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Kıraç Şartlarda Yetiştirilen Selvi Sirken (*Atriplex nitens*)'in Otunun Kalitesi Üzerine Farklı Ekim Zamanları ve Biçim Dönemlerinin Etkileri

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ÖZET: Bu araştırma 2019 ve 2020 yıllarında Iğdır Üniversitesi Ziraat Fakültesi'ne ait deneme arazisinde kuru şartlarda yürütülmüştür. Ekim (Mart ortası, Mart sonu, Nisan başı ve Nisan ortası) ve hasat dönemlerinin (vejetatif dönem sonu, çiçeklenme başlangıcı ve tam çiçeklenme dönemi) Selvi sirken (*Atriplex nitens*)'in ham protein oranı (HP), nötr çözücülerde çözünemeyen lif (NDF), asit çözücülerde çözünemeyen lif (ADF), kuru madde sindirilebilirliği (KMS), kuru madde tüketimi (KMT), sindirilebilir enerji (SE), metabolik enerji (ME) ve nispi yem değeri (NYD) üzerine etkileri belirlenmiştir. Deneme tesadüf bloklarında bölünmüş parseller deneme desenine göre 3 tekerrürlü olarak kurulmuştur. Araştırmanın ikinci yılında elde edilen ham protein oranı birinci yıla göre daha yüksek olduğu belirlenmiştir. Diğer incelenen yem kalite özellikleri yıllara göre herhangi bir değişiklik olmamıştır. Ekim zamanları incelenen tüm besin içerikleri üzerine önemli etkileri olmuştur. Ekim zamanlarının geciktirilmesiyle NDF ve ADF oranında düşüşler olurken, HP, KMS, KMT, SE, ME ve NYD miktarlarında artışlar olmuştur. Hasat dönemlerinin geciktirilmesiyle NDF ve ADF oranlarında artış olurken, HP, KMS, KMT, SE, ME ve NYD miktarlarında düşüşler olmuştur. Yıl, ekim ve biçim dönemlerine göre HP oranları %5.94 ile %13.86, NDF oranları %50.29 ile %64.33, ADF oranları %29.48 ile %41.01, KMS oranları %56.96 ile %65.93, KMT oranları %1.86 ile %2.39, SE miktarı 2.71 ile 3.09 Mcal kg^{-1}, ME miktarı 2.22 ile 2.54 Mcal kg^{-1} ve NYD değeri 82.40 ile 121.97 arasında olmuştur. Araştırma sonuçlarına göre kuru şartlarda *Atriplex nitens*'den yüksek kalitede ot elde edilebilmesi için ilk ekim zamanı olan Mart ortasında ekimlerinin yapılması ve vejetatif dönem sonunda hasat edilmesi gerektiği belirlenmiştir.

Anahtar Kelimeler: *Atriplex nitens*, selvi sirken, ekim zamanı, hasat dönemi, kuru ot kalitesi

The Effects of Different Sowing and Harvesting Times on Hay Quality of Mountain spinach (*Atriplex nitens*) Grown in Arid Conditions

ABSTRACT: This research was carried out in dry conditions in the trial land of Igdir University Faculty of Agriculture in 2019 and 2020. Effects on crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), dry matter digestibility (DMD), dry matter intake (DMI), digestible energy (DE), metabolizable energy (ME) and relative feed value (RFV) of sowing (mid-March, late-March, early-April and mid-April) and harvesting times (end of vegetative period, beginning of flowering and full flowering period) of mountain spinach (*Atriplex nitens*) were determined. The experiment was set up in randomized blocks according to the split plot design with 3 replications. It was determined that the crude protein obtained in the second year of the study was higher than the first year. Other examined hay quality characteristics did not change over the years. Sowing times had significant effects on all the nutrients studied. Delaying the sowing times resulted in decreases in NDF and ADF ratios, and increases in CP, DMD, DMI, DE, ME and RFV. While the NDF and ADF ratios increased with the delay of the harvest periods, there were decreases in the CP, DMD, DMI, DE, ME and RFV amounts. According to year, sowing and harvesting periods, CP ratios between 5.94% and 13.86%, NDF ratios 50.29% an 64.33%, ADF ratios 29.48% and 41.01%, DMD ratios 56.96% and 65.93%, DMI ratios 1.86% and 2.39%, DE amount 2.71 and 3.09 Mcal kg^{-1}, ME amount 2.22 and 2.54 Mcal kg^{-1} and RFV value 82.40 and 121.97 was found. According to the results of the study, it was determined that in order to obtain high quality herbage from mountain spinach in dry conditions, it should be sown in mid-March, which is the first sowing time, and harvested at the end of the vegetative period.

