

**T.C.
BİNGÖL UNIVERSITY
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**DETERMINATION OF ADAPTATION CAPABILITIES OF SOME
FOREIGN ORIGIN ALFALFA (*Medicago sativa* L.) CULTIVARS IN
BİNGÖL CONDITIONS**

PHD THESIS

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FOREWORD

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CONTENTS

FOREWORD.....	ii
CONTENTS.....	iii
LIST OF SYMBOLS AND ABBREIVATIONS.....	vi
LIST OF FIGURES.....	vii
LIST OF TABLES.....	viii
ÖZET.....	x
ABSTRACT.....	xi
1. INTRODUCTION.....	1
2. LITERATURE REVIEW.....	5
3. MATERIAL AND METHOD.....	17
3.1. Material	17
3.1.1. Location and Year of Research	18
3.1.1.1. Climate Data of Research Area	18
3.1.1.2. Soil Properties of Research Area	19
3.2. Method.....	20
3.2.1. Yield Features	22
3.2.1.1. Plant Height (cm).....	22
3.2.1.2. The Thickness of The Main Stem (mm).....	22
3.2.1.3. Number of Main Stems	23
3.2.1.4. Forage Yield (kg da ⁻¹).....	23
3.2.2.5. Dry Matter Yield (kg da ⁻¹)	23
3.2.2. Quality Features	23
3.2.2.1. Crude Protein (CP), ADF (Acid Detergent Fiber) and NDF (Neutral Detergent Fiber) Ratio (%)	23

3.2.2.2. Digestible Dry Matter (DDM), Dry Matter Intake (DMI), Relative Feed Value (RFV).....	23
3.2.3. Macro Elements (%).....	24
3.2.4. Micro Elements (mg kg ⁻¹).....	24
3.2.5. Data Evaluation	24
4. RESULTS AND DISCUSSION.....	25
4.1. Yield Features	25
4.1.1. Plant Height (cm).....	25
4.1.2. Stem Number	27
4.1.3. Stem Thickness (mm).....	29
4.1.4. Forage Yield (kg da ⁻¹).....	31
4.1.5. Dry Matter Yield (kg da ⁻¹).....	34
4.2. Quality Features	36
4.2.1. Crude Protein (CP) Ratio (%).....	36
4.2.2. ADF (Acid Detergent Fiber) Ratio (%).....	38
4.2.3. NDF (Neutral Detergent Fiber) Ratio (%).....	40
4.2.4. DDM (Digestible Dry Matter) Ratio (%).....	43
4.2.5. DMI (Dry Matter Intake) ratio (%).....	45
4.2.6. RFV (Relative Feed Value).....	47
4.3. Macro Elements	49
4.3.1. Ca (Calcium) Ratio (%)	49
4.3.2. Mg (Magnesium) Ratio (%).....	51
4.3.3. P (Phosphorus) Ratio (%).....	53
4.3.4. K (Potassium) Ratio (%).....	56
4.4. Micro Elements.....	58
4.4.1. Fe (Iron) Content (mg kg ⁻¹)	58
4.4.2. Cu (Copper) Content (mg kg ⁻¹)	61
4.4.3. Mn (Manganese) Content (mg kg ⁻¹).....	63
4.4.4. Zn (Zinc) Content (mg kg ⁻¹)	66

4.4.5. Al (Aluminum) Content (mg kg^{-1})	68
4.4.6. Cr (Chromium) Content (mg kg^{-1}).....	70
4.4.7. Ni (Nickel) Content (mg kg^{-1}).....	72
4.4.8. Se (Selenium) Content (mg kg^{-1})	74
5. CONCLUSIONS AND SUGGESTIONS.....	78
5.1. Yield Related Results.....	78
5.2. Quality Related Results.....	78
5.3. Macro Elements Related Results.....	79
5.4. Micro Elements Related Results.....	79
REFERENCES.....	81
AUTOBIOGRAPHY	93

LIST OF SYMBOLS AND ABBREVIATIONS

kg	: Kilogram
da	: Decare
mm	: Millimeter
cm	: Centimeter
P	: Phosphorus
K	: Potassium
Ca	: Calcium
Mg	: Magnesium
Mn	: Manganese
Fe	: Iron
Cu	: Copper
Zn	: Zinc
Al	: Aluminum
Cr	: Chromium
Ni	: Nickel
Se	: Selenium
ADF	: Acid Detergent Fiber
NDF	: Neutral Detergent Fiber
RFV	: Relative Feed Value
CPR	: Crude Protein Ratio
DMI	: Dry Matter Intake
DDM	: Digestible Dry Matter
NIRS	: Near Infrared Spectroscopy
µg	: Microgram
mg	: Milligram

LIST OF FIGURES

Figure 3.1. Location of research area	18
Figure 3.2. Some images of the experiment area.....	21
Figure 4.1. The plant height averages of foreign origin alfalfa cultivars.....	26
Figure 4.2. The stem number averages of foreign origin alfalfa cultivars.....	28
Figure 4.3. The stem thickness averages of foreign origin alfalfa cultivars.....	30
Figure 4.4. The forage yield averages of foreign origin alfalfa cultivars.....	33
Figure 4.5. The dry matter yield averages of foreign origin alfalfa cultivars.....	35
Figure 4.6. The crude protein averages of foreign origin alfalfa cultivars.....	37
Figure 4.7. The ADF value averages of foreign origin alfalfa cultivars.....	39
Figure 4.8. The NDF value averages of foreign origin alfalfa cultivars.....	42
Figure 4.9. DDM ratio averages of foreign origin alfalfa cultivars.....	44
Figure 4.10. DMI ratio averages of foreign origin alfalfa cultivars.....	46
Figure 4.11. RFV averages of foreign origin alfalfa cultivars.....	48
Figure 4.12. Ca ratio averages of foreign origin alfalfa cultivars.....	50
Figure 4.13. Mg ratio averages of foreign origin alfalfa cultivars.....	53
Figure 4.14. P ratio averages of foreign origin alfalfa cultivars.....	55
Figure 4.15. K ratio averages of foreign origin alfalfa cultivars.....	57
Figure 4.16. Fe content averages of foreign origin alfalfa cultivars.....	60
Figure 4.17. Cu content averages of foreign origin alfalfa cultivars.....	62
Figure 4.18. Mn content averages of foreign origin alfalfa cultivars.....	65
Figure 4.19. Zn content averages of foreign origin alfalfa cultivars.....	67

Figure 4.20. Al content averages of foreign origin alfalfa cultivars.....	69
Figure 4.21. Cr content averages of foreign origin alfalfa cultivars.....	71
Figure 4.22. Ni content averages of foreign origin alfalfa cultivars.....	74
Figure 4.23. Se content averages of foreign origin alfalfa cultivars.....	76



LIST OF TABLES

Table 3.1. Cultivars of alfalfa used in research	17
Table 3.2. Climate data of Bingöl province.....	18
Table 3.3. Soil analysis results of the trial area.....	19
Table 3.4. Yield, quality and mineral substance contents determined in the study..	22
Table 4.1. The variance analysis of plant height of alfalfa cultivars.....	25
Table 4.2. The plant heights of alfalfa cultivars (cm).....	26
Table 4.3. The variance analysis of stem number of alfalfa cultivars.....	27
Table 4.4. The stem number of alfalfa cultivar (number).....	28
Table 4.5. The variance analysis of stem thickness of alfalfa cultivars.....	29
Table 4.6. The stem thickness of alfalfa cultivars (mm).....	30
Table 4.7. The variance analysis of forage yield of alfalfa cultivars.....	31
Table 4.8. The forage yield of alfalfa cultivars (kg da ⁻¹).....	32
Table 4.9. The variance analysis of dry matter yield of alfalfa cultivars.....	31
Table 4.10. The dry matter yield of alfalfa cultivars (kg da ⁻¹).....	36
Table 4.11. The variance analysis of crude protein of alfalfa cultivars.....	37
Table 4.12. Crude protein of alfalfa cultivars (%).....	34
Table 4.13. The variance analysis of ADF ratio of alfalfa cultivars.....	38
Table 4.14. ADF ratio of alfalfa cultivars (%).....	39
Table 4.15. The variance analysis of NDF ratio of alfalfa cultivars.....	40
Table 4.16. NDF ratio of alfalfa cultivars (%).....	41
Table 4.17. The variance analysis of DDM ratio of alfalfa cultivars.....	43
Table 4.18. DDM ratio of alfalfa cultivars (%).....	43
Table 4.19. The variance analysis of DMI ratio of alfalfa cultivars.....	45
Table 4.20. DMI ratio of alfalfa cultivars (%).....	45
Table 4.21. The variance analysis of RFV ratio of alfalfa cultivars.....	47

Table 4.22 RFV ratio of alfalfa cultivars.....	47
Table 4.23. Optimal ratio of macro elements.....	49
Table 4.24. The variance analysis of Ca content of alfalfa cultivars.....	49
Table 4.25. Ca content of alfalfa cultivars (%)......	50
Table 4.26. The variance analysis of Mg content of alfalfa cultivars.....	51
Table 4.27. Mg content of alfalfa cultivars (%)......	52
Table 4.28. The variance analysis of P content of alfalfa cultivars.....	54
Table 4.29. P content of alfalfa cultivars (%)......	54
Table 4.30. The variance analysis of K content of alfalfa cultivars.....	56
Table 4.31. K content of alfalfa cultivars (%)......	56
Table 4.32. Optimal ratio of Micro elements.....	58
Table 4.33. The variance analysis of Fe content of alfalfa cultivars	59
Table 4.34. Fe content of alfalfa cultivars (mg kg ⁻¹)	59
Table 4.35. The variance analysis of Cu content of alfalfa cultivars	61
Table 4.36. Cu content of alfalfa cultivars (mg kg ⁻¹)......	62
Table 4.37. The variance analysis of Mn content of alfalfa cultivars	63
Table 4.38. Mn content of alfalfa cultivars (mg kg ⁻¹)......	64
Table 4.39. The variance analysis of Zn content of alfalfa cultivars	66
Table 4.40. Zn content of alfalfa cultivars (mg kg ⁻¹)......	66
Table 4.41. The variance analysis of Al content of alfalfa cultivars	68
Table 4.42. Al content of alfalfa cultivars (mg kg ⁻¹)......	69
Table 4.43. The variance analysis of Cr content of alfalfa cultivars	70
Table 4.44. Cr content of alfalfa cultivars (mg kg ⁻¹)......	71
Table 4.45. The variance analysis of Ni content of alfalfa cultivars	72
Table 4.46. Ni content of alfalfa cultivars (mg kg ⁻¹)......	73
Table 4.47. The variance analysis of Se content of alfalfa cultivars	75
Table 4.48. Se content of alfalfa cultivars (mg kg ⁻¹)......	75

DETERMINATION OF ADAPTATION CAPABILITIES OF SOME FOREIGN ORIGIN ALFALFA (*MEDICAGO SATIVA* L.) CULTIVARS IN BİNGÖL CONDITIONS

ABSTRACT

This study has carried out to determine the yield, quality features and mineral content of some foreign origin alfalfa cultivars in Bingöl ecological conditions. In the research, a total of 15 alfalfa cultivars, 12 of which are from foreign origin (Iside, Osjecka 99, Ezzelina, Diane, Prosementi, Queen, Emiliana, Riviera vicentina, Banat vs, La Torre, Sabrina and Escorial) and 3 of them as the standard types (Elci, Bilensoy 80 and Basbag) were used as plant material.

In the research; plant height, number of stems, stem thickness, forage yield and dry matter yield from yield features, CP (Crude Protein), ADF (Acid Detergent Fiber), NDF (Neutral Detergent Fiber), DDM (Digestible Dry Matter), DMI (Dry Matter Intake) and RFV (Relative Feed Value) from quality features, Ca (Calcium), Mg (Magnesium), P (Phosphorus) and K (Potassium) ratios from macro elements, Fe (Iron), Cu (Copper), Mn (Manganese), Zn (Zinc), Al (Aluminum), Cr (Chromium), Ni (Nickel) and Se (Selenium) from micro elements were investigated. Average plant height was 97.6 cm, number of stems 15.8, stem thickness 2.80 mm, forage yield 11018 kg da⁻¹, dry matter yield 3228 kg da⁻¹, CP ratio 20.40%, ADF ratio 33.0%, NDF ratio 42.41%, DDM ratio 63.18%, DMI ratio 2.85%, RFV 140.3, Ca content 1.57%, Mg content 0.39%, P content 0.34%, K content 2.03%, Fe content 427 mg kg⁻¹, Cu content 10.00 mg kg⁻¹, Mn content 46.7 mg kg⁻¹, Zn content 18.3 mg kg⁻¹, Al content 100.7 mg kg⁻¹, Cr content 4.25 mg kg⁻¹, Ni content 4.00 mg kg⁻¹ and Se content 0.97 mg kg⁻¹.

When these two-year results are evaluated together; Emiliana and Ezzelina cultivars stand out in terms of yield features, there is no statistical difference between the cultivars in terms of quality and macro elements and it was determined that Iside cultivar generally gave higher values than other cultivars in terms of micro elements.

Keywords: Alfalfa, forage yield, forage quality, macro elements, micro elements.

BAZI YURTDIŐI KAYNAKLI YONCA (*MEDİCAGO SATİVA* L.) ÇEŐİTLERİNİN BİNGÖL KOŐULLARINDA ADAPTASYON YETENEKLERİNİN BELİRLENMESİ

ÖZET

Bu çalışma, Bingöl ekolojik koőullarında bazı yurtdıőı kaynaklı yonca çeőitlerinin verim ve kalite özellikleri ile mineral madde içeriklerinin belirlenmesi amacıyla yürütölmüőtür. Araőtırmada 12 adedi yurtdıőı kaynaklı (Iside, Osjecka 99, Ezzelina, Diane, Prosementi, Queen, Emiliana, Riviera vicentina, Banat vs, La Torre, Sabrina ve Escorial) ve 3 adedi standart (Elçi, Bilensoy 80 ve Baőbağ) olmak üzere toplam 15 adet yonca çeőidi bitkisel materyal olarak kullanılmıőtır.

Araőtırmada, Yonca çeőitlerine ait verim özelliklerinden bitki boyu, sap sayısı, sap çapı, yeőil ot verimi ve kuru ot verimi, kalite özelliklerinden HP (Ham Protein), ADF (Asit Deterjanda Çözünmeyen Lif), NDF (Nötral Deterjanda Çözünmeyen Lif), SKM (Sindirilebilir Kuru Madde), KMT (Kuru Madde Tüketimi) ve NYD (Nispi Yem Değeri), makro elementlerden Ca (Kalsiyum), Mg (Magnezyum), P (Fosfor) ve K (Potasyum) oranları ile mikro elementlerden Fe (Demir), Cu (Bakır) Mn (Mangan), Zn (Çinko), Al (Alüminyum), Cr (Krom), Ni (Nikel) ve Se (Selenyum) içerikleri ele alınmıőtır.

Yapılan çalışmada; ortalama bitki boyu 97,6 cm, sap sayısı 15,8, sap çapı 2,80 mm, yeőil ot verimi 11018 kg da⁻¹, kuru ot verimi 3228 kg da⁻¹, HP oranı %20,40, ADF oranı %33,0, NDF oranı %42,41, SKM oranı %63,18, KMT oranı %2,85, NYD 140,3, Ca oranı %1,57, Mg oranı %0,39, P oranı %0,34, K oranı %2,03, Fe içeriğİ 427 mg kg⁻¹, Cu içeriğİ 10,00 mg kg⁻¹, Mn içeriğİ 46,7 mg kg⁻¹, Zn içeriğİ 18,3 mg kg⁻¹, Al içeriğİ 100,7 mg kg⁻¹, Cr içeriğİ 4,25 mg kg⁻¹, Ni içeriğİ 4,00 mg kg⁻¹ve Se içeriğİ 0,97 mg kg⁻¹ olarak bulunmuőtur.

