequently, it is evident that the best green

Egyptian clover for silage preservation is that from early planting dates, as it yields silage with high protein content. Results from the same table also indicate that neither seeding rates nor the interaction between planting dates and seeding rates had a significant effect on this trait. Comparing these values with the protein percentage of the fourth cut (Table 5) reveals no substantial differences, indicating minimal protein loss during the preservation of Egyptian clover as silage. This demonstrates the feasibility of preserving clover as silage over a 60-day storage period,After covering by polyethylene with the addition of molasses at a rate of 30 kg per ton of green clover [6].

Table (4) Effect of planting dates, seeding rates, and their interaction on the mean crude protein percentage in the produced silage (%)

planting dates	seeding rates			average D
	S1	S2	S3	
D1	12.16	12.43	12.86	12.48
D2	12.51	10.94	12.16	11.87
D3	9.54	11.29	11.72	10.85
D4	11.55	11.72	12.60	11.96
average S	11.44	11.59	12.34	
LSD0,05	dates	seeding	interaction	
	1.027	LSD	LSD	

Table (5) Effect of planting dates, seeding rates, and their interaction on the mean percentage of crude protein and soluble carbohydrates for the fourth cut (%)

planting dates	Crude protein percentage				Percentage of soluble carbohydrates			
	planting dates			averag eD	planting dates			average D
	S1	S2	S3		S1	S2	S3	
D1	13.91	13.47	13.65	13.68	39.47	40.43	42.28	40.73
D2	12.22	11.55	11.81	11.86	34.67	35.31	42.43	37.47
D3	12.07	12.42	13.12	12.54	34.02	35.88	37.90	35.93
D4	12.51	13.21	13.65	13.12	33.67	36.02	37.55	35.75
average S	12.68	12.67	13.06		35.46	36.91	40.04	
LSD 0.05	dates	seeding	interaction		dates	seeding	interaction	
	0.759	LSD	LSD		2.982	2.582	LSD	

Percentage of soluble carbohydrates in the produced silage (%)

Statistical analysis results indicate a significant effect of planting dates on the mean percentage of soluble carbohydrates in the produced silage, whereas seeding rates and the interaction between planting dates and seeding rates showed no significant effect on this trait. Table (6) shows that the highest percentage of soluble carbohydrates in the produced silage (39.34%) was obtained from the first planting date. The results in the same table indicate no significant effect of seeding rates or the interaction between planting dates and seeding rates on the mean value of this trait. Although the percentage clearly increased with higher seeding rates of Egyptian clover, this increase did not reach statistical significance. Comparing these values with the soluble carbohydrate percentages of the fourth cut (the cut used to produce the silage) shown in Table (5) reveals no major differences in carbohydrate levels before and after preservation. This implies the presence of sufficient dry matter to facilitate the fermentation processes required to preserve the clover as silage and to produce the desirable lactic acid; the latter relies on the plant's soluble carbohydrates, which convert into this acid during fermentation. These

findings demonstrate the feasibility of preserving Egyptian clover as silage [5, 9].

Table (6) Effect of planting dates, seeding rates, and their interaction on the mean percentage of soluble carbohydrates in the produced silage (%)

planting dates	seeding rates			average D
	S1	S2	S3	
D1	38.78	38.47	40.77	39.34
D2	31.53	34.01	32.76	32.77
D3	33.30	32.25	36.00	33.85
D4	32.13	33.18	30.74	32.02
average S	33.93	34.48	35.07	
LSD0,05	dates	seeding	interaction	
	5.365	LSD	LSD	

pH of the Produced Silage

Statistical analysis results demonstrate a significant effect of planting dates on the pH level of the produced silage.

The results shown in Table (7) indicate that silage produced from the three later planting dates exhibited high pH values, ranging from 5.06 to 5.21. In contrast, silage produced from the D1 planting date had a suitable pH of 3.90.The results indicate no significant effect of seeding rates, nor of the interaction between planting dates and seeding rates, on this trait. It is observed that the pH of the produced silage was high in most treatments, exceeding 5.0. At this pH level, the activity of microorganisms responsible for undesirable fermentations is altered; these processes break down the lactic acid essential for silage preservation and lead to the production of unwanted butyric acid [10]. This implies that the dry matter content (specifically the soluble carbohydrate percentage) in Egyptian Berseem planted at the first date was favorable. As shown in Table (5) which details the soluble carbohydrate content in the fourth cutting the levels were sufficient to facilitate the fermentation processes required to preserve Egyptian Berseem as silage.

Table (7) Effect of planting dates, seeding rates, and their interaction on the mean pH of the produced silage.

planting dates	seeding rates			average D
	S1	S2	S3	
D1	3.94	3.96	3.80	3.90
D2	4.92	5.09	5.18	5.06
D3	5.23	5.18	5.23	5.21
D4	5.49	5.33	4.75	5.19
average S	4.90	4.89	4.74	
LSD 0.05	dates	seeding	interaction	
	0.295	LSD	LSD	

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