Keywords: *Atriplex nitens*, Mountain spinach, sowing time, harvest period, hay quality

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INTRODUCTION

Feeding of animals is mostly met from meadow, pasture areas and forage crops cultivated in the field. In field agriculture, mostly alfalfa, corn, vetch and sainfoin are grown. When most of these plants are cultivated in field agriculture, are grown in extreme climate and soil conditions such as arid, salty and alkaline, there may be significant losses in yield and quality. Due to the decrease in yield and quality of these forage crops in extreme soil and climatic conditions, intensive searches have been initiated for alternative forage crops (Geerts et al., 2009; Razzaghi, 2011; Kır, 2016; Tan and Temel, 2017; Kır and Temel, 2017). Mistakes made in agricultural practices lead to significant increases in salinization and alkalinization of soils. On the other hand, climatic changes, erosion, fertilizer application and irrigation, and the lack of application of the crop rotation system cause an increase in the salinization and alkalinization rates of the soils, and as a result, the yield strength of the soils decreases (Türkeş, 2012).

There are 400 species belonging to the *Atriplex* genus, which are members of the *Chenopodiaceae* family and grow naturally, most of which are resistant to arid and salty conditions (Temel and Tan, 2012; Benzarti et al., 2013). In studies on *Atriplex* species, it has been determined that animal feed has a high value and contains many important organic compounds for the industry (Koocheki, 2000; Acar and Güncan, 2002; Aganga et al., 2003; Boughalleb et al., 2009; El Shaer, 2010; Benzarti et al., 2013).

Atriplex nitens is an annual herbaceous plant and is commonly found in natural areas in many parts of the world (Acar and Dursun, 2012; Anonymous 2021a). *Atriplex nitens*, which is generally known as weed, is evaluated as animal feed and human food (Acar and Güncan, 2002; Redzic, 2006; Acar and Dursun, 2012; Acar et al., 2017). *Atriplex nitens* have high adaptability to arid and cold climates and saline soils (Acar and Güncan, 2002; Christman, 2003; Acar and Dursun, 2012; Akinshina et al., 2014; Acar et al., 2019a). Studies have shown that *Atriplex nitens* plant has high nutritional values for animals (Watson, 1990; Rabbimov et al., 2011; Acar et al., 2019b). Nutritional value and digestibility of feed are significantly affected by plant species and varieties, environmental factors, cultural practices, sowing times and harvest times (Buxton, 1996; Aganga et al., 2003; Collins and Fritz, 2003; Özyiğit and Bilgen, 2006; Önal Aşçı and Acar, 2018; Temel and Keskin, 2020).

Very few agronomic and nutrient content studies have been conducted on the plant *Atriplex nitens*. On the other hand, there are very few studies on the effects of sowing and harvesting times on the nutrient content of *Atriplex nitens*. This study was carried out to determine the effects of different sowing and harvesting times of *Atriplex nitens* on animal feed quality in arid conditions.

MATERIALS AND METHODS

The experiment was carried out in the research fields of Iğdır University Agricultural Application and Research Directorate under dry conditions for 2 years (2019 and 2020). In 2019, when the experiment was conducted, the temperature was 13.8 °C, the precipitation was 162.4 mm and the relative humidity was 57.3%, In 2020, the temperature was 13.7 °C, the precipitation was 297.0 mm and the relative humidity was 57.7%. Although there was no significant change in temperature and relative humidity between the years in terms of climate data, the amount of precipitation in 2020 was higher in terms of precipitation (Anonymous, 2021b). The soils in the area where the experiment was established were analyzed and it was determined that the soils were clayey-loamy, very low in organic matter, slightly alkaline, slightly salty, low in phosphorus and high in potassium (Richards, 1954; Ülgen and Yurtsever, 1974; FAO, 1990).

Seed sowing of *Atriplex nitens* was done in 4 (four) times, namely mid-March, late March, early April and mid-April. *Atriplex nitens* in 2019 and 2020, mid-March sowing on 14 March and 21 March, late March sowing on 28 March and 31 March, early April sowing on 8 April and 10 April, mid-April sowing on 18 April and 20 April, respectively.

