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Effect of planting date and seaweeds extract on growth and forage yield of Alfalfa (*Medicago sativa* L.)

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I. Abstract

A field experiment was conducted during the winter season of 2023-2024 in an agricultural field in Al-Zubair district (20 km west of the center of Basra Governorate), located in the far southeast of Iraq at latitude 30°.28′N and longitude 47°.05′E which has sandy loam soil and well-water irrigation to determine the impact of three planting dates (15/September, 1/ October , and 15 /October), and four concentrations of seaweed extract (0,6, 12, and 18 g L^{-1}),on forage growth , yield and quality of alfalfa. A split-plot arrangement with three replications, a completely randomized block design (R.C.B.D.) was used. The planting of alfalfa at the date of 1 / Oct gave the highest plant height, branches number per plant ,forage and dry weigh for the four cuts . All of the features under study were improved by increasing the concentration of seaweed extract, with the largest improvement occurring at the highest concentration (18 g L^{-1}). The combination of 1st Oct × 18 g L^{-1} gave the highest values for the majority of the growth and yield measures, indicating significant impact.

Keywords: Alfalfa, planting dates ,seaweeds, forage yield

II. Introduction

The perennial herbaceous legume alfalfa (*Medicago sativa* L.) is extensively grown to produce high-quality fodder. Of all legume crop for fodder, alfalfa is known as the "king of fodders" because of its high nutritional content and variety of uses, including silage and green fodder. It is a perennial crop that, depending on the environment and crop management strategy, can remain in the ground for four to twenty-four years and Because of its a great deal of quality alfalfa hay is known as one of the most essential animal feeds., as rich in proteins, amino acids, minerals, and vitamins (Bastaubayeva *et al.,* 2023). In addition to its ability to fix nitrogen and synthesize protein . Alfalfa production was insufficient to meet local animal feed needs, as livestock suffer from a severe feed shortage, particularly during the summer months, receiving only enough to sustain themselves. Crop production is expected to be affected by the current warm weather conditions in Iraq. Therefore, efforts are underway to determine an optimal planting date for alfalfa to withstand both high and low temperatures at the beginning of the season. Abdalrady *et al*.,(2017) found that the plants sowed on 20 / December produced the tallest plants, the greatest branches number per plant, fresh and dry forage yields, and protein yields.

Giving crops the nutrients they require, such as through the use of naturally occurring organic substances like seaweed extracts, is one of modern techniques to crop growth and development. Since it is a good source of growth regulators and macro and micronutrients, this foliar fertilizer has been popular in recent years, When sprayed on a plant, it increases the capacity of the roots to absorb nutrients, increases the thickness and strength of the stem, and increases the area of the leaves, all of which promote root and vegetative growth and, ultimately, production(Anisimov and Chaikina ,2014). These components include carbohydrates, vitamins, amino acids, and phytohormones(Das etal.,2025) .Thus, the study sought to ascertain when alfalfa

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should be planted in due to climate change and the impact of seaweed extract foliar spraying on alfalfa fodder growth, yield, and quality.

III. Materials and methods

An experiment was conducted during the winter season 2023-2024 in an agricultural field in Al-Zubair district (20 km south of Basra Governorate) to determine the effect of three planting dates (15/September, 1/ October , and 15/ October), symbolized as D1, D2, and D3 respectively, and four concentrations of seaweed extract (0,6, 12, and 18 g L^{-1}), as S0, S1, S2, and S3 respectively, on the yield and quality of alfalfa forage. Soil samples were collected from the field at a depth of 15 -30 cm, let to air dry, and then sieved at a depth of 2 mm. The methods described in Black (1965) and Page *et al.* (1982) were used to evaluate physical and chemical properties of the soil, which are summarized in table (1). In a split-plot arrangement with three replications, a (R.C.B.D.) design was used. Planting dates were placed in the sub-plots, while seaweed concentrations were placed in the main plots. The experimental unit area was 2×3 m^2. The rate of sowing used was 36 kg ha^{-1}. Using the local variety, a thin layer of soil was applied to the seeds. Following planting, urea fertilizer (46% N) was applied to the soil at a rate of 80 kg N ha^{-1}(Al-Mandalawi and Al-Refeia, 2017),with four doses of urea: one at planting and three more following each cutting. Weeds were removed, and irrigation was done as needed. A sample of early-flowering plants was chosen by cutting them near the ground, At every cutting the observed parameters are the Plant height, branches number, fresh and dry forage yield. Kjeldahl method was used to estimate the nitrogen percentage, and the A.O.A.C(1995) equation was utilized to obtain the protein as follows:

Protein percentage = nitrogen percentage x 6.25.