Elde edilen bu iki yıllık sonuçlar birlikte deđerlendirildiğİnde; verim açasından Emiliana ve Ezzelina çeőitlerinin ön plana çıktığı, kalite ve makro elementler açasından çeőitler arasında herhangi istatistiksel bir farklılığın olmadığı, mikro elementler açasından ise Iside çeőidinin genel olarak diğİr çeőitlere nazaran daha yüksek deđerler verdiğİ belirlenmiőtir.

Anahtar Kelimeler: Yonca, ot verimi, ot kalitesi, makro elementler, mikro elementler.

1. INTRODUCTION

Hunger is increasing in the world and people nutritional needs gain importance. Protein-containing foods play a major role in a balanced diet of people. An adult needs 70 grams of protein per day. In order to have a balanced diet, half of it must be vegetables and half of it from animal origin. However, in our country, daily protein consumption of animal origin per person varies between 17-25 g (Gokkaya 2019).

Although Turkey is among the countries that can feed it, but it is impossible to say that the population have fed in a balanced manner. Proteins have great importance in a balanced diet. Turkey's people are malnourished in terms of protein compared to many developed countries also our main food source is carbohydrates. The main reason for this unfavorable situation is mostly the problems related to our animal husbandry (Soya 1997).

The main purpose of the agriculture of forage crops is to provide fodder with the quality roughage required by livestock. Forage crops are of great importance in the chain of delivering water and nutrients from the soil to the plant, then the animal, then the animal protein, and then the human. The potential of forage crops agriculture is undoubtedly one of the most important factors affecting a country's production of animal products (Gecit et al. 2009).

Forage crops are plants that contain nutrients that livestock must take into their bodies in order to survive and produce the products expected from them, in addition they do not adversely affect animal health and animal products when animals fed them in certain limits, which are cultured or grow spontaneously in nature (Sayar 2017).

Forage crops farming is the most important way of continuous and safe roughage production (Akman et al. 2006). Forage crops farming, which has an important role in agricultural activities, is the insurance of plant and animal production. Animals, which

converted into meat, primarily use grasses produced on agricultural lands and dairy products and people benefit from these products (Soya et al. 2005). Forage crops have great importance in animal nutrition in terms of being a cheap source, containing essential nutrients for the rumen flora of animals, being rich in vitamins and minerals, increase the reproductive power of animals and provide high quality animal products (Serin and Tan 2001).

In animal nutrition, it is very important to provide cheap and quality feed to farm animals. It also has benefits such as bringing organic matter to the soil and preventing erosion (Gecit et al. 2009; Sayar 2017).

In addition, one of the most important benefits of mixed or pure cultivation of forage crops is to reduce the grazing pressure on pastures, which are our natural grass production resources (Sayar et al. 2015).

The majority of forage crops belong to the legume and grass family. Green forage plants belonging to the legumes (Leguminosae) family have a special and important place in animal nutrition due to their superiority over other green forage plants (Akyildiz 1969). According to the estimates, 38% of the protein consumed by the animals, 16% of the lipids and 5% of the carbohydrates have supplied from legumes forage crops (Acikgoz 2001). Due to the high nutritional value of leguminous forage crops, the higher the ratio of these plants in meadows and pastures, the higher the feed value of meadows and pastures (Ak 1997).

Forage crops farming has great importance in developed countries and these countries allocate a significant portion of their agricultural land to forage crop farming. For example, the ratio allocated to forage crops in the total field land are 49.8% in Australia, 36.5% in Germany, 31.4% in the Netherlands. 25.8% in France, 25.4% in England and 23.0% in the USA (Acikgoz et al. 2005).

In Turkey, in parallel with the support of forage crops in recent years, the rate of forage crops in field agriculture has increased from 2-3% to 7.4%. Turkey's current roughage production can meet approximately half of the total roughage need (Sayar et al. 2010).

Our natural meadows and pastures are the most important feeding and forage crops for our animal materials. However, these areas have been subjected to heavy and excessive grazing for years due to some reasons (legal issues, unconsciousness, etc.) and now they are far from supplying the roughage needs of our livestock (Soya et al. 2005). One of the most effective methods in reducing these pressures on our pastures is promoting the cultivation the main and second forage crops and in addition to this, it is to provide quality roughage. Alfalfa, which has defined as the queen of forage crops, has high adaptability, long life, can harvested many times in a vegetation period, high productivity, high nutritional value and some varieties are grazeable due to these reasons, it differs from other forage crops. This valuable forage crops have seen naturally in almost every region of Turkey and its cultivation has been increasingly widespread in recent years (Kir and Soya 2008). Alfalfa, which is called the empress of forage crops, known as the oldest forage crop, is a famous plant that has been cultivated in a planned and systematic way from the ages before, including today (Genckan 1992).

Alfalfa (*Medicago sativa* L.) is a forage plant with high value and gives plenty of forage. Our country is the gene center of alfalfa and the oldest recorded information states that alfalfa was used as a forage crops in Turkey 3300 years ago (Hansen 1988).

Alfalfa is rich in protein, as well as vitamins such as carotene (Provitamin A) and tocopherol (vitamin E). With the help of deep root, alfalfa easily benefits from water and plant nutrients found in deep areas that other plants could not use. Alfalfa leaves a nitrogen-rich soil for the next plant in its root nodosities (Soya et al. 1997). Alfalfa naturally found in almost every region of Turkey. Cultivation of alfalfa has become increasingly common in recent years. This situation makes it necessary to research and adapt new varieties for our country besides existing alfalfa varieties. Because of the

mentioned reasons, it has become compulsory to develop new varieties of forage crops and especially alfalfa. For increasing the number of registered varieties by conducting regional adaptation studies especially after the enactment of the Pasture Law No. 4342, important developments have taken place in terms of culture and forage crops in Turkey (Kir 2006).

This research have conducted to determine the yield and quality characteristics of some imported alfalfa (*Medicago sativa* L.) cultivars in Bingöl ecological conditions. In Bingöl province, alfalfa is the most cultivated after cereals. Although Bingöl province has alfalfa cultivation potential, the yield and quality elements of alfalfa are unknown. Producers continue to grow alfalfa with the methods they have learned since the past. It is important for Bingöl province to reveal the yield and quality characteristics of imported alfalfa varieties with high yields and determine the cultivars that show superior characteristics. Productive and high quality imported alfalfa cultivars used by the producers have revealed as a result of this study and when an awareness is created for the use of these cultivars, producers have obtained more products per unit area and indirectly have contributed to the development of animal husbandry in the region, especially in Bingöl. In addition, this study have served as a reference for both future studies and determination of the seed that producers have preferred. For these purposes, this work have being continued for two years with total 15 alfalfa varieties, 12 of which are imported cultivars and 3 of which are standard cultivars. The yield and quality characteristics of alfalfa have revealed in two years.

In summary, the purpose of this thesis is alfalfa production increasement and determination the adaptation capabilities of high-yielding and high quality foreign-origin alfalfa cultivars in the area. As a result of this study, high yielding and high quality cultivars that suitable for the region have been determined.

2. LITERATURE REVIEW

In this study, the first harvest takes place when ten percent of the alfalfa field is in flowering condition; crude protein ratio is 21.4%, ADF 35.3%, NDF 55.6%, and ADL 11.7%. The second harvest takes place when fifteen percent of the alfalfa field is in flowering condition; the crude protein ratio is 16.5%, ADF 36.3%, NDF 51.2%, and ADL 10.5% (Horner 1983).

The Elci cultivar of alfalfa height was 59.8-76.3 cm in the first year and 90.0-121.3 cm in the second year. In the second and third years of the study, the total green forage yield was 9159-6284 kg da⁻¹ and 7538-10715 kg da⁻¹, the hay yield was 1533-2200 kg da⁻¹ and 1877-2572 kg da⁻¹, respectively. Also crude protein ratio was between 15.51-19.25% in the first year and 16.19-18.40% in the second year. It was determined that the crude protein yield varied between 334.9-538.7 kg da⁻¹ in the second year and between 445.8-633.8 kg da⁻¹ in the third year (Sevimay 1992).

This study was conducted in Konya conditions in order to compare the cultivars that emerged by free pollination of the Alfalfa with some registered cultivars. As a result, the average plant height in the first and second year was 74.62-81.06 cm; protein ratio 17.58-18.23%; the total green forage yield 4451.34- 3735.73 kg da⁻¹; the total hay yield 887.58-1057.70 kg da⁻¹; the protein yield was determined as 159.12-186.55 kg da⁻¹ (Tamkoc 1992).

This research was carried out in order to investigate forage yield of eight alfalfa cultivars under Ankara conditions. As a result of three years of research, the total green forage yield was 7907-11140 kg da⁻¹. They stated that the dry matter yield varied between 2619-3615 kg da⁻¹ on average (Altinok and Karakaya 2002).

This study was carried out to compare the green and dry matter yields and also some agronomic features of 2 alfalfa cultivars in Erzurum conditions; the total green forage yield was found to be 4735.6-5804.1 kg da⁻¹, dry matter yield varied between 1104.7-1333.5 kg da⁻¹ and the average plant height between 59.8-84.2 cm in three harvests (Seker 2003).

This study has carried out to determine high yielding alfalfa accession and cultivars under Erzurum conditions. The dry matter yield was 1473-2000 kg da⁻¹ for cultivars in the first year; in the second year, it changed between 1373-1800 kg. Crude protein contents of these accession varied between 15.66-19.05% in the first year; In the second year, it changed between 15.44-17.74%; the crude protein yields varied between 263.2-348.5 kg da⁻¹ in the first year and 218.6-299 kg da⁻¹ in the second year (Sengul et al. 2003).

In the study 4 different alfalfa cultivars were used in Bornova ecological conditions, flower color blue-purple, lying status 1 point, the rate of sparseness 0% and the rate of winter damage 0% were reported. The researchers, number of flowering days 22.0-24.3 days, plant height 61.7-65.8 cm, stem thickness 2.78-2.90 mm, number of stems 12.14-12.41, green forage yield 6338-7025 kg da⁻¹, dry matter rate of 22.15-23.13% and dry matter yield is between 1541-1700 kg da⁻¹, stated that there was variation (Soya et al. 2005).

In the study they carried out at the Field Crops Central Research Institute Research Application Farm between 1999 and 2002, they investigated some important features and relations between features in the alfalfa (*Medicago sativa* L.) population that obtained from different sources. In the research between 2000 and 2001, plant heights of alfalfa cultivars were obtained from five harvests that were 84.8 cm, 63.7 cm, 57.0 cm, 49.7 cm, 42.4 cm and the number of stems have measured 53.3, 57.1, 67.5, 58.8, 64.9 and were recorded from the harvests respectively in the year 2000. The plant heights were 60.9 cm, 56.6 cm, 60.2 cm, 48.6 cm and the number of stem have measured 46.9, 54.7, 62.9, 76.3

and have obtained from the harvests respectively in the year 2001 (Karakurt and Firincioglu 2005).

This study has conducted to determine the adaptability of alfalfa and some grasses under Turkish Republic of Northern Cyprus. According to the results, average plant height of alfalfa was 72.96 cm, the green forage yield was 10828.72 kg/ha, and the dry matter yield was 2642.39 kg ha⁻¹ (Kusvuran et al. 2005).

In a study that conducted in Tekirdag conditions for investigation of some changes in nutrients that stored in the roots and stems in different growth periods. The average crude protein ratio in the body of *Medicago sativa* was 18.13%, the Ca ratio was 0.52% and the P ratio was 0.082% (Bayraktar 2005).

In order to investigate the yield performance of different alfalfa cultivars in China; a research project was conducted at Henan Agricultural University in Zhengzhou. It was determined that the dry matter yield 1760-1040 kg da⁻¹, the average plant height 55.6-69.9 cm, the crude protein ratio 19.4-21.5% and the crude ash ratio was varied between 7.3- 12.6% (Zang et al. 2005).

This research was conducted in Izmir conditions, depending on the year and variety of alfalfa cultivars, the plant height was 74.78-86.78 cm, green forage yield 791-1705 kg da⁻¹, dry matter yield 22.584- 334.25 kg da⁻¹, crude protein ratio 17.86 – 20.26 %, crude protein yield 37.25-52.23 g/plant and crude ash ratio varied between 9.86-11.42% (Kir 2006).

In the study pasture type 5-medic alfalfa cultivars have used under Bornova (Izmir) conditions, they found that the green forage yield was 791-1705 g/plant, the dry matter yield was 164.3- 362.8 gr/plant. They stated that these differences are important in terms of year, cultivar and year x cultivar interactions. They stated that the crude protein ratio varied between 17.86-20.26% and these differences might cause the year x cultivar interaction to be significant. They determined that the crude protein yield varied between

29.38-71.28 g/plant and stated that year x cultivar interaction was important by the effect of year and variety factors (Kir and Soya 2008).

In the study has conducted to determine the adaptation of morphological and some agronomic characteristics of different alfalfa genotypes (Tru-test, Bacana, FG8R612 and Elci) between 2002-2004 years in Bornova and Odemis environmental and soil conditions. It was found that the average plant height was 71.08 cm, the average dry matter yield was 2163 kg da⁻¹ and stem number was 11.62 (Demiroglu et al. 2008).

In other study, the results of a research project conducted in 2005-2006 to determine the forage yield and plant characteristics of eight different alfalfa cultivars were reported (Aday, Kayseri, Bilensoy, Elci, Posavina, Mırna, Platove MA-414) under Ankara and Konya conditions. According to the results of research, the plant height average of alfalfa varieties was 59.53-83.88 cm, green forage yield was 8084.48-9292.67 kg da⁻¹ at Konya location and 7398.95-8691.77 kg da⁻¹ in Ankara location, dry matter yield was 1944.6-2209.6 kg da⁻¹ in Konya location and 1764.6-2025 kg da⁻¹ in Ankara location, average crude protein rate was 14.81-20.13% in Konya location and 14.72-19.30% in Ankara location. The crude protein yield varied between 268.4-356.8 kg da⁻¹ in the Konya location and between 246-335.8 kg da⁻¹ in the Ankara location (Mohammed 2008).

In research, the amounts of Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn in stems, leaves and fruits of many *Medicago* species distributed in Diyarbakır province have determined by atomic absorption spectroscopy. According to their results, heavy metal levels were determined as Fe>Mn>Zn>Cu>Ni in all parts of the studied species. When the parts were compared, it was seen that the amounts of Fe, Mn, Zn, Cu and Ni in the leaves were higher the stem and fruit (Demir 2008).

In an investigation study some agricultural and quality characteristics of different alfalfa (*Medicago sativa* L.) clones have been analyzed; as a result, plant height was 43.2-73.2 cm, stem thickness was 1.86-4.76 mm, crude protein ratio was 17.3-23.2%, ADF ratio was 16.8-33.3%, NDF ratio was 20.3-35.2%, digestible dry matter was 63.0-75.8%, dry

matter intake was 3.4-5.9%, relative feed value was 166.4-347.4 and the crude ash ratio was obtained as 8.0-18.6% (Basbag et al. 2009).