In the experiment, the total parcel area was determined as 11.25 m^2, with each parcel length 5 m and parcel width 2.25 m. The plants in the plots were sowing at 45 cm row spacing and 10 cm intra-row spacing (Acar et al., 2019b). No irrigation or fertilizer application was made before sowing and during the experiment.

Harvests of *Atriplex nitens* plants were made in 3 (three) different harvest periods (end of vegetative period, beginning of flowering and full flowering). Harvest dates of plants according to sowing times and harvest time are given in Table 1. Plants were harvested 10 cm above the soil level after leaving 50 cm at the beginning of the plot and one row at the plot edges as edge effects (Acar et al., 2019b; Kır and Temel, 2017; Temel and Keskin, 2020). From the harvested plants, 10 plants were selected to represent the parcel and after drying for a while in the shade, they were allowed to dry in the drying oven at 70 ^{o}C until their weight stabilized. The dried samples were ground to a size of 1 mm in a laboratory type herb mill and made ready for analysis.

Table 1. Harvest dates of plants according to sowing times and harvest time

	End of the vegetative period	**Beginning of flowering**	**Full flowering**
		2019 year	
1. Sowing time	16.06.2019	18.07.2019	22.07.2019
2. Sowing time	20.06.2019	23.07.2019	24.07.2019
3. Sowing time	29.06.2019	25.07.2019	29.07.2019
4. Sowing time	02.07.2019	29.07.2019	03.08.2019
		2020 year	
1. Sowing time	22.06.2020	19.07.2020	30.07.2020
2. Sowing time	25.06.2020	22.07.2020	01.08.2020
3. Sowing time	29.06.2020	25.07.2020	03.08.2020
4. Sowing time	02.07.2020	28.07.2020	05.08.2020

Crude protein ratio in the ground hay samples was determined by using the micro kjeldahl method and the total nitrogen content was determined and the crude protein content was determined by multiplying the amount of nitrogen found with the coefficient of 6.25 (AOAC, 1997). NDF and ADF ratios were determined using the method suggested by Van Soest et al. (1991). Dry matter digestibility, dry matter intake, digestible energy, metabolic energy and relative feed value were determined according to the following methods and formulas.

- DMD rate = [88.9 - (0.779xADF)] (Oddy et al., 1983).
- DMI ratio = [120/NDF] (Sheaffer et al., 1995)
- DE amount = [0.27+0.0428x(DMD)] (Fonnesbeck et al., 1984)
- ME amount = [0.821xDE] (Khalil et al., 1986)
- RFV value = [DMDxDMI/1.29] (Sheaffer et al., 1995)

The significance levels of factors and interactions were determined by using the JMP (5.0.1) (JMP, 2003) statistical program of the research data, and the averages of the important factors were grouped according to the LSD test.

RESULTS AND DISCUSSION

Crude Protein Ratio

Animals need adequate protein intake for their growth, development and health. The protein has important contributions to the formation of meat, milk, feathers and fleece of animals. In addition to protein needs, if the energy needs of the animals are met, the efficiency to be obtained in the animals will increase and the healthy development of the animals will be ensured (Kutlu et al., 2005; Kutlu and Özen, 2009).

Crude protein ratios of *Atriplex nitens* grown in dry conditions are given in Table 2. Crude protein content was 8.53% in 2019 and 9.60% in 2020. Crude protein content of *Atriplex nitens* was higher in its second year. It is estimated that the high amount of precipitation in the second year causes the plants to develop better and the crude protein content to be higher. Excessive precipitation will cause an increase in the leaf rate in the plant and therefore an increase in the amount of protein (Fales and Fritz, 2007; Temel and Keskin, 2020). It has been determined that *Atriplex nitens* has higher leaf and lower stem content in years when precipitation is high (Keskin and Temel, 2022).

Crude protein ratios were 8.59%, 9.24%, 9.04% and 9.40% in mid-March, late March, early April and mid-April sowing times, respectively (Table 2). Crude protein content in the first sowing time was the lowest compared to the later sowing times. There was no significant difference between the crude protein contents of the next three sowing times. It has been reported that in late sowings, the plants will enter the generative period earlier with the effect of increasing temperature, and therefore the stem thickness will be low and the stem rate will be low, so the amount of crude protein will be high (Collins and Fritz, 2003; Özyiğit and Bilgen, 2006; Önal Aşcı and Acar, 2018; Acar et al., 2019a; Keskin and Temel, 2022). In the studies carried out on *Atriplex* and *Chenopodium* species, it was determined that there would be a significant change in the crude protein ratio according to the sowing times, and especially in late sowings, the leaf ratio and the stem ratio were low in the plant, and therefore the protein amount was high (van Niekerk et al., 2009; Grzeszczuk et al., 2010; Temel and Keskin, 2020; Temel and Yolcu, 2020).