The analysis of variance was used, and the GenStat program was used to find significant differences between the mean scores for the attributes using the least LSD test at a probability of 0.05.

Table 1. Physical and chemical analysis of soil

Properties	Value	Unit
(E.C.)	7.50	dS m^{-1}
pH	7.20	-
Organic Matter	0.2	%
Available N	20.23	mg kg^{-1}
Available P	9.63	mg kg^{-1}
Available K	90.95	mg kg^{-1}
Sand	70.63	g kg^{-1}
Silt	10.80	g kg^{-1}
Clay	18.57	g kg^{-1}
Soil texture	Loamy sand	

IV. Results and discussion

Plant height (cm)

Results in Table 2 indicated that planting dates had a significant effect on plant height in all cuts . Highest plant height was recorded at1/ October (D2) was 22.96, 28.64 , 37.70 and 45.13cm in the 1st , 2nd , 3rd and 4th cut respectively, while the planting date 15/ September (D1) gave the lowest height for the four cuts about 17.53, 25.13,30.00 and 34.47 cm, respectively.This might be explained by favorable climatic factors including temperature and light intensity, which increased internode elongation and, as a result, plant height.

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The results show that seaweed extract led to substantial changes in plant height compared to the control, as shown in Table 1. The highest plant height were founded with the concentration of 18g L^{-1}(S3) the 1st cut ,3rd and 4th cut were 28.70,36.86,45.73cm respectively ,whereas the treatment S2 gave the highest plant height at the 2nd cut(27.54cm), on the other hand the lowest plant height was found in S0 treatment (control) were 10.77, 26.73,31.60 and 34.20 cm for the four cuts respectively. This finding conforms with Al-Ghazal et al.'s (2023) results. The seaumic extract contains humic acid, macronutrients, micronutrients, hormones, and amino acids, all of which significantly impact growth leading to increased plant height.The interaction was significant at the all cuts , D2 × S3 at 1st cut and 4th cut produced the tallest plant were 33.57 and 52.79 cm respectively , D2 × S1 in the 2ndcut and 3rd cut gave the highest (36.44 and 40.91 cm respectively), However, the planting date D1 with the seaweed extract control treatment had the lowest values across all cuts.

Number of branches(branch m^{-2})

Table (2) showed a significant effect of the two study factors and the interaction between them on branches number of plant Maximum number of branches were gained on D2 for all cuts were 510.25,454.17,483.42 and 488.67 branch m^{-2} respectively, while the lowest branches were found at the late date (D3) ,this due to the a favorable environment created by the ideal sowing date resulted in a greater number of branches .Maximum branches gained by the treatment S3 in all cuts were 411.67,420.56,442.78 and 448.67 branch m^{-2} respectively, less number of branches were found by the use of control treatment . This might be that seaweed extract encourages cell division and plant growth, increasing photosynthesis and accumulation of photosynthetic products(Khan *et al.,*2009). Overall, the findings indicated that interactions were significant at the all cuts ,D2×S3 gave the maximum branches were 550.67,560.67,570.67and 594.00 branch m^{-2} respectively, On the other hand the interaction D1×S0 at the 1st cut and the interaction D3×S0 gave the minimum number of branches were 135.00,162.00,230 and 197.67 branch m^{-2} respectively.

Table2. Effect of planting dates and seaweed application on plant height, number of tillers of Alfalfa

Treatments	Plant height (cm)				Number of branches m^{-2}			
Planting dates	**1st cut**	**2nd cut**	**3rd cut**	**4th cut**	**1st cut**	**2nd cut**	**3rd cut**	**4th cut**
D1	17.53	25.13	30.00	34.47	283.33	325.50	363.42	341.25
D2	22.96	28.64	37.70	45.13	510.25	454.17	483.42	488.67
D3	17.54	26.14	37.00	41.15	254.75	273.50	318.83	317.17
L.S.D. (p≤ 0.05)	1.247	1.19	0.31	0.52	12.88	14.25	14.25	41.27
Sea weed								
S0	10.77	26.73	31.60	34.2	255.56	211.44	280.00	252.44
S1	18.27	27.28	35.21	38.59	337.78	370.89	406.11	392.00
S2	19.64	27.54	35.92	42.47	392.78	401.33	425.33	436.33
S3	28.70	24.99	36.86	45.73	392.78	420.56	442.78	448.67
L.S.D. (p≤ 0.05)	0.96	0.54	0.57	0.25	19.83	8.61	13.67	29.90
D1S0	10.34	20.720	25.59	2833	135.00	265.00	299.67	265.67
D1S1	14.17	22.000	27.31	31.47	290.33	350.00	394.67	365.67