In a study conducted on some legume at Uludag University; crude protein, crude ash, acid detergent fiber (ADF), neutral detergent fiber (NDF), acid detergent lignin (ADL) ratios were 17.84%, 5.75%, 28.87%, 42.51% and 10.87% in *Medicago sativa*, respectively. Digestible dry matter (DDM), dry matter intake (DMI) and relative feed value (RFV) were determined 66.4%, 2.8%, 145.4 in *Medicago sativa*, respectively (Canbolat and Karaman 2009).

After an annual study, some morphological characteristics of the 20 alfalfa (*Medicago sativa* L.) ecotypes were obtained from the Aegean Agricultural Research Institute International Gene Bank on alfalfa breeding studies: The plant height was obtained between 55.80 and 84.80 cm. The stem thickness was found between 1.00 and 18.90 mm. The stem number was determined between 5.2 and 12. The leaflet length was measured between 13.82-18.65 mm. The leaflet width was determined between 5.88 and 9.99 mm and finally leaf area index was presented between 0.41 and 2.03 cm² (Yesil and Sengul 2009).

In this research the crude protein, NDF and ADF rates in alfalfa plants that has harvested during flower budding, early flowering and full bloom periods under Romanian conditions were determined. During the budding period crude protein, NDF and ADF ratios were; 30.6%, 42.0% and 32.0%; in the early flowering period crude protein, NDF and ADF ratios were 32.6%, 45.0% and 34.8%, and in the full flowering period crude protein, NDF and ADF ratios were 33.9%, 48.3% and 37.5% (Pop et al. 2010).

The study based on an investigation was conducted in Izmir in order to determine the performance of leguminous forage crops cultivars under Mediterranean climatic conditions; the average plant height of two alfalfa cultivars was determined as 65.55 cm, average green forage yield as 8046 kg da⁻¹ and average dry matter yield as 2055 kg da⁻¹ (Demiroglu and Avcioglu 2010).

The research, which has carried out in order to determine the forage yield and some yield elements of some alfalfa cultivars at different sowing times under Van conditions, has conducted under producer conditions in Gulpinar district of Van province between 2006 and 2009. In the study, the crude protein yield ($125\text{-}140\text{ kg da}^{-1}$, $150\text{-}196\text{ kg da}^{-1}$), phosphorus (P) content ($0.16\text{-}0.17\%$, $0.11\text{-}0.12\%$), potasyum (K) content ($2.01\text{-}2.03\%$, $2.14\text{-}2.18\%$), calcium (Ca) content ($1.28\text{-}1.30\%$, $1.86\text{-}1.88\%$) and magnesium (Mg) content values ($0.24\text{-}0.25\%$, $0.24\text{-}0.26\%$) were stated to have changed between content values in 2007 and 2008, respectively (Turan and Celen 2010).

In a study conducted in Dicle University; plant height, green forage yield, dry matter yield and crude protein ratio values in four alfalfa cultivars were examined and their yield performances were investigated. As a result of the research, according to the annual average data, it was determined that the highest total green forage (4896 kg da^{-1}) and dry matter yield (1266 kg da^{-1}) were obtained from the Elci cultivar, and the highest average crude protein ratio (22.67%) was obtained from the Bilensoy cultivar. The highest plant height has obtained from the SYN-1 accession and its height was 63.47 cm followed by the Elci cultivar with 61.52 cm (Saruhan and Kusvuran 2011).

The study were carried out in order to determine the forage yield and forage quality of some perennial legume and *Poaceae* forage crops in the irrigated conditions of the Cukurova region between 2007 and 2009. In the study, they used the MA414 alfalfa cultivar. According to the results of the research, it was reported that the plant height of alfalfa was 58.2 cm, hay yield was 1136.3 kg da^{-1} , crude protein ratio was 16.5% and crude protein yield was 186.4 kg da^{-1} (Kokten et al. 2011).

The research has conducted in Ankara conditions in order to determine some alfalfa characteristics and 20 genotypes of alfalfa cultivars from different sources of Kayseri ecotype have used. As a result of the research, the plant height varied between 56.4-76.8 cm, the stem thickness was measured between 3.2-4.2 mm and the number of stem was found between 38.1-66.8 (Saruhan and Kusvuran 2011).

This study was conducted to determine the yield potential and adaptability of alfalfa cultivars comparing three Hungarian origin (L-1734, L-1735, L-1736) and two native standard (Bilensoy-80, Sazova) alfalfa cultivars in irrigated conditions under Ankara conditions. According to the results of the research, the average plant height of two years were 59.3-65.9 cm, dry matter yields were between 1044.4-1228.2 kg da⁻¹, green forage yield were between 3241.6-3770 kg da⁻¹ and the Hungarian origin alfalfa cultivars can be grown in Middle Anatolia conditions (Unal et al. 2012).

In a two-year study using two alfalfa cultivar candidates (ETA-1, ETA-2) and Elci, Kalender, Artal cultivars in Cukurova ecological conditions, the average of the two harvests, the forage yield was 8284-8775 kg da⁻¹, the hay yield was 1883-1994 kg da⁻¹, the crude protein ratio was 17.6-18.3%, the ADF and NDF ratios were 36.5-38.4 % and 47.6-49.3%, respectively (Cinar 2012).

This study has conducted to investigate the effect of alfalfa and *Bromus inermis* mixture by gypsum applications on forage yield in Ankara climate conditions. Forage yield of pure cultivated alfalfa was found between 748-1095.7 kg da⁻¹. dry matter yield 154-231 kg da⁻¹ and crude protein yield as 24.7-38 kg da⁻¹, were determined. The researchers stated that increasing gypsum doses causes an increase in all yields (Taskin and Sevimay 2012).

This study has conducted in order to determine the performance of some mixtures of perennial warm season *Poaceae* forage crops with alfalfa in 2009-2011 years in the irrigated conditions of Adana. The plant height of alfalfa grown in pure and mixed form varied between 44.3-70.5 cm by years and green forage yield in pure alfalfa varied between 3072-4899.7-5357.3 kg da⁻¹ in 2009-2011 years. The dry matter yields were 773.3-1370.7-1274 kg da⁻¹, crude protein ratios were 20.2-21-20.5%, crude protein yields were 140.3-271.3-230.5 kg da⁻¹, ADF ratios were 29.7-24.2-26.2%, NDF ratios were 39.4-37-39.2%, digestible dry matter ratios were 65.8-70.1-68.5%, the relative feed value

were 155.4-176.4-162.8 and the highest crude protein ratio (20.6%), relative feed value (164.8) and digestible dry matter ratio (68%) from pure alfalfa has obtained (Cinar 2012).

In the study they conducted with Verko, Sunter, Hemedan, Elci, Kayseri and Planet cultivars in Konya and Ankara ecological conditions in 2006 and 2007, they reported that two-year average plant height was 62.0-68.2 cm, dry matter yield was 2094.0-2230.0 kg da⁻¹, crude protein rate was 18.5-19.4% and crude protein yield varied between 402.0-422.0 kg da⁻¹ (Avci et al. 2013).

In the study they conducted with six different alfalfa cultivars (Elci, Kalander, Calfa, MA-525 HQ, Bilensoy and Krimea) between 2007-2010 in Cukurova conditions, forage yield was 5791.0-6771.0 kg da⁻¹, the dry matter yield was 1673.0-2039.0 kg da⁻¹, the ADF ratio was 32.7-34.4% and the NDF ratio varied between 43.1-44.3%. (Yucel et al. 2013).

The research conducted in order to determine the yield and quality characteristics of some perennial warm season legume of forage crops in Adana region in the irrigated conditions. The Nimet cultivar of alfalfa was used in their adaptation study which they have done and as a result of the research, the average plant height was found 69.2 cm, the green forage yield was obtained 5094.5 kg da⁻¹, the total dry matter yield was 1135 kg da⁻¹, the average crude protein rate was 17.8%, the ADF rate was 34.3%, NDF ratio was obtained 46.5% and finally the relative feed value RFV was 124.5 (Gundel et al. 2014).

In the study, 5 alfalfa cultivars were used in Ethiopia. As a result of the research, the average plant height was between 74.48 and 86.51 cm, ADF rate obtained between 20.71 and 26.19%, NDF rate was between 36.86-43.53%, the crude protein ratio varied between 18.15 and 19.56%, the crude ash content varied between 10.03-10.69%, the relative feed value was obtained between 154.01-189.5 and the dry matter yield was found between 4.22 and 4.77 t/ha (Geleti et al. 2014).

The research investigated the effects of harvest time on quality features of alfalfa. They determined that there was a statistically significant increase in crude cellulose content, ADF and NDF ratios and a decrease in nitrogenous substances with the progress of vegetation. Statistically the highest crude protein content (28.97%) was obtained at the beginning of budding, the lowest crude protein content (11.97%) was determined at the stage after the flowers fall (Skladanka et al. 2014).

The study was conducted in Bornova and Odemis ecological conditions in 2006 and 2007 years with four different alfalfa genotypes (TT-2008, TT-2009, Pioneer-5683 and Elci), it was found that there were significant differences in the aspect of genotypes between locations. In both conditions, six harvests have obtained in the first year and eight harvests in the second year they have done. The researchers found that in Odemis condition the forage yield of the genotypes was 9769.0-12235.0 kg da⁻¹, dry matter yield 2078.0-2818.0 kg da⁻¹, main stem length 77.12-86.80 cm and the main stem thickness was 3.57-3.99 mm, in Bornova conditions forage yield 9260.0-11832.0 kg da⁻¹, dry matter yield 1984.0-2493.0 kg da⁻¹, main stem length 70.82-76.12 cm and main stem thickness 2.84-3.12 mm changed (Kavut et al. 2014).

The research has conducted to determine yield and quality features of some perennial forages as both sole crops and intercropping mixtures in Diyarbakir conditions between 2009 and 2011. ADF rate (28.3-29.8-28.1%), NDF ratio (35.0-44.3-45.3%), crude protein ratio (21.5-19.3-20,0%) crude protein yield (370-584-550 kg da⁻¹), digestible dry matter (66.9-65.7-67.0%), relative feed value (177.6-138.6-138.3) dry matter intake (3.43-2.72-2.66%) and dry matter yield (1719-3021-2752 kg da⁻¹) were determined for *Medicago sativa* (Sayar et al. 2014).

In the research carried out to determine the quality feature of some forage plants collected from the Bingöl University campus, 22 legume forage crops has studied. In the study crude protein, ADF ratio, NDF ratio, DDM ratio, DMI ratio, RFV and mineral substance (P, K, Ca, Mg) contents of forage crops were determined. In the study conducted, the rate

of ADF was 31.86%, the rate of NDF was 47.10%, RFV was 126.6 and mineral matter (P, K, Ca, Mg), 0.69%, 5.14%, 0.90%, 0.20% in alfalfa. When evaluated in terms of mineral substance, the highest values for P and K have obtained in alfalfa (*Medicago sativa* L.) (Cacan et al. 2015).

In order to determine the most suitable alfalfa cultivars in Kirsehir conditions between 2013 and 2014, ten different alfalfa cultivars (Bilensoy, Elci, Emiliano, Gea, Kayseri, Manum, Plato, Prosementi, Sunter and Victoria) have used. In the study taken from two harvests, average forage yield 1311.0-1650.9 kg da⁻¹, dry matter yield 453.6-574.4 kg da⁻¹, crude protein rate 18.38-20.45%, crude protein yield 88.2-112.9 kg da⁻¹, ADF rate between 33.50-36.94% and NDF rate changed between 45.73-47.46% (Inal 2015).

The aim of research is to determine the forage yield and quality of some alfalfa cultivars under Isparta conditions. As a result, of this research, the average plant height were found 67.74-72.44 cm, the total green forage yield was obtained 8181-10247 kg da⁻¹, the dry matter yield was determined 2097-2567 kg da⁻¹, the crude protein ratio varied between 16.23-17.53%. The crude protein yield were found between 333.07-449.73 kg da⁻¹, ADF ratio was between 30.26-33.44% and finally NDF ratio varied between 42.27-44.98% (Yilmaz and Albayrak 2016).

This research has conducted under Isparta conditions in order to determine the seed yield and yield characteristics of 10 alfalfa genotypes collected from “Goller Region”, the plant height varied between 80.33 to 103.22 cm (Bicakci and Balabanli 2016).

In the study carried out in order to determine the forage yield of alfalfa (*Medicago sativa* L.) cultivars in Isparta conditions in 2010-2011; green grass yield 9101 kg da⁻¹, dry grass yield was 1754-2567 kg da⁻¹, crude protein yield was 275.77-449.73 kg da⁻¹, crude protein ratio was 15.65-17.53%, ADF ratio varied between 30.26-35.73% and NDF ratio changed between 42.13-44.80% (Yilmaz ve Albayrak 2016).

In the study conducted to determine dry matter yield and quality features of some alfalfa cultivars grown in two different locations Ankara and Isparta depending on year x variety interactions, in Ankara condition two-year average plant height 53.25-73.38 cm, dry matter yield 3339-2845 kg da⁻¹, average crude protein rate 15.14-18.56%, NDF rate of 43.46-48.47%, and ADF rate of 33.16-35.21% were recorded, in Isparta condition average crude protein ratio was 16.28-19.13%, average plant height was 60.88-75.75 cm, ADF ratio of 31.33-34.92%, NDF ratio of 42.08-46.81%, and dry matter yield was between 2617-2032 kg da⁻¹ (Yuksel et al. 2016).

Quality analyzes of 3 different alfalfa cultivars were made in the study under Erzurum conditions. According to the two-year average results, the lowest and highest crude protein ratios were 16.78% and 19.01%, the lowest and highest ADF ratios were 38.60% and 40.32%, while the lowest and highest NDF ratios varied between 42.67% and 44.28% (Dumlu et al. 2017).

In the study conducted to determine the forage yield and quality of some alfalfa cultivars in Bursa ecological conditions, in the first yield year the total amount forage yield 7626.5-552.6 kg da⁻¹, total hay yield 1830.6-1382.2 kg da⁻¹, total crude protein yield 269.4-367.3 kg da⁻¹, average crude protein ratio 20.32-21.06%, ADF ratio 26.81-30.12%, NDF ratio varied between 38.07- 41.87% (Erbeyi 2017).

In a study, different alfalfa cultivars have compared from the aspect of yield and quality features under Yozgat ecological conditions. This research was conducted in randomly designed experimental blocks with three replications between 2013 and 2015. In the study Bilensoy, Victoria, Kayseri, Verko, Gea, Emiliano, Plato, Basbag, Sunter and Nimet (10 alfalfa varieties) have used. The plant height values of alfalfa cultivars were between 57.5 cm and 86.9 cm, hay yields was between 2107.0 kg da⁻¹ and 4330.5 kg da⁻¹, crude protein ratios between 24.2% and 26.1%, ADF ratios between 28.0% and 32.3% and NDF rates varied between 40.0% and 45.8%. According to the results of research

Basbag, Sunter, Emiliano, Victoria, Blessing, and Plato cultivars have suggested for Yozgat and similar ecological conditions (Engin and Mut 2017).

In order to determine the suitable alfalfa varieties for the Eastern Anatolia region, 16 different alfalfa varieties have compared from aspect of yield and quality features in Bingöl conditions. In the study, Bilensoy-80, Alsancak, Basbag, Elci, Gea, Gozlu-1, Omerbey, Kayseri, Magnum-V, Magna-601, Verko, Nimet, Ozpinar, Savas, Verdor and Sunter alfalfa varieties have used. The study has carried out in a randomized block design with three replications between 2014 and 2016. According to the results of the research, plant height values of alfalfa cultivars were 41.9-54.7 cm, forage yields was 2735-3591 kg da⁻¹, hay yields was 924-1227 kg da⁻¹, crude protein ratios was 23.9-25.9%, crude protein yields was 219-301 kg da⁻¹, ADF ratios varied between 18.7-23.0%, NDF ratios 27.1-32.2%, digestible dry matter ratios 71.0-74.4%, dry matter intake 3.83-4.53% and relative feed value between 210.7-262.1. Based on the results obtained at the end of the research, Gea cultivar, which has superior yield and quality features, was suggested for Bingöl and similar climate conditions (Cacan et al. 2018).