There were significant changes in crude protein ratios of *Atriplex nitens* according to the harvest periods. Crude protein ratios were 11.68%, 8.19% and 7.33% at the end of the vegetative period, the beginning of flowering and the full flowering periods, respectively. With the delay of the harvest period, there were significant decreases in crude protein rates. Studies on *Atriplex* species have determined that there are significant changes in the crude protein ratio according to the form periods (Watson, 1990). The amount of intracellular substances such as protein and carbohydrates will also be high, as the leaf ratios and stem ratios are low in the early development stages, the cell walls of the plants are not yet developed and the number of young cells is high (Hoffman et al., 2003; Kacar et al., 2006; Papanastasis et al., 2008; Önal Aşcı and Acar, 2018; Acar et al., 2019b; Temel and Keskin, 2022). It has been determined that there is a decrease in the protein ratio due to the increase in the amount of cellulose in the late harvest periods (Aganga et al., 2003; Frost et al., 2008; Yousef Elahi, 2013).

When the year, sowing time and harvest period were evaluated together, the crude protein ratio varied between 5.94% and 13.86%. The highest crude protein ratio was detected with 13.86%, which was harvested at the second sowing time and at the end of the vegetation period in 2019, and the lowest crude protein ratio with 5.94% was determined in 2019 in *Atriplex nitens* plants planted at the first sowing time and harvested in full flowering.

Table 2. Crude protein and NDF contents of *Atriplex nitens* according to different years, sowing time and harvest periods

Year (Y)	Sowing time (ST)	Crude protein (%) Harvest time (HT) End of the vegetative period	Beginning of flowering	Full flowering	Year Aver.		Neutral detergent fiber (%) Harvest time (HT) End of the vegetative period	Beginning of flowering	Full flowering	Year Aver.
2019	ST.1	10.90 d	6.57 jk	5.94 k	8.53 b	ST.1	50.29 m	61.54 c-e	64.33 a	58.53
	ST.2	13.86 a	6.38 jk	5.94k		ST.2	51.09 lm	62.38 b-d	62.32 b-d	
	ST.3	9.73 ef	6.81 ıj	8.76 g		ST.3	55.94 hı	61.42 de	62.92 a-d	
	ST.4	11.50 cd	7.36 hı	8.62 g		ST.4	50.94 l	58.63 f	60.51 e	
2020	ST.1	11.43 cd	10.20 e	6.52 jk	9.60 a	ST.1	54.31 ıj	53.55 jk	63.23 a-c	57.34
	ST.2	12.54 b	9.24 fg	7.47 hı		ST.2	52.41 kl	57.18 f-h	64.24 a	
	ST.3	11.68 c	9.75 ef	7.53 h		ST.3	51.59lm	57.70 fg	63.50 ab	
	ST.4	11.79 c	9.24 fg	7.87 h		ST.4	50.72 lm	56.71 gh	62.92 a-d	
HT averg.		11.68 a	8.19 b	7.33 c		HT averg.	52.16 c	58.64 b	62.99 a	
ST Aver.		LSD value and significant					ST Aver.	LSD value and significant		
ST.1 8.59 b	Y			0.23**		ST.1	57.88 a	Y		1.26 öd
ST.2 9.24 a	ST			0.37**		ST.2	58.27 a	ST		0.98**
ST.3 9.04 a	Y x ST int.			0.53*		ST.3	58.85 a	Y x ST int.		1.38 öd
ST.4 9.40 a	HT			0.24**		ST.4	56.88 b	HT		0.60**
	Y x HT int.			0.35**				Y x HT int.		0.85 **
	ST x HT int.			0.49**				ST x HT int.		1.21**
	Y x ST x HT int.			0.69**				Y x ST x HT int.		1.71**

ST-1: mid-March, ST-2: late March, ST-3: early April, ST-4: mid-April
**: p>0.01, *: p>0.05, the difference between data shown with the same letters is not statistically significant.

Neutral Detergent Fiber Ratio

Cellulose, hemicellulose, lignin and silicon contents are expressed as NDF (Neutral Detergent Fiber). NDF is an indicator of volumetric capacity of the feed, degree of digestibility of the feed by the animals and specific gravity of feeds (Kutlu et al., 2005).