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D1S2	15.39	31.47	36.30	3738	367.33	336.00	380.00	367.00
D1S3	30.23	26.31	30.77	40.70	340.67	351.00	379.33	366.67
D2S0	11.57	28.97	32.56	35.68	478.33	207.33	310.33	294.00
D2S1	21.43	36.44	40.91	43.39	471.67	492.00	490.33	492.00
D2S2	25.28	24.81	36.79	48.46	540.33	556.67	562.33	574.67
D2S3	33.57	24.32	40.57	52.79	550.67	560.67	570.67	594.00
D3S0	10.40	30.50	36.65	38.60	153.33	162.00	230.00	197.67
D3S1	19.20	23.40	37.41	40.90	251.33	270.67	333.33	318.33
D3S2	18.25	26.33	34.68	41.41	270.67	311.33	333.67	367.33
D3S3	22.31	24.32	39.25	43.70	343.67	350.00	378.33	385.33
L.S.D. ($p \leq 0.05$)	1.70	1.26	0.65	0.33	24.51	16.95	27.79	59.40

Fresh forage yield (tons ha^{-1})

It is observed from the results of table (3) that the fresh forage yield was significantly impacted by the planting dates, seaweed extract, and their interaction. Maximum fresh yield was found under second planting date D2 were 10.451, 9.757,10.345and 10.246 tons ha^{-1} at the 1st, 2nd ,3rd and 4th cut respectively. Conversely, the first date D1yielded the lowest fresh forage yield were, 5.153, 5.671, 5.678 and 5.739 tons ha^{-1}for the all cuts respectively. The advantage of the second date in fresh fodder production can be attributed to its superiority in several of vegetative growth traits, such as plant height and branches number (Table 2).The results in Table (3) showed that application of seaweed extract showed significant effect on fresh forage yield of Alfalfa at cuts when applied at S4 treatment were 10.127,10,700,10.808 and 10.911 tons s ha^{-1} at the 1st ,2nd ,3rd and 4th cuts respectively, On the other hand the minimum fresh forage yield was obtained at the control treatment (S0) about 5.091,3.638,3.915 and 5.739 tons ha^{-1} for the four cuts respectively. The physiological role of seaweed extract, which contain major and minor nutrients and bioactive compounds with positive effects that increase most vegetative growth (plant height and branches per m^{-2}) and are reflected in the fresh forage yield . As for interaction the fresh forage yield increased when planting at D2 across the application of S3 about 13.483, 14.090, 14.632 and 14.445 tons s ha^{-1} at all cuts respectively, while the interaction D1×S0 gave the minimum values for all cuts.

Dry forage yield (tons ha^{-1})

Table 3 shows the significant effect of planting dates, the application of seaweed extract, and the interaction between them on the dry forage yield for all cuttings except the third cuts. The second date (D2) achieved the highest average for dry forage yield, recording 1.868 ,2.063 and2.164 tons s ha^{-1}. Conversely, the first date (D1) gave the lowest dry forage yield, with values of 1.053,1.245, and 1.415 tons s ha^{-1} for the 1st ,2nd and 4th cuts respectively. Furthermore, the application of seaweed extract varied significantly in this trait except the third cut, Higher yield dry forage yield was obtained at the S3 were 2.045, 2.257, and 2.282 tons ha^{-1} for the 1st ,2nd and 4th cuts respectively. This difference can be attributed to the superiority of D2 and S3 in terms of fresh forage yield, which positively influenced the dry forage yield. Additionally, the interaction was shown to be significant in 1st,2nd and 4th cuts ,However, at the 3rd cut was not significant. The maximum dry forage yield 2.715, 2.930, and 2.687 tons ha^{-1} was produced in the planting date D2 with S3 for the 1st , 2nd and 4th cuts, respectively. On the other hand, the lowest forage dry yield was obtained at D1×S0 about 2.697, 3.187 and 3.419 tons ha^{-1} for the three cutting respectively.

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Table3. Effect of planting dates and seaweed application on Fresh and dry forage yield of Alfalfa