The study has conducted to make the agricultural evaluation of Romanian alfalfa cultivars in Northern Bulgaria. The research continued for four years between 2012 and 2015. In the study, six alfalfa cultivars (Catinca, Madalina, Magnat, Sandra, Roxana, Daniela) and three Bulgarian standard alfalfa cultivar were used as material. According to the average values of the examined agronomic features of alfalfa cultivars, dry matter yields varied between 9.32 t/ha and 9.69 t/ha, crude protein ratios varied between 19.39% and 20.32% and plant height values varied between 72.75 cm and 77.50 cm (Marinova et al. 2018).

In a study, 16 different alfalfa (*Medicago sativa* L.) cultivars have grown in Kayseri conditions in 2014-2015 years. According to the data obtained in the research used; plant height 55.75-84.83 cm, green forage yields 5125-7389 kg da⁻¹, dry matter yields 1349-1879 kg da⁻¹, crude protein yields 243-283 kg da⁻¹, crude protein ratio 16.57-20.28%,

ADF ratios of 24.57-42.27% and NDF ratios varied between 46.89- 55.21% (Harmanlıoglu 2019).

In the research, 48 alfalfa genotypes and 2 certified alfalfa genotypes naturally grown in Iğdır ecological conditions have used. According to the result; plant height 41.06-118.50 cm, crude protein ratio 15.92-22.31%, NDF ratio 37.42-49.29%, ADF ratio is 26.50-38.69% and digestible dry matter ratio was determined as 58.39-70.87% (Eren 2019).

The research have conducted to determine forage quality features of alfalfa (*Medicago sativa* L.) obtained from ten different regions during the spring of 2018 and 2019 in the Southeastern Anatolia Region of Turkey. According to the result of chemical analysis, average dry matter ratio was 92.64%, crude ash was 11.35%, rate of organic matter 81.29%, crude protein rate 25.34%, rate of crude cellulose 30.54%, the NDF rate 28.29%, the ADF rate 22.76%, rate of digestible dry matter 71.17%, dry matter intake 4.27% and relative feed value was 236.1 (Basbag et al. 2020).

This research have conducted to determine the yield and quality features of some alfalfa populations in Bingöl province. These local genotypes have taken from 23 different regions in 2015. The study have carried out in a randomized complete block design with three replications. According to the results of the research, the highest green forage and hay yields have found in populations collected from the villages of Servi, Mutluca, Garip, Sarıcecek-1 and Bağlıisa. The Servi population produced highest crude protein. The varieties were more qualified than the populations from the aspect of relative feed value. Researchers found that the populations of Servi, Mutluca, Garip, Sarıcecek-1 and Bağlıisa were usable in breeding systems (Cacan et al. 2020).

In order to determine the aspect of yield and quality features of alfalfa varieties from the 39 different fields in Bingöl villages, the study have carried out in 2018. As a result, plant height 59.3-109.3 cm, forage yield 1016-4683 kg da⁻¹, dry matter yield 230-1050 kg da⁻¹, crude protein ratio 16.2-23.5%, crude protein yield 44.3-193.2 kg da⁻¹, ADF ratio 25.7-35.7%, NDF ratio 33.9-46.4%, DDM ratio 61.1-68.9%, DMI 2.59-3.57% and RFV varied

between 123-191. The first field of Garip village has highest yield (forage and dry matter yield) and the second field of Kumgecit village has the highest quality (Cacan and Arslan 2021).



3. MATERIAL AND METHOD

3.1. Material

Totally 15 alfalfa cultivars have been used in the study, 12 of which were of foreign origin and the remaining three were used as standard and native ones. The institutes and organizations supplying alfalfa used in this research and dormancy value of alfalfa have presented in Table 3.1. According to the Registration Reports of the Ministry of Agriculture and Forestry, the average dormancy values of cultivars used in the study varied between 4 to 7.

Table 3.1. Cultivars of alfalfa used in research

	Cultivars	Organization where it is provided
1	Iside	May Tohum
2	Osjecka 99	Tareks Tohumculuk
3	Ezzelina	Alfa Tohum
4	Diane	Ulusoy Tohumculuk
5	Prosementi	Tasaco Tarım Incorporated company.
6	Queen	Neobi Tohumculuk
7	Emiliana	Kazak Tarım
8	Riviera vicentina	Alper Tarım Ticaret
9	Banat vs	Maro Tarım Incorporated company.
10	La Torre	Maro Tarım Incorporated company.
11	Sabrina	<u>Variety Registration And Seed Certification</u>
12	Escorial	<u>Variety Registration And Seed Certification</u>
13	Elci	Standard Variety
14	Bilensoy 80	Standard Variety
15	Basbag	Standard Variety

3.1.1. Location and Year of Research

This research have conducted in Bingöl University Genc Vocational School's Application and Research Area between of 2019-2021 under watery conditions. The area of Genc town is 1646 km². It has surrounded by the central district of Bingöl province and Murat River in the north, Diyarbakır province in the south, Solhan district in the east, and Elazığ province in the west. The district center has established on a flat area on the banks of the Murat River and has an altitude of 1125 m (Anonymous, 2021a).

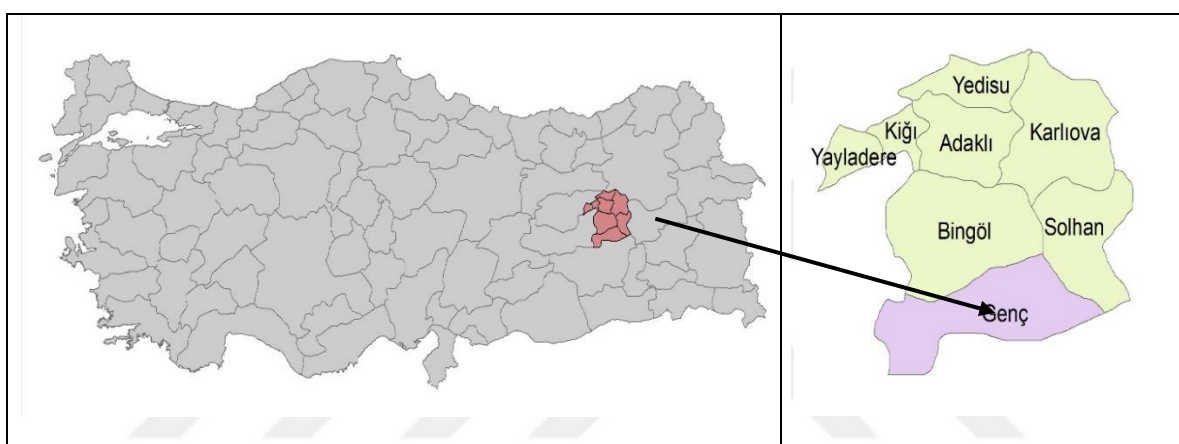


Figure 3.1. Location of research area

3.1.2. Climate Data of Research Area

The climate data of the province of Bingöl for 2020, 2021 and long years have given in Table 3.2.

Table 3.2. Climate data of Bingöl province

Month	Average Temperature (°C)			Total Precipitation (mm)			Relative Humidity (%)		
	2020	2021	LY	2020	2021	LY	2020	2021	LY
January	0.4	-1.1	-2.2	81.4	185.0	136.5	65.2	69.3	72.8
February	0.8	4.0	-0.9	102.5	56.2	131.0	67.0	60.2	71.0
March	7.5	6.1	4.7	265.8	133.9	131.3	69.1	62.4	65.2
April	11.4	14.3	10.9	134.0	22.5	110.1	60.5	50.2	61.1
May	16.9	20.4	16.2	138.8	3.3	80.6	55.6	33.3	56.9
June	22.4	24.4	22.2	10.0	1.8	21.1	40.6	30.2	44.3
July	27.0	28.4	26.7	5.7	0.2	6.9	35.3	28.6	37.2
August	26.5	27.3	26.7	0.6	3.9	4.9	29.9	31.0	36.0
September	24.0	21.3	21.3	1.2	12.7	14.8	32.3	36.1	41.3
October	17.1	14.8	14.5	0.0	72.6	69.0	36.3	41.8	56.4

November	8.5	9.4	6.8	56.2	67.2	94.7	59.7	66.5	65.2
December	3.1	1.4	0.7	43.0	109.1	131.1	72.0	72.5	73.1
Average/Total	13.8	14.2	12.3	839.2	668	932	51.9	48.5	56.7

LY: Long years.

According to the data obtained, monthly average temperature value was 13.8 °C, total precipitation was 839.2 mm and relative humidity was 51.9% for 2020 and monthly average temperature value was 14.2°C, total precipitation was 668 mm and relative humidity was 48.5% for 2021. It has observed that the average temperature values for the years 2021 and 2022 are above the long-years average, while the precipitation amounts and relative humidity values are below the long-years averages.

3.1.3. Soil Properties of Research Area

Analysis of soil samples taken from 10 different points and 0-30 cm depth of the research location was carried out in Bingöl University Faculty of Agriculture, Soil Science and Nutrition Department Laboratory. Soil analysis results of the research location are given in Table 3.3.

Table 3.3. Soil analysis results of the trial area

Texture				pH	EC (μS/cm)	OM (%)	K ₂ O (kg da ⁻¹)	P ₂ O ₅ (kg da ⁻¹)	Lime (%)
Clay	Plate	Sand	Class						
19.11	16.71	64.18	Sandy Clay Loamy	7.10	0.45	2.19	39.75	4.88	2.85

The soil structure of the research location was found to be sandy, clay and loamy (clay rate 19.11%, plate rate 16.71% and sand rate 64.18%), pH level neutral, salt-free, less limy, organic matter and available phosphorus ratios low, potassium content sufficient determined.

3.2. Method

The trial have sown on 21 June 2019, following the soil preparation made in May. The research set up with 3 replications according to the randomized blocks trial pattern. In the experiment, parcel lengths were 5 m, the distance between rows was 20 cm and 6 rows were planted in each parcel. 3 kg of seed have used per decare in planting. Before

sowing, 4 kg nitrogen (N) and 10 kg phosphorus (P_2O_5) have applied to experimental plots (Cacan et al., 2018; Cacan et. al., 2020).

Irrigation of the experiment have done by sprinkler irrigation. Depending on the climate, the irrigation interval have done between 7-12 days. When any weeds, diseases and pests have detected in the parcels, they were struggles against. Some images of the trial area have given in Figure 3.2.





Figure 3.2. Some images of the experiment area

Alfalfa cultivars harvested four times in each year and required analyzes have done after second harvest. As result of two years of research, the features seen in Table 3.4 were determined.

Table 3.4. Yield, quality and mineral substance contents determined in the study

Yield Features		Macro Minerals	
1	Plant height (cm)	1	Calcium (%)
2	Number of main stems	2	Magnesium (%)
3	The thickness of the main stem (mm)	3	Phosphor (%)
4	Forage yield (kg da ⁻¹)	4	Potassium (%)
5	Dry matter yield (kg da ⁻¹)		
Quality Features		Micro Minerals	
1	Crude Protein (CP) (%)	1	Iron (mg kg ⁻¹)
2	Acid Detergent Fiber (ADF) (%)	2	Copper (mg kg ⁻¹)
3	Neutral Detergent Fiber (NDF) (%)	3	Manganese (mg kg ⁻¹)
4	Digestible Dry Matter (DDM) (%)	4	Zinc (mg kg ⁻¹)
5	Dry Matter Intake (DMI) (%)	5	Aluminum (mg kg ⁻¹)
6	Relative Feed Value (RFV)	6	Chromium (mg kg ⁻¹)
		7	Nickel (mg kg ⁻¹)
		8	Selenium (mg kg ⁻¹)

Observations and studies to determine the yield characteristics have made in 10 plants that have randomly selected from each parcel of the trial, in aqueous conditions before the second harvest as indicated below.

3.2.1. Yield Features

3.2.1.1. Plant Height (cm)

The distance between the first buds until the soil surface have measured with a ruler (Anonymous 2021b).

3.2.1.2. The Thickness of the Main Stem (mm)

The stem thickness of the first plants that form flower bud have measured with a caliper between the second and third node (Anonymous 2021b).

3.2.1.3. Number of Main Stems

Ten plants were determined in each parcel. The stems emerging from the determined 10 plant roots have counted, the average number of stems was determined by taking the average per cultivar (Anonymous 2021b).

3.2.1.4. Forage Yield (kg da⁻¹)

Forage yield located one row further from the top of the parcel, one row from the bottom of the parcel, and 0.5 m have removed from the edges of the parcel. The remaining area have harvested by cutting, the forage yield obtained from each parcel have weighed, and the values obtained have converted to yield per decare (Anonymous 2021b).

3.2.1.5. Dry Matter Yield (kg da⁻¹)

A sample of 0.5 kg of forage obtained from each parcel have randomly taken and dried in a drying chamber at 70 °C for 48 hours in drying chamber. Then it has been kept in drying chamber for 24 hours and then weighed so the dry herbage weight has been found then the obtained dry matter has been converted to yield per decare (Anonymous 2021b).

3.2.2. Quality Features

3.2.2.1. Crude Protein (CP), ADF (Acid Detergent Fiber) and NDF (Neutral Detergent Fiber) Ratio (%)

Crude protein, ADF and NDF analyzes were performed at Ondokuz Mayıs University of Agriculture Faculty Laboratory with the help of NIRS (Near Infrared Spectroscopy) device.

3.2.2.2. Digestible Dry Matter (DDM), Dry Matter Intake (DMI), Relative Feed Value (RFV)

With the help of the determined ADF and NDF, digestible dry matter (DDM), dry matter intake (DMI) and relative feed values (RFV) have calculated using the following formulas.

$$\text{DDM} = 88.9 - (0.779 \times \text{ADF} \%)$$

$$\text{DMI} = 120 / \text{NDF}\%$$

$$\text{RFV} = (\text{DDM} \times \text{DMI}) / 1.29 \quad (\text{Morrison 2003}).$$

3.2.3. Macro Elements (%)

P (Phosphor), K (Potassium), Ca (Calcium) and Mg (Magnesium) have performed at Ondokuz Mayıs University of Agriculture Faculty Laboratory with the help of NIRS (Near Infrared Spectroscopy) device.

3.2.4. Micro Elements (mg kg⁻¹)

Fe (Iron), Cu (Copper), Manganese (Mn), Zn (Zinc), Al (Aluminum), Cr (Chromium), Ni (Nickel) and Se (Selenium) were performed at Bingöl University Central Laboratory Application and Research Center with the help of ICP-MS device.

3.3. Data Evaluation

The data obtained each year have been evaluated by variance analysis with the help of the JMP statistical package program (a software belonging to the SAS program), and the differences of the groups have been compared with the Tukey tests (JMP 2018).

4. RESULTS AND DISCUSSION

4.1. Yield Features

4.1.1. Plant Height (cm)

The variance analysis of plant height of foreign origin alfalfa cultivars have given in Table 4.1. As seen in Table 4.1, the difference between the plant heights of alfalfa cultivars was significant in terms of years and cultivars ($P \leq 0.01$), in terms of year x cultivar interaction was determined to be insignificant.