Neutral Detergent Fiber rations of *Atriplex nitens* are given in Table 2. The NDF rate was measured as 58.53% and 57.34% in 2019 and 2020, respectively. The NDF ratio of *Atriplex nitens* did not differ significantly between years.

There were significant changes in NDF ratios according to the sowing times. While there was no significant difference between the NDF rates in the first three sowing times (mid-March, late March, early April), the NDF rate in the last sowing time (56.88%) was slightly lower than the other sowing times. Due to the fact that *Atriplex nitens* is a C3 plant, the plants grown in arid conditions accelerate the transition to the generative period with the effect of increasing temperature in the summer period. The stem rate of plants that cannot show sufficient vegetative development remains lower. It has been reported that there are significant differences in the amount of NDF depending on the sowing time in many species of *Atriplex* and *Chenopodium* genus, and in case of low stalk ratio, the plant causes a decrease in the amount of cellulose and hemicellulose, and therefore a decrease in the NDF ratio (Aganga et al., 2003; Collins and Fritz, 2003; Özyiğit and Bilgen, 2006; van Niekerk et al., 2009; Önal Aşçı and Acar, 2018; Temel and Keskin, 2022).

NDF rates were determined as 52.16%, 58.64% and 62.99%, respectively, when *Atriplex nitens* was harvested at the end of the vegetative period, the beginning of flowering and the full flowering periods. While the NDF rate was low in the early harvest period, there was an increase in the NDF rate as the harvest was delayed. Studies have shown that the protein and non-structural carbohydrate contents of the plant begin to decrease with the delay of the harvest period, and on the contrary, structural carbohydrates such as hemicellulose and cellulose increase (Watson, 1990; Hoffman et al., 2003; Frost et al., 2008; Papanastasis et al., 2008; Yousef Elahi, 2013; Önal Aşçı and Acar, 2018; Acar et al., 2019b).

NDF ratio varied between 50.29% and 64.33% according to the interactions of the year, sowing time and harvest period. The lowest NDF ratio was 50.29%, which was harvested at the first sowing time and at the end of the vegetation period in 2019, and the highest NDF ratio with 64.33% was obtained in 2019 in *Atriplex nitens* plants, which were planted at the first sowing time and harvested at full bloom in 2019.

Acid Detergent Fiber Ratio

Acid Detergent Fiber contains cellulose, lignin and silicon. It is an indicator of the digestibility of animal feeds and the ability of animals to obtain energy from feeds (Kutlu et al., 2005).

The ADF of *Atriplex nitens* is given in Table 3. The ADF rate was determined as 35.90% in 2019 and 36.10% in 2020. There was no significant difference in the ADF ratios obtained in both years of the trial.

While there was no significant difference in ADF ratios in mid-March, end-March and early-April sowing, the ADF ratio was lower in mid-April, the last sowing time, compared to the other three sowing times. C3 plants cultivated in arid conditions complete their vegetative development early in the summer and pass to generative development. It was determined that this situation caused a decrease in the stem rate of the plants and therefore a decrease in the amount of cellulose (Collins and Fritz, 2003; van Niekerk et al., 2009; Temel and Keskin, 2022).

Delaying the harvest periods caused increases in ADF rates. ADF rates were found to be 31.65%, 37.10% and 39.24% at end of the vegetative period, beginning of flowering and full flowering periods, respectively. It has been determined that late harvesting of *Atriplex nitens* causes increases in ADF rates. As can be seen in the studies, it has been reported that delaying the harvest period causes an increase in structural carbohydrates (Watson, 1990; Aganga et al., 2003; Hoffman et al., 2003; Fales and Fritz, 2007; Frost et al., 2008; Papanastasis et al., 2008; Jung, 2012; Yousef Elahi, 2013; Acar et al., 2019b).

ADF ratio varied between 29.48% and 41.01% according to the interactions of the year, sowing time and harvest time. The lowest ADF ratio was 29.48%, which was harvested at the first sowing time and at end of vegetation period in 2019, and the highest ADF ratio was 41.01% in 2019, in *Atriplex nitens* plants planted at the first sowing time and harvested in full bloom.