Treatments	Fresh forage yield (tons ha^{-1})				Dry forage yield (tons ha^{-1})			
Planting dates	**1st cut**	**2nd cut**	**3rd cut**	**4th cut**	**1st cut**	**2nd cut**	**3rd cut**	**4th cut**
D1	5.153	5.671	5.678	5.739	1.053	1.245	1.148	1.415
D2	10.451	9.757	10.345	10.246	1.868	2.063	2.141	2.164
D3	10.002	9.026	9.266	9.387	1.715	1.978	1.93	1.965
L.S.D. (p≤ 0.05)	0.624	0.918	0.915	0.685	0.234	0.192	NS	0.198
Sea weed								
S0	5.091	3.638	3.915	3.969	0.675	0.666	0.861	0.755
S1	8.852	9.126	9.294	9.303	1.697	2.164	1.923	2.101
S2	8.738	9.141	9.702	9.647	1.764	1.962	1.990	2.253
S3	10.127	10.700	10.808	10.911	2.045	2.257	2.178	2.282
L.S.D. (p≤ 0.05)	0.330	0.524	0.290	0.264	0.1502	0.2537	NS	0.3807
D1S0	2.697	3.187	3.383	3.419	0.602	0.584	0.65	0.668
D1S1	5.383	5.877	5.708	5.971	1.011	1.631	1.166	1.447
D1S2	5.137	5.653	5.770	5.764	1.005	1.120	1.035	1.688
D1S3	7.397	7.967	7.851	7.802	1.595	1.644	1.739	1.856
D2S0	7.110	3.293	3.767	3.681	0.663	0.669	0.697	0.701
D2S1	11.330	11.513	11.545	11.372	2.212	2.487	2.428	2.518
D2S2	9.880	10.130	11.434	11.488	1.880	2.168	2.605	2.75
D2S3	13.483	14.090	14.632	14.445	2.715	2.930	2.834	2.687
D3S0	9.467	4.433	4.593	4.808	0.761	0.746	1.236	0.897
D3S1	9.843	9.987	10.628	10.567	1.867	2.373	2.175	2.337
D3S2	11.197	11.640	11.901	11.690	2.406	2.597	2.350	2.321
D3S3	9.500	10.043	9.942	10.485	1.826	2.198	1.961	2.303
L.S.D. (p≤ 0.05)	0.699	0.9179	0.907	0.698	0.2874	0.4026	NS	NS

Crude protein content (%)

Table 4 displays research data on crude protein content obtained by planting dates and applying seaweed. the highest protein content of 16.13% was recorded on plots where planted on D1at the 1st cut, while maximum protein content found in second date(D2) were 19.62 and 19.07% at the 2nd and 3rd cuts respectively, However, the planting date did not significantly affect the protein content at the fourth cutting. These planting date were suitable for producing the highest soft and dry yields (Table 3) and increasing the nitrogen concentration in the vegetative part. Results in Table 4 show that spraying with seaweed extract significantly affected the leaf content of protein for all cuts. The content of protein was produced by the plants treated with seaweed extract at a concentration of S3 treatment were 18.26, 20.21,19.74 and 12.22% at the1st,2nd,3rd and 4thcuts respectively. Seaweed may have contributed to this increase by raising the amount of nitrogen in plants and are regarded as a valuable source of proteins and macronutrients (Echave *et al.,*2021)which in turn led to an increase in protein content. The interaction treatment D2×S3 at the 1st cut produced the highest increase in protein about 18.93% ,also the treatments D3×S3 and D3×S3 gave the highest content of protein were 20.64 and 13.22% at the 2nd and 4th cuts respectively, on the other hand the interaction treatments of D2×S1recorded the highest content of protein(21.24%)

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Table4. Effect of planting dates and seaweed application on protein content of Alfalfa

Treatments	protein (%)			
Planting dates	**1st cut**	**2nd cut**	**3rd cut**	**4th cut**
D1	16.13	17.71	17.4	10.2
D2	14.25	19.62	19.07	10.59
D3	14.76	19.21	15.94	10.35
L.S.D. (p≤ 0.05)	0.792	0.743	0.301	NS
Sea weed				
S0	12.7	16.79	14.34	9.06
S1	13.77	19.07	17.14	9.35
S2	15.46	19.33	18.68	10.88
S3	18.26	20.21	19.74	12.22
L.S.D. (p≤ 0.05)	0.421	0.480	0.511	0.482
D1S0	14.26	13.14	16.00	9.29
D1S1	14.92	17.61	16.79	10.52
D1S2	17.07	20.16	17.10	10.22
D1S3	18.26	19.95	19.72	10.75
D2S0	10.49	19.91	14.75	8.91
D2S1	12.86	20.47	21.24	9.08
D2S2	14.72	18.09	20.15	11.67
D2S3	18.93	20.03	20.16	12.68
D3S0	13.34	17.31	12.25	8.99
D3S1	13.52	19.15	13.38	8.45
D3S2	14.60	19.76	18.80	10.74
D3S3	17.58	20.64	19.34	13.22
L.S.D. (p≤ 0.05)	0.888	0.915	0.792	0.879

V. Conclusions

Under same agricultural conditions, planting alfalfa in early October together with foliar treatment of seaweed extract at 18 g L^{-1} is advised to obtain increased fodder yield and better quality. These results offer a workable plan to increase alfalfa output, particularly in due to Iraq's changing climate.

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