Table 4.1. The variance analysis of plant height of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	608.89	304.45	5.68
Year	1	976.47	976.47	18.22**
Cultivar	14	2157.65	154.12	2.87**
Year x Cultivar	14	845.52	60.39	1.12
Error	58	3107.84	---	---
General	89	---	---	---
CV	7.50%			

** $P \leq 0.01$.

Two-year averages of plant heights of different alfalfa cultivars and groupings of these averages have given in Table 4.2. In terms of cultivars, the highest plant height cultivar is Emiliana (106.2 cm), it has seen that other cultivars except Basbag and Sabrina cultivars are in the same group statistically. The lowest plant height was determined in Basbag (87.6 cm) and Sabrina (90.8 cm) cultivars. In terms of years, the average plant height (100.9 cm) determined in 2021 higher than the average plant height determined in 2020 (94.4 cm).

Table 4.2. The plant heights of alfalfa cultivars (cm)

Cultivars	2020	2021	Mean
Banat vs	98.7	99.3	99.0 abc
Basbag	86.6	88.7	87.6 c
Bilensoy 80	96.7	103.3	100.0 abc
Diane	92.1	101.9	97.0 abc
Elci	93.8	106.2	100.0 abc
Emiliana	108.8	103.5	106.2 a
Escorial	87.4	98.6	93.0 abc
Ezzelina	97.4	109.8	103.6 ab
Iside	87.4	105.7	96.6 abc
La Torre	91.2	97.4	94.3 abc
Osjecka 99	90.8	97.4	94.1 abc
Prosementi	99.9	103.9	101.9 abc
Queen	93.5	102.3	97.9 abc
Riviera vicentina	104.7	100.7	102.7 ab
Sabrina	86.2	95.3	90.8 bc
Mean	94.4 B	100.9 A	97.6
LSD (0.05)	Year:3.1	Cultivar: 15.0	Year x Cultivar: ns

ns: none significant.

The averages of the two-year plant height of the cultivars have given in Figure 4.1. It is seen Banat vs, Bilensoy 80, Elçi, Emiliana, Ezzeilina, Prosementi, Queen and Riviera vicentina cultivars are above the average (97.6 cm), while the other cultivars are below the average.

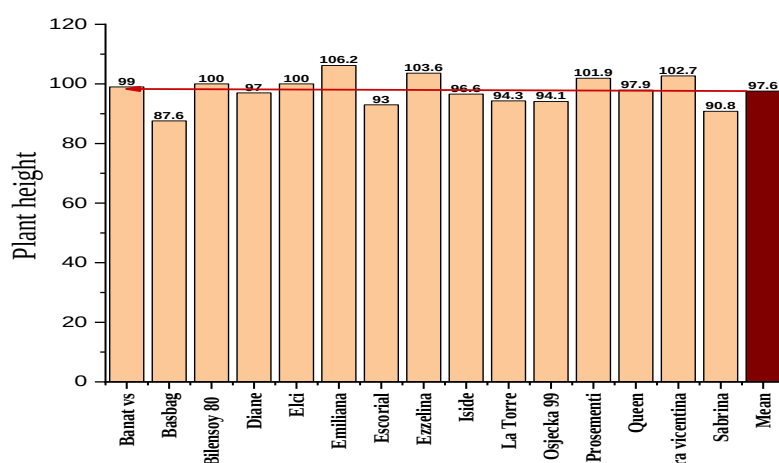


Figure 4.1. The plant height averages of foreign origin alfalfa cultivars

According to the previous studies on the plant height in alfalfa; the results have reported between 79-100 cm in Bornova conditions (Akbari and Avcıoğlu 1992), 57.70-79.40 cm in Northern Cyprus in Turkmenkoy conditions (Kusvuran et al. 2005), 74.8-86.8 cm in Izmir conditions (Kir 2006), 85.10-93.20 cm in Tokat-Kazova conditions (Kir and Karadag 2010), 66.61-101.28 cm in Antalya conditions (Oten and Albayrak 2016), 80.33-103.22 cm in Goller Region (Bicakci and Balabanli 2016), 76.3-90 cm in Yozgat ecological conditions (Engin and Mut 2017) and 59.3-109.3 cm in Bingöl conditions (Cacan and Arslan 2021). It has been seen that the 87.6-106.2 cm alfalfa height obtained in this study is similar to the plant heights obtained in previous studies.

4.1.2. Stem Number

The variance analysis of stem number of foreign origin alfalfa cultivars have given in Table 4.3. As seen in Table 4.3, the difference between the stem numbers of alfalfa cultivars were determined to be insignificant in terms of year, cultivar and year x cultivar interaction.

Table 4.3. The variance analysis of stem number of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	3.00	1.50	0.16
Year	1	10.75	10.75	1.14
Cultivar	14	93.31	6.67	0.70
Year x Cultivar	14	29.42	2.10	0.22
Error	58	546.77	---	---
General	89	---	---	---
CV	19.4%			

Two-year averages of plant heights of different alfalfa cultivars and groupings of these averages have given in Table 4.4. The number of stems of the cultivars is 14.9-18.3, the average is 16.1 in the first year, between 12.3 and 17.9 and the average is 15.4 in the second year. As the average of two years, it changed between 3.8-18.1 and the average has obtained as 15.8.

Table 4.4. The stem number of alfalfa cultivars (number)

Cultivars	2020	2021	Mean
Banat vs	15.3	16.4	15.8
Basbag	17.2	16.0	16.6
Bilensoy 80	16.3	14.1	15.2
Diane	16.2	16.2	16.2
Elci	15.1	15.0	15.1
Emiliana	14.9	14.5	14.7
Escorial	16.7	17.7	17.2
Ezzelina	15.2	14.7	14.9
Iside	16.8	14.2	15.5
La Torre	16.7	15.1	15.9
Osjecka 99	18.3	17.9	18.1
Prosementi	16.6	16.1	16.4
Queen	16.2	16.1	16.1
Riviera vicentina	15.2	12.3	13.8
Sabrina	15.2	15.3	15.3
Mean	16.1	15.4	15.8
LSD (0.05)	Year: ns	Cultivar: ns	Year x Cultivar: ns

ns: none significant.

The averages of the two-year stem number of the cultivars have given in Figure 4.2. It has seen Basbag, Diane, Escorial, La Torre, Osjecka 99, Prosementi and Queen cultivars were above the average (15.8), while the other cultivars were below average.

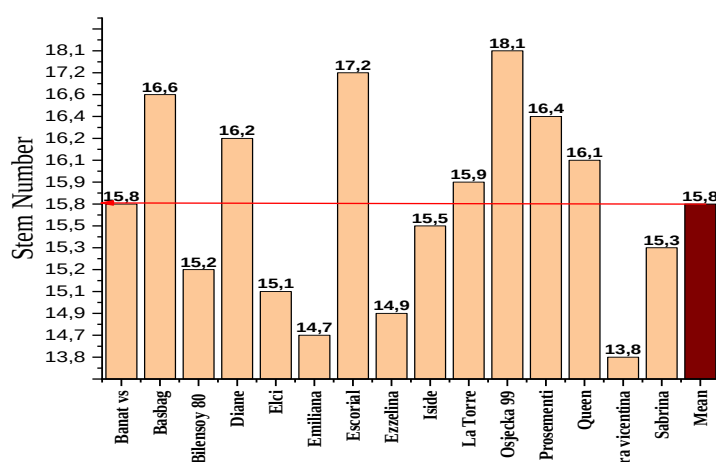


Figure 4.2. The stem number averages of foreign origin alfalfa cultivars

Regarding to previous studies the stem numbers in alfalfa; Soya et al. (2005) have been determined between 12.1-12.4 in Bornova conditions, Kir and Soya (2008) have been presented between 11,3-18,5 in Izmir conditions, Mohammed (2008) has found 10.6-25.8 in Ankara and Konya conditions, Demiroglu et al. (2008) have found 11.3-11.9 in Bornova and Odemis conditions and Kavut et al. (2014) have determined between 12.9-14.9 in Izmir conditions. In this study, the average number of stems have reported between of 13.8-18.1, similar to results mentioned in above researches.

4.1.3. Stem Thickness (mm)

The variance analysis of stem thickness of foreign origin alfalfa cultivars have given in Table 4.5. As seen in Table 4.5, the difference between the stem thickness of alfalfa cultivars is significant in terms of year and cultivar ($P \leq 0.01$), in terms of year x cultivar interaction was determined to be insignificant.

Table 4.5. The variance analysis of stem thickness of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	0.55	0.27	2.62
Year	1	3.68	3.68	35.12**
Cultivar	14	5.74	0.41	3.91**
Year x Cultivar	14	2.52	0.18	1.72
Error	58	6.07	---	---
General	89	---	---	---
CV	11.6%			

** $P \leq 0.01$.

Two-year averages of stem thickness of foreign origin alfalfa cultivars and groupings of these averages are given in Table 4.6. In terms of cultivars, it was determined that the highest stem thickness was Emiliana (3.31 mm), and the lowest stem thickness Basbag (2.25 mm), Banat vs, Diane, Elci, Ezzelina, Iside, Osjecka 99, Queen, Riviera vicentina and Sabrina cultivars are also in the group with the highest value. In terms of years, it was determined that the 2.60 mm average stem thickness obtained in 2020 was statistically lower than the 3.00 mm average stem thickness obtained in 2021.

Table 4.6. The stem thickness of alfalfa cultivars (mm)

Cultivars	2020	2021	Mean
Banat vs	2.76	3.28	3.02 ab
Basbag	1.98	2.52	2.25 c
Bilensoy 80	2.15	3.10	2.63 bc
Diane	2.55	3.08	2.82 abc
Elci	2.36	3.11	2.73 abc
Emiliana	3.34	3.28	3.31 a
Escorial	2.46	2.64	2.55 bc
Ezzelina	2.78	2.96	2.87 abc
Iside	2.56	3.05	2.81 abc
La Torre	2.33	2.78	2.56 bc
Osjecka 99	2.60	3.53	3.06 ab
Prosementi	2.87	2.74	2.81 abc
Queen	2.67	2.74	2.70 abc
Riviera vicentina	3.13	3.14	3.13 ab
Sabrina	2.44	3.07	2.76 abc
Mean	2.60 B	3.00 A	2.80
LSD (0.05)	Year: 0.136	Cultivar: 0.661	Year x Cultivar: ns

ns: none significant.

The averages of the two-year stem thickness of the cultivars have given in Figure 4.3. It has seen Banat vs, Diane, Emiliana, Ezzeilina, Iside, Osjecka 99, Prosementi and Riviera vicentina cultivars were above the average (2.80 mm) and the other cultivars were below the average.

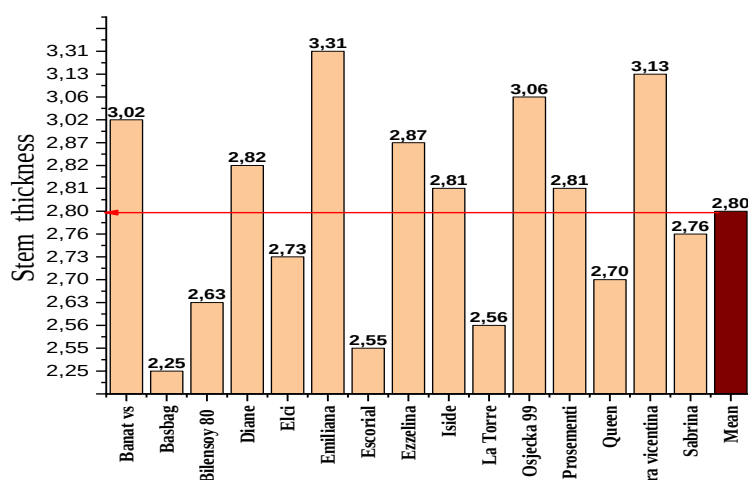


Figure 4.3. The stem thickness averages of foreign origin alfalfa cultivars

Regarding to previous studies on stem thickness in alfalfa; Tosun et al. (1979) have reported that it was 2.69 mm in the first harvest and 2.55 mm in the second harvest in Erzurum conditions, Seker (2003) has found 2.78-2.89 mm in Erzurum ecological conditions, Soya et al. (2005) have determined 2.78-2.90 mm in Bornova ecological conditions, Demiroglu et al. (2008) have reported that it varied between 2.74-3.07 in Bornova conditions and 2.33-2.69 mm in Odemis conditions, Tongel and Ayan (2010) have determined it varied between 2.93-3.27 mm on 19 alfalfa cultivars in Samsun ecological conditions, Yilmaz (2011) has found 2.99-3.14 mm in Isparta conditions, Kavut et al. (2014) have determined 2.84-3.12 mm in Bornova conditions, Gokalp et al. (2017) have conducted two-year study that they have obtained stem thickness between 3.19-3.32 mm in Kazova conditions, Erbeyi (2017) have found 2.38-2.87 mm in Bursa ecological conditions, Acikbas et al. (2017) have determined 2.82-3.28 mm in Isparta conditions and Dumlu et al. (2017) reported that the stem thickness varies between 2.81-3.04 mm in Erzurum conditions. We found the stem thickness between 2.25-3.31 mm in this study that is similar to the results mentioned in above researches.

4.1.4. Forage Yield (kg da⁻¹)

The variance analysis of forage yield of foreign origin alfalfa cultivars have given in Table 4.7. As seen in Table 4.7, the difference between the forage yields of alfalfa cultivars is significant in terms of year and cultivar ($P \leq 0.05$), in terms of year x cultivar interaction is determined to be insignificant.

Table 4.7. The variance analysis of forage yield of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	30470290	15235145	3.94
Year	1	18468886	18468886	4.78*
Cultivar	14	123028497	8787750	2.27*
Year x Cultivar	14	54072850	3862346	1.00
Error	58	224246425	---	---
General	89	---	---	---
CV	17.8%			

*: $P \leq 0.05$

Two-year averages of forage yield of different alfalfa cultivars and groupings of these averages have given in Table 4.8. In terms of cultivars, it has seen that the highest forage yield cultivars is Ezzelina (14069 kg da⁻¹). Banat vs, Bilensoy 80, Emiliana, Diane, Elci, Osjecka 99, Prosementi, Riviera vicentina, Iside and Queen cultivars are also in the highest value group. The lowest forage yield was determined in Basbag, Sabrina, La Torre and Escorial cultivars. In terms of years, it has reported that the average forage yield (11471 kg da⁻¹) in 2021 is higher than the forage yield (10565 kg da⁻¹) in 2020.

Table 4.8. The forage yield of alfalfa cultivars (kg da⁻¹)

Cultivars	2020	2021	Mean
Banat vs	10150	10337	10243 ab
Basbag	10664	8748	9706 b
Bilensoy 80	10782	12014	11398 ab
Diane	11811	11673	11742 ab
Elci	10246	11977	11111 ab
Emiliana	10742	12052	11397 ab
Escorial	8761	10697	9729 b
Ezzelina	11878	16261	14069 a
Iside	9033	11453	10243 ab
La Torre	9673	9574	9624 b
Osjecka 99	10373	11588	10981 ab
Prosementi	13187	11662	12424 ab
Queen	9972	12173	11072 ab
Riviera vicentina	11836	11563	11700 ab
Sabrina	9372	10298	9835 b
Mean	10565 B	11471 A	11018
LSD (0.05)	Year: 829	Cultivar: 4020	Year x Cultivar: ns

ns: none significant.