Dry Matter Digestibility, Dry Matter Intake, Digestible Energy, Metabolizable Energy

Animals' feed consumption and digestibility rates (DMD and DMI) and the energy values (DE and ME) obtained from feeds have important effects on the development, growth, productivity and healthy survival of animals. Digestible energy is the energy obtained by subtracting the amount of energy excreted in the feces from the total energy. Metabolic energy, on the other hand, refers to the remaining energy by subtracting the energy excreted by urine and methane gas from digestible energy (Kutlu et al., 2005; Kutlu and Özen, 2009).

According to the data obtained in the study, DMD, DMI, DE and ME contents did not show any significant change in both years of the experiment.

When *Atriplex nitens* was sown in mid-March, late March, early April and mid-April, the DMD rates were 60.63%, 60.73%, 60.37% and 61.70%, the DMI rates were 2.09%, 2.08%, 2.05% and 2.13%, the DE amounts were 2.87 Mcal kg^{-1}, 2.87 Mcal kg^{-1}, 2.85 Mcal kg^{-1} and 2.91 Mcal kg^{-1} and ME amounts were 2.35 Mcal kg^{-1}, 2.36 Mcal kg^{-1}, 2.34 Mcal kg^{-1} and 2.39 Mcal kg^{-1}, respectively. While no significant changes were observed in the contents of DMD, DMI, DE and ME in the first three sowing times (mid-March, late-March and early April), there was an increase in the contents of DMD, DMI, DE and ME in the last sowing time (mid-April). It is estimated that due to the delay in sowing time, the plants switch to the generative period in the early summer period and the decrease in stem rates causes these results to be obtained. As a matter of fact, it has been determined in studies that plants are rich in non-structural carbohydrates due to delaying the sowing period and entering the generative period earlier (Hoffman et al., 2003; Fales and Fritz, 2007; Frost et al., 2008; Papanastasis et al., 2008; Jung, 2012; Yousef Elahi, 2013).

There were significant decreases in DMD, DMI, DE and ME contents of *Atriplex nitens* plants harvested at end of vegetative period, beginning of flowering and full flowering periods. Delaying the harvest period increases amount of structural carbohydrates (Cellulose, hemicellulose, lignin) in the plant. Increases in structural carbohydrates also cause a decrease in content such as DMD, DMI, DE and ME, which significantly affect feed value (Hoffman et al., 2003; Fales and Fritz, 2007; Papanastasis et al., 2008; Yousef Elahi, 2013).

According to the year, sowing time and harvest periods, the DMD ratios were between 56.96% and 65.93%, the DMI ratios were between 1.86% and 2.39%, the DE amount was between 2.71 and 3.09 Mcal kg^{-1}, the ME amount was between 2.22 and 2.54 Mcal kg^{-1}.

Table 3. ADF and DMD contents of *Atriplex nitens* according to different years, sowing time and harvest periods

		Acid detergent fiber (%)					**Dry matter digestibility (%)**			
Year (Y)	**Sowing time (ST)**	**Harvest time (HT)**					**Harvest time (HT)**			
		End of the vegetative period	**Beginning of flowering**	**Full flowering**	**Year averg.**		**End of the vegetative period**	**Beginning of flowering**	**Full flowering**	**Year averg.**
2019	**ST.1**	29.48 k	38.14 c-e	41.01 a	35.90	**ST.1**	65.93 a	59.19 g-ı	56.96 k	60.93
	ST.2	30.21 k	38.96 b-d	39.83 a-c		**ST.2**	65.37 a	58.55 h-ı	57.87 ı-k	
	ST.3	33.41 hı	39.93 a-c	36.47 ef		**ST.3**	62.87 cd	57.79 ı-k	60.49 fg	
	ST.4	29.56 k	37.36 d*f	36.44 ef		**ST.4**	65.87 a	59.80 f-h	60.52 fg	
2020	**ST.1**	34.25 g-ı	34.30 gh	40.54 ab	36.10	**ST.1**	62.22 c-e	62.18 de	57.32 jk	60.78
	ST.2	31.26 jk	35.99 fg	40.75 ab		**ST.2**	64.55 ab	60.86 ef	57.15 jk	
	ST.3	32.76 h-j	36.55 ef	40.65 ab		**ST.3**	63.38 b-d	60.43 fg	57.24 jk	
	ST.4	32.29 ıj	35.54 fg	38.29 c-e		**ST.4**	63.75 bc	61.21 ef	59.07 g-ı	
HT averg.		31.65 c	37.10 b	39.24 a		**HT averg.**	64.24 a	60.00 b	58.33 c	
ST Aver.		**LSD value and significant**				**ST Aver.**		**LSD value and significant**		
ST.1	36.29 a	**Y**		1.03 öd		**ST.1**	60.63 b	**Y**		0.80 öd
ST.2	36.17 a	**ST**		0.80**		**ST.2**	60.73 b	**ST**		0.63**
ST.3	36.63 a	**Y x ST int.**		1.14 öd		**ST.3**	60.37 b	**Y x ST int.**		0.88 öd
ST.4	34.91 b	**HT**		0.70**		**ST.4**	61.70 a	**HT**		0.54**
		Y x HT int.		0.98**				**Y x HT int.**		0.77**
		ST x HT int.		1.39**				**ST x HT int.**		1.08**
		Y x ST x HT int.		1.97**				**Y x ST x HT int.**		1.53**