The averages of the two-year forage yield of the cultivars have given in Figure 4.4. It is seen Bilensoy 80, Diane, Elçi, Emiliana, Ezzeilina, Prosementi, Queen and Riviera vicentina cultivars are above the average (11018 kg da⁻¹), while the other cultivars are below the average.

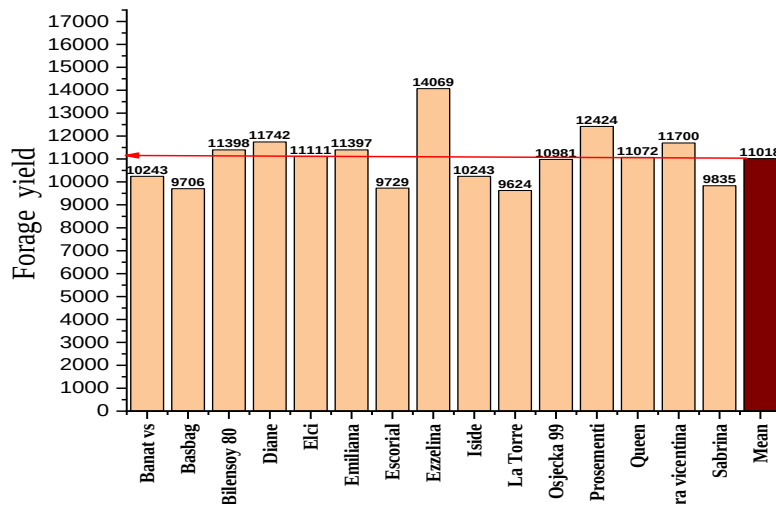


Figure 4.4. The forage yield averages of foreign origin alfalfa cultivars

The forage yield obtained in current study is similar to the forage yields in previous studies of alfalfa that have been mentioned below; Altınok and Karakaya (2002) have found 9779 kg da⁻¹ in Ankara conditions, Kusvuran et al. (2005) have obtained 10828 kg da⁻¹ in Northern Cyprus in Turkmenkoy ecological conditions, Gokalp et al. (2017) have determined 11150-13905 kg da⁻¹ in Tokat-Kazova conditions. However, the forage yield was obtained in the study was higher than the forage yields of Basbag et al. (2002) have reported that forage yield varied between 3672.13-6153.38 kg da⁻¹ in irrigated conditions of Diyarbakir, Seker (2003) has obtained 4735.6-5804.1 kg da⁻¹ in Erzurum conditions, Soya et al. (2005) have determined 6338-7025 kg da⁻¹ in ecological conditions of Bornova, Albayrak and Ekiz (2005) have obtained 718-2267 kg da⁻¹ determined in Ankara conditions, Kir (2006) has found 791-1705 kg da⁻¹ obtained in Izmir conditions, Turan and Celen (2010) has found 2.254-3.374 kg da⁻¹ in Van ecological conditions, Taskın and Sevımay (2012) have determined 748-1095.7 kg da⁻¹ in Ankara conditions, Unal et al. (2012) have obtained 3241.6-3770 kg da⁻¹ in Ankara conditions, Cinar et al. (2014) have found 6015 kg da⁻¹ in Adana conditions, Inal (2015) has determined 1310-1650 kg da⁻¹ under Kirsehir conditions and Yilmaz et al. (2015) have reported 1297-1771 kg da⁻¹ in Kahramanmaraş conditions. The yield obtained in alfalfa cultivation is largely related to the number of harvests. The number of harvests is higher in warm regions and less in cold regions. The difference in the number of harvests causes the

forage yield obtained in alfalfa cultivation to be different. Therefore, different forage yields can be obtained in different ecological regions.

4.1.5. Dry Matter Yield (kg da⁻¹)

The variance analysis of dry matter yield of foreign origin alfalfa cultivars have given in Table 4.9. As seen in Table 4.9, the difference between the dry matter yields of alfalfa cultivars is significant only for cultivars ($P \leq 0.05$), in terms of year and year x cultivar interaction was determined to be insignificant.

Table 4.9. The variance analysis of dry matter yield of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	3973932.2	1986966	8.38
Year	1	225850.2	225850.2	0.95
Cultivar	14	7743337.5	553095.5	2.33*
Year x Cultivar	14	2262902.6	161635.9	0.68
Error	58	13757591	---	---
General	89	---	---	---
CV	15.1%			

*: $P \leq 0.05$.

Two-year averages of dry matter yield of different alfalfa cultivars and groupings of these averages have given in Table 4.10. In terms of cultivars, it has been seen that the highest dry matter yield has been obtained from Ezzelina cultivar. Banat vs, Bilensoy 80, Emiliana, Diane, Elci, Osjecka 99, Prosementi, Riviera vicentina, Sabrina, Iside and Queen are also among the highest value groups. The lowest dry matter yield was determined in Basbag, La Torre and Escorial cultivars.

Table 4.10. The dry matter yield of alfalfa cultivars (kg da⁻¹)

Cultivars	2020	2021	Mean
Banat vs	3012	3074	3043 ab
Basbag	3076	2633	2855 b
Bilensoy 80	3180	3283	3232 ab
Diane	3327	3171	3249 ab
Elci	3143	3398	3270 ab
Emiliana	3194	3450	3322 ab
Escorial	2709	2974	2841 b

Ezzelina	3535	4376	3955 a
Iside	2954	3085	3020 ab
La Torre	3038	2854	2946 b
Osjecka 99	3260	3310	3285 ab
Prosementi	3857	3510	3684 ab
Queen	2913	3495	3204 ab
Riviera vicentina	3446	3501	3474 ab
Sabrina	3031	3063	3047 ab
Mean	3178	3279	3228
LSD (0.05)	Year: ns	Cultivar: 995	Year x Cultivar: ns

ns: none significant.

The averages of the two-year hay yield of the cultivars have given in Figure 4.5. It is seen Bilensoy 80, Diane, Elçi, Emiliana, Ezzeilina, Osjecka 99, Prosementi and Riviera vicentina cultivars are above the average (3228 kg da⁻¹) and the remaining cultivars are below the average.

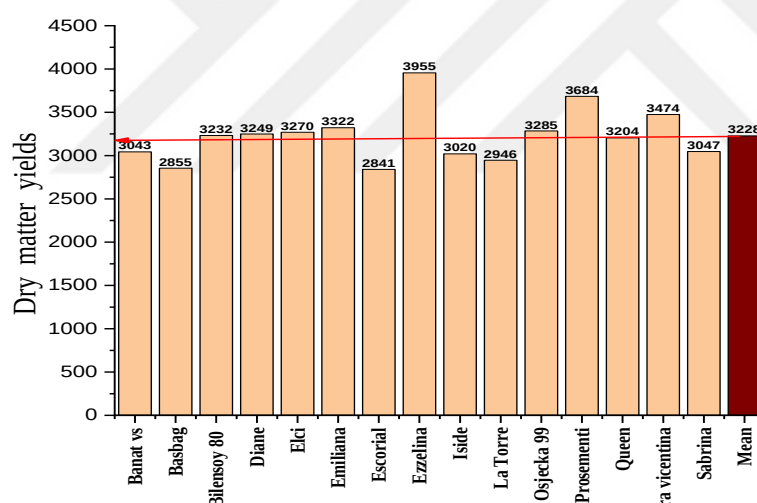


Figure 4.5. The dry matter yield averages of foreign origin alfalfa cultivars

The dry matter yields have obtained in current study is similar to the dry matter yields in previous researches of alfalfa that have presented below. Altinok and Karakaya (2002) obtained 3.214 kg da⁻¹ in Ankara conditions, Avci et al. (2013) obtained 2094.0-2230.0 kg da⁻¹ in Konya and Ankara conditions and Yuksel et al. (2016) obtained 2845-3339 kg da⁻¹ and 2032-2617 kg da⁻¹ in Ankara and Isparta locations, respectively. However, the dry matter yields in the study have found to be higher than the dry matter yields of 1104.7-1333.5 kg da⁻¹ in Erzurum ecological conditions (Seker 2003), 2031-2710 kg da⁻¹

in Odemis and Bornova conditions (Kavut et al. 2014), 1143-2183 kg da⁻¹ in the Goller region (Acikbas et al. 2017) and 1122.7-1396.9 kg da⁻¹ in Erzurum ecological conditions (Dumlu et al. 2017). The dry matter yield has directly related to the forage yield obtained. In areas where forage yield is high, dry matter yield has generally also obtained higher.

4.2. Quality Features

4.2.1. Crude Protein (CP) Ratio (%)

The variance analysis of crude protein ratios of foreign origin alfalfa cultivars have given in Table 4.11. As seen in Table 4.11, the difference between the crude protein ratios of alfalfa cultivars was determined to be insignificant in terms of year, cultivar and year x cultivar interaction.

Table 4.11. The variance analysis of crude protein of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	1.06	0.53	0.33
Year	1	0.64	0.64	0.39
Cultivar	14	30.60	2.19	1.34
Year x Cultivar	14	17.31	1.24	0.76
Error	58	94.79	---	---
General	89	---	---	---
CV	6.27%			

Two-year averages of crude protein ratios of different alfalfa cultivars and groupings of these averages have given in Table 4.12. The crude protein ratios of the cultivars are between 18.84-21.70% in the first year and average of 20.49%, between 19.01-21.03% in the second year and average is 20.32%, it has been obtained between 19.14-21.32% as the average of two years and 20.40% was obtained as the two-year average.

Table 4.12. Crude protein (%) of alfalfa cultivars

Cultivars	2020	2021	Mean
Banat vs	20.34	21.03	20.68
Basbag	21.07	19.33	20.20
Bilensoy 80	18.84	20.81	19.82
Diane	21.05	20.52	20.78
Elci	20.53	20.29	20.41
Emiliana	19.26	19.01	19.14
Escorial	21.28	20.58	20.93
Ezzelina	20.25	19.83	20.04
Iside	20.48	20.82	20.65
La Torre	21.34	20.10	20.72
Osjecka 99	21.70	20.95	21.32
Prosementi	20.05	20.69	20.37
Queen	19.74	19.24	19.49
Riviera vicentina	19.95	20.59	20.27
Sabrina	21.41	20.97	21.19
Mean	20.49	20.32	20.40
LSD (0.05)	Year: ns	Cultivar: ns	Year x Cultivar: ns

ns: none significant.

The averages of the two-year crude protein of the cultivars have given in Figure 4.6. It is seen Banat vs, Diane, Elçi, Escorial, Iside, La Torre, Osjecka 99 and Sabrina cultivars are above the average (20.40%), while the other cultivars are below the average.

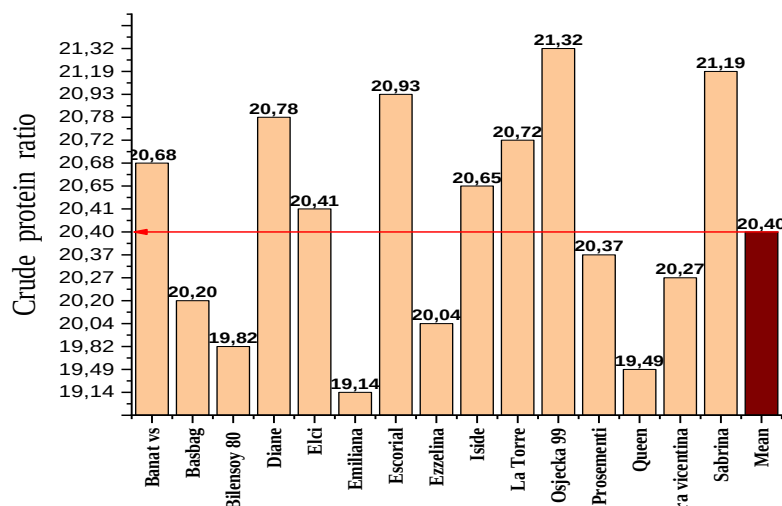


Figure 4.6. The crude protein averages of foreign origin alfalfa cultivars

Kir and Soya (2008) reported CP ratios as 17.86-20.26% in pasture-type alfalfa cultivars, Turan and Çelen (2010) obtained CP ratios as 16.0-16.8% in some alfalfa cultivars in

Van conditions, Saruhan and Kusvuran (2011) determined CP ratios as 17.94-22.67% in some alfalfa genotypes, Yilmaz and Albayrak (2016) found that the CP ratios of some alfalfa cultivars were 16.23-17.53% in Isparta conditions, Gokalp et al. (2017) found that the CP ratios of some alfalfa cultivars were 17.16-18.88% in Tokat conditions. The crude protein ratios obtained in other studies and the crude protein ratios (19.14-21.32%) obtained in the current study are close to each other.

4.2.2. ADF (Acid Detergent Fiber) Ratio (%)

The variance analysis of ADF ratio of foreign origin alfalfa cultivars have given in Table 4.13. As seen in Table 4.13, the difference between the ADF ratios of alfalfa cultivars is significant only for year ($P \leq 0.01$), in terms of cultivars and year x cultivar interaction was determined to be insignificant.

Tablo 4.13. The variance analysis of ADF ratio of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	16.84	8.42	0.96
Year	1	302.36	302.36	34.43**
Cultivar	14	150.64	10.76	1.23
Year x Cultivar	14	88.16	6.30	0.72
Error	58	509.40	---	---
General	89	---	---	---
CV	8.98%			

** $P \leq 0.01$.

Two-year averages of ADF ratio of different alfalfa cultivars and groupings of these averages have given in Table 4.14. The ADF ratio of the cultivars is between 31.4-37.8% in the first year and the average is 34.8%, in the second year between 28.5-34.8% and the average is 31.2%, it has varied between 31.0% and 36.1% as the average of two years and 33.0% has obtained as the two-year average. In terms of years, the ratio of ADF (34.8%) determined in 2020 was higher than the ratio of ADF (31.2%) determined in 2021.

Table 4.14. ADF ratio of alfalfa cultivars (%)

Cultivars	2020	2021	Mean
Banat vs	37.8	28.5	33.1
Basbag	35.0	33.0	34.0
Bilensoy 80	37.3	30.6	34.0
Diane	35.2	31.0	33.1
Elci	34.0	30.5	32.2
Emiliana	37.3	34.8	36.1
Escorial	31.4	30.7	31.0
Ezzelina	35.2	32.1	33.7
Iside	33.8	31.3	32.6
La Torre	33.5	30.1	31.8
Osjecka 99	32.8	30.5	31.7
Prosementi	34.6	31.0	32.8
Queen	36.4	33.2	34.8
Riviera vicentina	35.2	30.5	32.8
Sabrina	33.2	29.9	31.6
Mean	34.8 A	31.2 B	33.0
LSD (0.05)	Year: 1.25	Cultivar: ns	Year x Cultivar: ns

ns: none significant.

The averages of the two-year ADF value of the cultivars have given in Figure 4.7. It is seen Banat vs, Basbag, Bilensoy 80, Diane, Emiliana, Ezzeilina and Queen cultivars are above the average (33.0%), while the other cultivars are below the average.

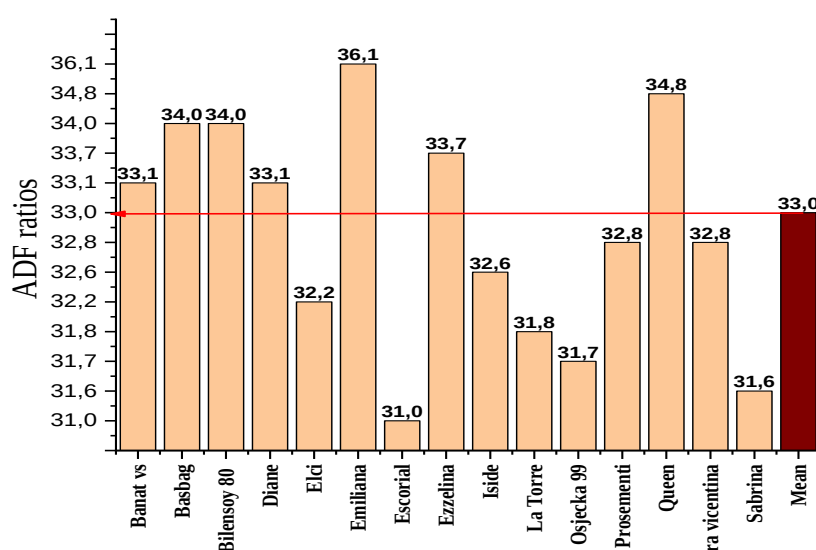


Figure 4.7. The ADF value averages of foreign origin alfalfa cultivars

ADF ratio that has found in current study is similar to ADF ratios previous studies of alfalfa that have presented below. Kiraz (2011) has obtained 33.76%, Cacan et al. (2012) have determined 30.1-37.66% in some *Medicago* species in Diyarbakır condition, Gundel et al. (2014) have obtained 34.3%, Yilmaz and Albayrak (2016) have found 30.26-33.44% in some alfalfa cultivars in Isparta conditions, Acikbas et al. (2017) have determined 31% in natural alfalfa genotypes in Goller region, Engin and Mut (2017) have obtained 30.3% in some alfalfa cultivars. However, the ADF ratio obtained in current study was higher than the 26.60% ADF ratio have obtained in alfalfa by Canbolat et al. (2013). Dumlu et al. (2017) have reported that ADF ratio in alfalfa varied between 38.60-40.32% was higher than the ADF ratio that has found in current study.

4.2.3. NDF (Neutral Detergent Fiber) Ratio (%)

The variance analysis of NDF ratio of foreign origin alfalfa cultivars have given in Table 4.15. As seen in Table 4.15, the difference between the NDF ratios of alfalfa cultivars is significant only for year ($P \leq 0.01$), in terms of cultivars and year x cultivar interaction was determined to be insignificant.

Table 4.15. The variance analysis of NDF ratio of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	41.69	20.84	1.69
Year	1	328.15	328.15	26.60**
Cultivar	14	213.11	15.22	1.23
Year x Cultivar	14	110.42	7.89	0.64
Error	58	715.57	---	---
General	89	---	---	---
CV	8.28%			

** $P \leq 0.01$.

Two-year averages of NDF ratio of different alfalfa cultivars and groupings of these averages have given in Table 4.16. The NDF ratio of the cultivars is between 40.81-47.88% in the first year and the average is 44.32%, between 37.87-44.35% in the second year and average of 40.50%, NDF ratio has varied between 39.70-45.82% as the average of two years and 42.41% was obtained as the two-year average. In terms of years, it was

determined that the ratio of NDF (44.32%) detected in 2020 was higher than the ratio of NDF (40.50%) detected in 2021.

Table 4.16. NDF ratio of alfalfa cultivars (%)

Cultivars	2020	2021	Mean
Banat vs	47.88	37.87	42.87
Basbag	43.92	41.35	42.63
Bilensoy 80	47.43	39.94	43.68
Diane	44.01	39.96	41.99
Elci	44.25	40.17	42.21
Emiliana	47.28	44.35	45.82
Escorial	41.34	39.58	40.46
Ezzelina	44.98	41.73	43.36
Iside	45.01	40.98	43.00
La Torre	43.15	39.51	41.33
Osjecka 99	41.24	40.12	40.68
Prosementi	42.61	40.32	41.47
Queen	45.91	43.11	44.51
Riviera vicentina	44.91	39.86	42.39
Sabrina	40.81	38.60	39.70
Mean	44.32 A	40.50 B	42.41
LSD (0.05)	Year: 1.48	Cultivar: ns	Year x Cultivar: ns

ns: none significant.

The averages of the two-year NDF value of the cultivars have given in Figure 4.8. It is seen that Banat vs, Basbag, Bilensoy 80, Emiliana, Ezzeilina, Iside and Queen cultivars are above the average (42.41%), while the other cultivars are below the average values.

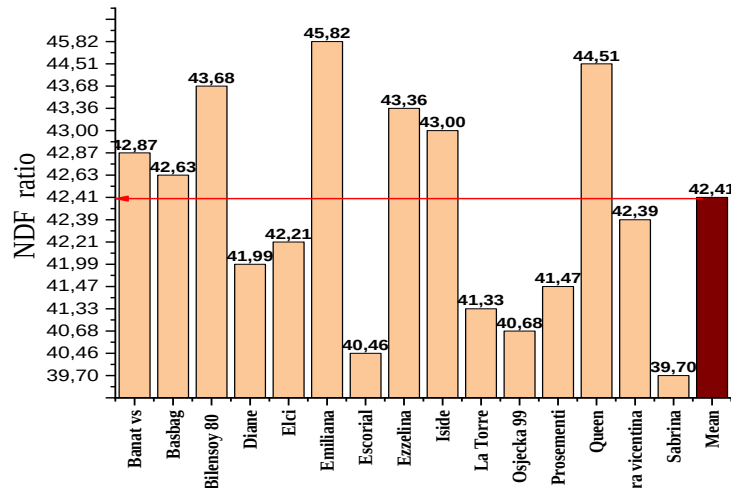


Figure 4.8. The NDF value averages of foreign origin alfalfa cultivars

Kiraz (2011) determined the NDF ratio as 40.15% in *Medicago sativa*, Cacan et al. (2012) determined the ratio of NDF in some *Medicago* species as 38.9-49.8% in Diyarbakır, Canbolat et al. (2013) obtained NDF ratio in hay grass of alfalfa as 40.44% , Gundel et al. (2014) gained NDF ratio in *Medicago sativa* as 46.5% in Cukurova conditions, Yilmaz and Albayrak (2016) found 42.27-44.98% in some alfalfa cultivars in Isparta conditions, Engin and Mut (2017) found the average NDF ratio as 43.5% in their study on quality and forage yield in some alfalfa cultivars, Acıkbaz et al. (2017) found the average NDF ratio to be 41.2% in natural alfalfa genotypes in Goller Region, Dumlu et al. (2017) determined 42.67-44.28% as average NDF ratios of alfalfa, Eren (2019) obtained 43.64% as average NDF ratio in alfalfa genotypes in Iğdir ecological conditions. It has seen that the NDF ratios obtained in other studies and the NDF ratios obtained in the current study are close to each other.

ADF and NDF ratios are compounds that make up the plant cell wall and have directly related to the maturity of the plant. ADF and NDF ratios are lower in early harvests, and ADF and NDF ratios are higher in late harvests. This is the main reason why different ADF and NDF ratios have obtained in different studies.

4.2.4. DDM (Digestible Dry Matter) Ratio (%)

The variance analysis of DDM ratio of foreign origin alfalfa cultivars have given in Table 4.17. As seen in Table 4.17, the difference between the DDM ratios of alfalfa cultivars is significant only for year ($P \leq 0.01$), in terms of cultivars and year x cultivar interaction was determined to be insignificant.

Table 4.17. The variance analysis of DDM ratio of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	10.22	5.11	0.96
Year	1	183.49	183.49	34.43**
Cultivar	14	91.41	6.53	1.23
Year x Cultivar	14	53.50	3.82	0.72
Error	58	309.13	---	---
General	89	---	---	---
CV	3.65%			

** $P \leq 0.01$.

Two-year averages of DDM ratio of different alfalfa cultivars and groupings of these averages have given in Table 4.18. The DDM ratio of the cultivars is between 59.48-64.46% in the first year and the average is 61.75%, it is between 61.78%-66.71% in the second year and the average is 64.61%, it has varied among 60.80-64.74% as the average of two years and 63.18% has obtained as the two-year average. In terms of years, it was determined that the ratio of DDM detected in 2021 (64.61%) was higher than the ratio of DDM determined in 2020 (61.75%).

Table 4.18. DDM ratio of alfalfa cultivars (%)

Cultivars	2020	2021	Mean
Banat vs	59.48	66.71	63.10
Basbag	61.62	63.20	62.41
Bilensoy 80	59.84	65.03	62.44
Diane	61.46	64.76	63.11
Elci	62.45	65.11	63.78
Emiliana	59.83	61.78	60.80
Escorial	64.46	65.02	64.74
Ezzelina	61.46	63.90	62.68
Iside	62.59	64.49	63.54

La Torre	62.79	65.44	64.12
Osjecka 99	63.32	65.11	64.22
Prosementi	61.95	64.78	63.37
Queen	60.55	63.00	61.77
Riviera vicentina	61.49	65.17	63.33
Sabrina	63.01	65.60	64.30
Mean	61.75 B	64.61 A	63.18
LSD (0.05)	Year: 0.97	Cultivar: ns	Year x Cultivar: ns

ns: none significant.

The averages of the two-year DDM ratio of the cultivars have given in Figure 4.9. It is seen that Elci, Escorial, Iside, La Torre, Osjecka 99, Prosementi, Riviera vicentina and Sabrina cultivars are above the average (63.18%), while the other cultivars are below the average.

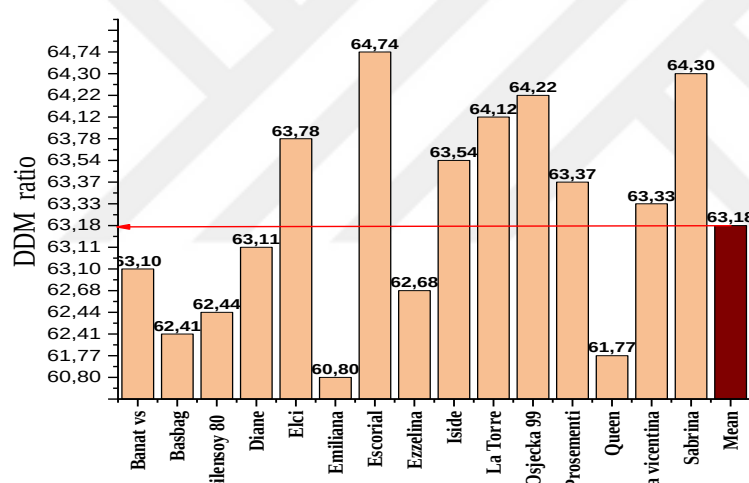


Figure 4.9. DDM ratio averages of foreign origin alfalfa cultivars

Digestible dry matter ratios in alfalfa were determined 63.0-75.8% in Diyarbakir ecological conditions (Basbag et al. 2009), 65.7-67.0 % in Diyarbakır conditions (Sayar et al. 2014), 64.08% in Bingöl ecological conditions (Cacan et al. 2015), 63.6-68.1% in Isparta ecological conditions (Acikbas et al. 2017), 66.16% in Aydın-Karacasu ecological conditions (Beyaz 2018) and 61.1-68.9% in Bingöl conditions (Cacan and Arslan 2021). It has seen that the DDM ratios obtained in other studies and the DDM ratios obtained in the current study are close to each other.

4.2.5. DMI (Dry Matter Intake) Ratio (%)

The variance analysis of DMI ratio of foreign origin alfalfa cultivars have given in Table 4.19. As seen in Table 4.19, the difference between the DMI ratios of alfalfa cultivars is significant only for year ($P \leq 0.01$), in terms of cultivars and year x cultivar interaction was determined to be insignificant.

Table 4.19. The variance analysis of DMI ratio of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	0.17	0.08	1.43
Year	1	1.47	1.47	25.04**
Cultivar	14	0.91	0.07	1.11
Year x Cultivar	14	0.44	0.03	0.53
Error	58	3.41	---	---
General	89	---	---	---
CV	8.49%			

** $P \leq 0.01$.

Two-year averages of DMI ratio of different alfalfa cultivars and groupings of these averages have given in Table 4.20. The DMI ratio of the cultivars is between 2.53-2.94% in the first year and the average is 2.73%, it is between 2.74-3.17% in the second year and the average is 2.98%, it has varied between 2.64-3.04% as the average of two years and 2.85% have obtained as the two-year average. In terms of years, it was determined that the DMI ratio (2.98%) detected in 2021 was higher than the DMI ratio (2.73%) detected in 2020.

Table 4.20. DMI ratio of alfalfa cultivars (%)

Cultivars	2020	2021	Mean
Banat vs	2.53	3.17	2.85
Basbag	2.73	2.92	2.82
Bilensoy 80	2.54	3.02	2.78
Diane	2.75	3.04	2.89
Elci	2.73	2.99	2.86
Emiliana	2.54	2.74	2.64
Escorial	2.91	3.05	2.98
Ezzelina	2.68	2.88	2.78
Iside	2.68	2.93	2.81

La Torre	2.78	3.04	2.91
Osjecka 99	2.93	3.00	2.96
Prosementi	2.84	2.99	2.91
Queen	2.64	2.80	2.72
Riviera vicentina	2.67	3.02	2.85
Sabrina	2.94	3.15	3.04
Mean	2.73 B	2.98 A	2.85
LSD (0.05)	Year: 0.10	Cultivar: ns	Year x Cultivar: ns

ns: none significant.

The two-year DMI ratio averages of the cultivars have given in Figure 4.10. It is seen that Diane, Elci, Escorial, La Torre, Osjecka 99, Prosementi and Sabrina cultivars are above the average (2.85%), while the other cultivars are below the average.

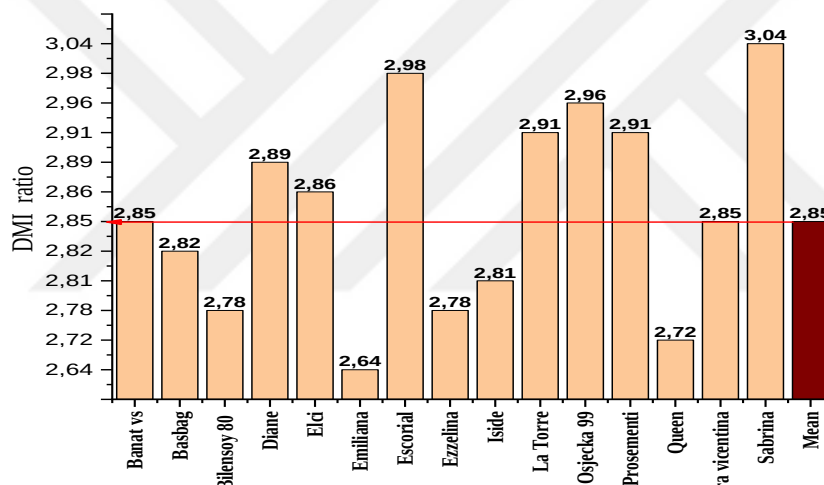


Figure 4.10. DMI ratio averages of foreign origin alfalfa cultivars

Cacan et al. (2012) reported 2.4-3.1% as DMI ratios in some annual alfalfa species in Diyarbakır, Eren (2019) determined DMI ratios of 48 genotypes and 2 alfalfa cultivars as 2.43-3.21% in Iğdır ecological conditions, Cacan and Arslan (2021) reported that the DMI ratios of alfalfa were determined between 2.59-3.57% in the Bingöl plain villages. It has seen that the DMI ratios obtained in other studies and the DMI ratios obtained in the current study are similar to each other.