ST-1: mid-March, ST-2: late March, ST-3: early April, ST-4: mid-April

**: p>0.01, *: p>0.05, the difference between data shown with the same letters is not statistically significant.

Table 4. DMI and DE contens of *Atriplex nitens* according to different years, sowing time and harvest periods

		Dry matter ıntake (%)					**Digestible energy (Mcal kg^{-1})**			
Year (Y)	**Sowing time (ST)**	**Harvest time (HT)**					**Harvest time (HT)**			
		End of the vegetative period	**Beginning of flowering**	**Full flowering**	**Year Aver.**		**End of the vegetative period**	**Beginning of flowering**	**Full flowering**	**Year Aver.**
2019	**ST.1**	2.39 a	1.95 ı-k	1.86 l	2.07	**ST.1**	3.09 a	2.80 f-h	2.71 j	2.88
	ST.2	2.35 a-c	1.92 ı-l	1.92 ı-l		**ST.2**	3.07 a	2.78 g-ı	2.75 h-j	
	ST.3	2.15 f	1.95 ıj	1.91 j-l		**ST.3**	2.96 c	2.75 h-j	2.86 ef	
	ST.4	2.36 ab	2.05 h	1.98 ı		**ST.4**	3.09 a	2.83 e-g	2.86 ef	
2020	**ST.1**	2.21 e	2.24 de	1.90 j-l	2.11	**ST.1**	2.93 cd	2.93 cd	2.72 ıj	2.87
	ST.2	2.29 cd	2.10 f-h	1.87 l		**ST.2**	3.03 ab	2.88 de	2.71 ıj	
	ST.3	2.32 bc	2.08 gh	1.89 kl		**ST.3**	2.98 bc	2.85 ef	2.72 ıj	
	ST.4	2.37 ab	2.11 fg	1.91 j-l		**ST.4**	3.00 bc	2.89 de	2.80 f-h	
HT averg.		2.30 a	2.05 b	1.91 c		**HT averg.**	3.02 a	2.84 b	2.77 c	
ST Aver.		**LSD value and significant**				**ST Aver.**		**LSD value and significant**		
ST.1	2.09 ab	**Y**		0.05 öd		**ST.1**	2.87 b	**Y**		0.03 öd
ST.2	2.08 bc	**ST**		0.04**		**ST.2**	2.87 b	**ST**		0.03**
ST.3	2.05 c	**Y x ST int.**		0.05 öd		**ST.3**	2.85 b	**Y x ST int.**		0.04 öd
ST.4	2.13 a	**HT**		0.02**		**ST.4**	2.91 a	**HT**		0.02**
		Y x HT int.		0.03**				**Y x HT int.**		0.03**
		ST x HT int.		0.04**				**ST x HT int.**		0.05**
		Y x ST x HT int.		0.06**				**Y x ST x HT int.**		0.06**

ST-1: mid-March, ST-2: late March, ST-3: early April, ST-4: mid-April

**: p>0.01, *: p>0.05, the difference between data shown with the same letters is not statistically significant.

Table 5. ME and RFV contents of *Atriplex nitens* according to different years, sowing time and harvest periods

		Metabolizable energy (Mcal kg^{-1})					Relative feed value			
Year (Y)	**Sowing time (ST)**	**Harvest time (HT)**					**Harvest time (HT)**			
		End of the vegetative period	**Beginning of flowering**	**Full flowering**	**Year Aver.**		**End of the vegetative period**	**Beginning of flowering**	**Full flowering**	**Year Aver.**
2019	**ST.1**	2.54 a	2.30 h-j	2.22 l	2.36	**ST.1**	121.97 a	89.50 ıj	82.40 l	98.05
	ST.2	2.52 ab	2.28 ı-k	2.26 j-l		**ST.2**	119.10 ab	87.33 jk	86.37 j-l	
	ST.3	2.43 de	2.25 j-l	2.35 gh		**ST.3**	104.53 de	87.53 jk	89.50 ıj	
	ST.4	2.54 a	2.32 g-ı	2.35 gh		**ST.4**	120.40 ab	94.87 gh	93.10 hı	
2020	**ST.1**	2.41 ef	2.41 ef	2.23 kl	2.35	**ST.1**	106.63 d	108.07 d	84.33 kl	99.66
	ST.2	2.49 bc	2.36 fg	2.23 kl		**ST.2**	114.67 c	99.03 fg	82.83 l	
	ST.3	2.45 c-e	2.34 gh	2.23 kl		**ST.3**	114.33 c	97.43 fg	83.50 kl	
	ST.4	2.46 cd	2.37 fg	2.30 h-j		**ST.4**	116.93 bc	100.43 ef	87.37 jk	
HT averg.		2.48 a	2.33 b	2.27 c		**HT averg.**	114.82 a	95.53 b	86.23 c	
ST Aver.		**LSD value and significant**					**ST Aver.**	**LSD value and significant**		
ST.1	2.35 b	**Y**		0.03 öd		**ST.1**	98.82 b	**Y**		2.03 öd
ST.2	2.36 b	**ST**		0.02**		**ST.2**	98.22 b	**ST**		1.97**
ST.3	2.34 b	**Y x ST int.**		0.03 öd		**ST.3**	96.21 c	**Y x ST int.**		2.78*
ST.4	2.39 a	**HT**		0.02**		**ST.4**	102.18 a	**HT**		1.50**
		Y x HT int.		0.03**				**Y x HT int.**		2.13**
		ST x HT int.		0.04**				**ST x HT int.**		3.01**
		Y x ST x HT int.		0.05**				**Y x ST x HT int.**		4.25**

ST-1: mid-March, ST-2: late March, ST-3: early April, ST-4: mid-April

**: p>0.01, *: p>0.05, the difference between data shown with the same letters is not statistically significant.

Relative Feed Value

The relative feed value is accepted as a quality measure developed for alfalfa crop in the USA (Ball et al., 1996). The relative feed value is calculated using NDF and ADF values (Rohweder et al., 1978; Ball et al., 1996; Morrison, 2003). The relative feed value determined for alfalfa is accepted as 100 and it is accepted that the quality of the feeds falling below this value decreases (Redfearn et al., 2006). RFV value above 150 indicates that the grass is of first quality. RFV value between 125 and 150 2nd quality, 103-124 is 3rd quality, 87-102 is 4th quality, 75-86 is 5th quality, and below 75 is 6th quality (Rohweder et al., 1978).

The relative feed value varied between 82.40 and 121.97 according to the year, sowing time and harvest periods (Table 5). There has been no significant different in RFV value over the years. However, sowing time and harvest periods caused significant changes in RFV value. While the lowest RFV value (96.21) was obtained at the third sowing time, the RFV value (102.18) was the highest at the last sowing time. On the other hand, delaying the harvest periods caused significant decreases in the RFV value. It has also been determined in many studies that the RFV value starts to decrease with the progress of the development periods (Türk and Albayrak, 2012; Panahi et al., 2012; Temel and Keskin, 2019; Hou et al., 2021).

Relative feed value of *Atriplex nitens* was Class 5, even at the first sowing time of 2019, when the lowest RFV value was obtained (82.40) and harvests in full flowering. On the other hand, relative feed value of *Atriplex nitens* was 4th Class in the first sowing time of 2019 and the harvest at the end of the vegetative period, when the highest RFV value (121.97) was obtained.

CONCLUSION

The crude protein ratio of *Atriplex nitens* differed between 2019 and 2020 when the research was conducted. However, the other examined quality characteristics did not change over the years. Sowing and harvesting times had significant effects on all quality features. While NDF and ADF rates were low in late sowing, CP, DMD, DMI, DE, ME and RFV contents were high. CP, DMD, DMI, DE, ME and RFV of the early harvested plants were high, while NDF and ADF were low. According to results of research, it was determined that in order to obtain high quality forage from *Atriplex nitens* in dry conditions, it should be sown in mid-March, which is the first sowing time, and harvested at the end of the vegetative period.

Conflict of Interest

The article authors declare that there is no conflict of interest between them.

Author's Contributions

The authors declare that they have contributed equally to the article.

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