4.2.6. RFV (Relative Feed Value)

The variance analysis of RFV ratio of foreign origin alfalfa cultivars have given in Table 4.21. As seen in Table 4.21, the difference between the RFV ratios of alfalfa cultivars is significant in terms of year ($P \leq 0.01$), in terms of cultivars and year x cultivar interaction was determined to be insignificant.

Table 4.21. The variance analysis of RFV ratio of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	710.37	355.19	1.25
Year	1	8012.60	8012.60	28.19**
Cultivar	14	4334.07	309.58	1.09
Year x Cultivar	14	2196.57	156.90	0.55
Error	58	16483.85	---	---
General	89	---	---	---
CV	12.01%			

** $P \leq 0.01$.

Two-year averages of RFV ratio of different alfalfa cultivars and groupings of these averages have given in Table 4.22. RFV average of the cultivars is between 117.0-145.5 in the first year and the average is 130.9, it is between 131.8-164.0 in the second year and the average is 149.8, it has varied between 125.0-152.2 as the average of two years and 140.3 was obtained as the two-year average. In terms of years, it was determined that the RFV (149.8) detected in 2021 was higher than the RFV (130.9) detected in 2020.

Table 4.22. RFV ratio of alfalfa cultivars

Cultivars	2020	2021	Mean
Banat vs	117.0	164.0	140.5
Basbag	130.5	143.3	136.9
Bilensoy 80	118.2	152.4	135.3
Diane	131.3	153.7	142.5
Elci	132.5	151.1	141.8
Emiliana	118.1	131.8	125.0
Escorial	145.5	154.4	150.0
Ezzelina	127.8	143.0	135.4
Iside	130.5	146.6	138.6
La Torre	135.4	154.3	144.8
Osjecka 99	144.2	151.5	147.8

Prosementi	136.9	150.1	143.5
Queen	124.2	137.1	130.7
Riviera vicentina	127.5	152.5	140.0
Sabrina	143.7	160.8	152.2
Mean	130.9 B	149.8 A	140.3
LSD (0.05)	Year: 7.11	Cultivar: ns	Year x Cultivar: ns

The averages of the two-year RFV value of the cultivars have given in Figure 4.11. It is seen that Banat vs, Diane, Elci, Escorial, La Torre, Osjecka 99, Prosementi and Sabrina cultivars are above the average (140.3), while the other cultivars are below the average.

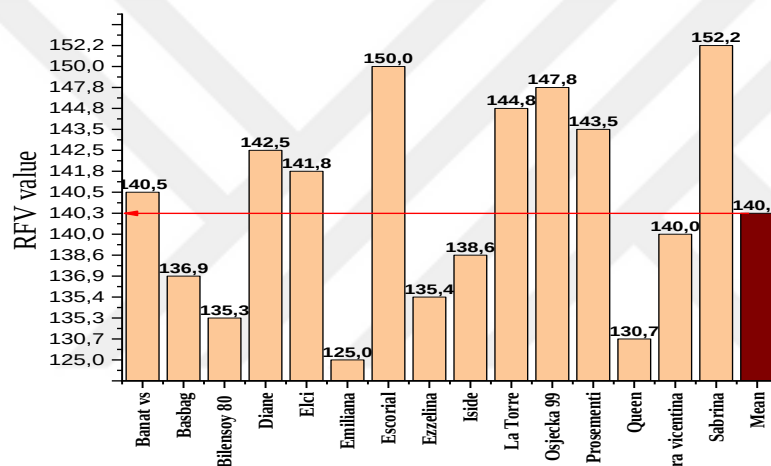


Figure 4.11. RFV averages of foreign origin alfalfa cultivars

Cacan et al. (2012) reported that RFV is 111.4-156.3 in some *Medicago* species in ecological condition of Diyarbakır, Gundel et al. (2014) determined 124.5 as RFV is in *Medicago sativa* in Cukurova conditions, Acıkbaz et al. (2017) reported that RFV average in natural alfalfa genotypes is 145.4 in the Goller region, Eren (2019) reported that RFV varied between 112.12-176.25 in alfalfa genotypes in Iğdır ecological conditions. It has seen that the RFV obtained in the current study and RFV obtained in other studies are close to each other.

4.3. Macro Elements

Limit values of macro elements in alfalfa have given in Table 4.23.

Table 4.23. Optimal ratio of macro elements ([Owen Plank](#), 1989)

Macro Elements	Optimal Ratio
Calcium (Ca)	0.80-3.00%
Magnesium (Mg)	0.25-1.00%
Phosphorus (P)	0.25-0.70%
Potassium (K)	2.00-3.50%

The optimum values have considered being Ca ratio 0.80-3.00%, Mg ratio 0.25-1.00%, P ratio 0.25-0.70% and K ratio 2.00-3.50% in alfalfa ([Owen Plank](#), 1989).

4.3.1. Ca (Calcium) Ratio (%)

The variance analysis of Ca content of foreign origin alfalfa cultivars have given in Table 4.24. As seen in Table 4.24, the difference between the Ca content of alfalfa cultivars was determined to be insignificant in terms of year, cultivar and year x cultivar interaction.

Table 4.24. The variance analysis of Ca content of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	0.057	0.029	3.71
Year	1	0.002	0.002	0.20
Cultivar	14	0.139	0.010	1.29
Year x Cultivar	14	0.095	0.007	0.88
Error	58	0.45	---	---
General	89	---	---	---
CV	5.60%			

Two-year averages of Ca content of different alfalfa cultivars and groupings of these averages have given in Table 4.25. The Ca ratios of the cultivars are between 1.47-1.66% in the first year and average is 1.57%, it is between 1.45-1.64% in the second year and

average is 1.57%, it has varied between 1.50-1.64% as the average of two years and 1.57% has obtained as the two-year average.

Table 4.25. Ca content of alfalfa cultivars (%)

Cultivars	2020	2021	Mean
Banat vs	1.47	1.59	1.53
Basbag	1.64	1.64	1.64
Bilensoy 80	1.50	1.56	1.53
Diane	1.55	1.45	1.50
Elci	1.54	1.58	1.56
Emiliana	1.50	1.51	1.50
Escorial	1.66	1.62	1.64
Ezzelina	1.55	1.61	1.58
Iside	1.55	1.58	1.56
La Torre	1.58	1.59	1.59
Osjecka 99	1.64	1.59	1.62
Prosementi	1.62	1.53	1.58
Queen	1.61	1.55	1.58
Riviera vicentina	1.51	1.63	1.57
Sabrina	1.57	1.57	1.57
Mean	1.57	1.57	1.57
LSD (0.05)	Year: ns	Cultivar: ns	Year x Cultivar: ns

ns: none significant.

The averages of the two-year Ca ratio of the cultivars have given in Figure 4.12. It is seen that Basbag, Escorial, Ezzelina, La Torre, Osjecka 99, Prosementi and Queen cultivars are above the average (1.57%) and the other cultivars are below the average.

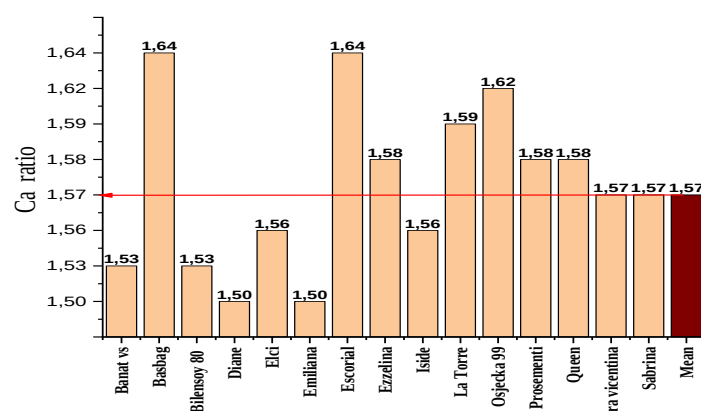


Figure 4.12. Ca ratio averages of foreign origin alfalfa cultivars

Since the major part of calcium is located in the cell walls, in case of its deficiency, primarily the tissues have damaged. Abnormal fruit and budding formation occurs (Karaman 2012). Calcium deficiency stops plant growth and it is manifested by the appearance of small leaves and stems. The development of young leaves have disrupted and deficient plants turn pale green. Necrotic spots form on the leaves. Chlorosis occurs in the inner vessels (Anonymous, 2021c). The most important negative effect of calcium excess inhibition the availability of some other nutrients and their uptake by plants (Mengel et al. 2001).

Ca ratio of 0.80-3.00% in alfalfa has accepted as the optimum value (Owen Plank, 1989). It is seen that the Ca ratios (1.50-1.64%) determined in this study are within the limit values stated by Owen Plank (1989). The results about Ca is similar with Ca contents of 1.00-2.50% (Ibrikci et al. 1994) and 1.57-1.58% (Turan and Celen 2010). Ca content in current study was higher than Ca content (0.70%) has determined by Alp et al. (2001).

4.3.2. Mg (Magnesium) Ratio (%)

The variance analysis of Mg content of foreign origin alfalfa cultivars have given in Table 4.26. As seen in Table 4.26, the difference between the Mg content of alfalfa cultivars is significant only for year ($P \leq 0.01$), in terms of cultivars and year x cultivar interaction was determined to be insignificant.

Table 4.26. The variance analysis of Mg content of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	0.0001	0.00004	0.10
Year	1	0.0056	0.00561	15.18**
Cultivar	14	0.0066	0.00047	1.28
Year x Cultivar	14	0.0055	0.00039	1.07
Error	58	0.02	---	---
General	89	---	---	---
CV	4.92%			

** $: P \leq 0.01$.

Two-year averages of Mg content of different alfalfa cultivars and groupings of these averages have given in Table 4.27. The Mg ratios of the cultivars are between 0.39-

0.43% in the first year and the average is 0.40%, it is between 0.36-0.40% in the second year and average is 0.38%, it has varied between 0.38-0.41% as the average of two years and 0.39% has obtained as the two-year average. In terms of years, it was determined that the 0.38% Mg ratio obtained in 2021 was statistically lower than the 0.40% Mg ratio obtained in 2020.

Table 4.27. Mg content of alfalfa cultivars (%)

Cultivars	2020	2021	Mean
Banat vs	0.39	0.38	0.38
Basbag	0.43	0.38	0.41
Bilensoy 80	0.39	0.38	0.38
Diane	0.39	0.36	0.38
Elci	0.39	0.38	0.39
Emiliana	0.39	0.37	0.38
Escorial	0.41	0.39	0.40
Ezzelina	0.40	0.40	0.40
Iside	0.39	0.39	0.39
La Torre	0.40	0.38	0.39
Osjecka 99	0.39	0.39	0.39
Prosementi	0.42	0.38	0.40
Queen	0.40	0.39	0.40
Riviera vicentina	0.39	0.39	0.39
Sabrina	0.40	0.38	0.39
Mean	0.40 A	0.38 B	0.39
LSD (0.05)	Year: 0.008	Cultivar: ns	Year x Cultivar: ns

ns: none significant.

The averages of the two-year Mg ratio of the cultivars have given in Figure 4.13. It is seen that Basbag, Escorial, Emiliana, Prosementi and Queen cultivars are above the average (0.39%), while the other cultivars are below the average.

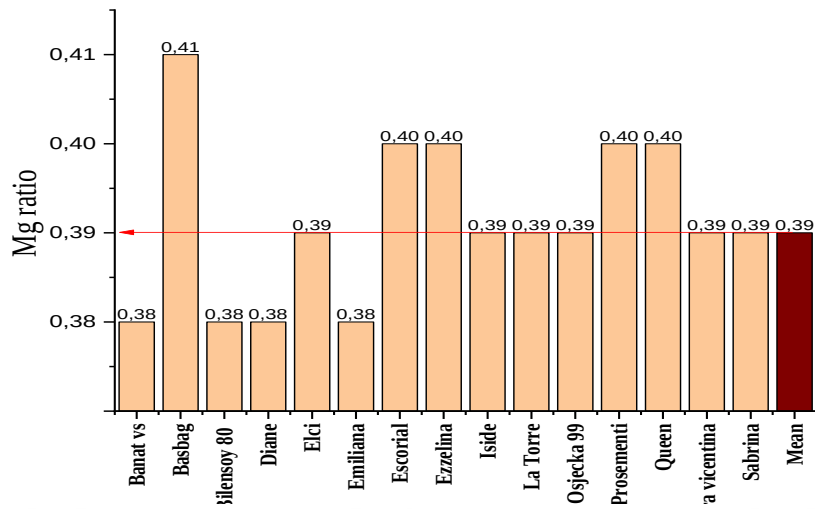


Figure 4.13. Mg ratio averages of foreign origin alfalfa cultivars

Mg is an important element in plants. Leaves suffering from Mg deficiency are very sensitive to light and fall prematurely. Root development is adversely affected, yield and quality are reduced (Marschner 2008). The most important negative effect of magnesium excess in plants is the prevention of K and Ca uptake (Karaman 2012).

The optimum Mg ratio in alfalfa should be between 0.25-1.00 % (Owen Plank, 1989). It has seen that the Mg ratio (0.38-0.41%) obtained in this study is within sufficient ratio. The Mg ratio obtained in this study show similarity with Mg ratio of 0.30-0.80% (Ibrikci et al. 1994). The Mg ratio found in current study was higher than the Mg ratios of 0.20% was determined by Alp et al. (2001), 0.23-0.26% obtained in Van conditions by Turan and Celen (2010) and the Mg content of the two years average was obtained by Ozkose (2018) as 1.97 g/kg in some alfalfa cultivars in two different locations.

4.3.3. P (Phosphorus) Ratio (%)

The variance analysis of P ratio of foreign origin alfalfa cultivars have given in Table 4.28. As seen in Table 4.28, the difference between the P ratios of alfalfa cultivars is significant in terms of year ($P \leq 0.05$), in terms of cultivars and year x cultivar interaction was determined to be insignificant.

Table 4.28. The variance analysis of P content of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	0.0001	0.00004	0.16
Year	1	0.0014	0.00136	5.23*
Cultivar	14	0.0064	0.00046	1.75
Year x Cultivar	14	0.0035	0.00025	0.97
Error	58	0.02	---	---
General	89	---	---	---
CV	4.77%			

*: $P \leq 0.05$.

Two-year averages of P content of different alfalfa cultivars and groupings of these averages have given in Table 4.29. The P ratios of the cultivars are between 0.31-0.35% in the first year and average is 0.33%, in the second year between 0.32-0.36% and an average is 0.34%, it has varied between 0.32-0.35% as the average of two years and 0.34% was obtained as the two-year average. In terms of years, it was determined that the 0.34% P ratio obtained in 2021 was statistically higher than the 0.33% P ratio obtained in 2020.

Table 4.29. P content of alfalfa cultivars (%)

Cultivars	2020	2021	Mean
Banat vs	0.35	0.34	0.35
Basbag	0.34	0.32	0.33
Bilensoy 80	0.31	0.35	0.33
Diane	0.34	0.35	0.35
Elci	0.33	0.35	0.34
Emiliana	0.31	0.33	0.32
Escorial	0.33	0.34	0.34
Ezzelina	0.33	0.34	0.34
Iside	0.33	0.34	0.34
La Torre	0.34	0.34	0.34
Osjecka 99	0.35	0.34	0.35
Prosementi	0.33	0.34	0.34
Queen	0.32	0.33	0.32
Riviera vicentina	0.32	0.35	0.33
Sabrina	0.35	0.36	0.35
Mean	0.33 B	0.34 A	0.34
LSD (0.05)	Year: 0.01	Cultivar: ns	Year x Cultivar: ns

ns: none significant

The averages of the two-year P ratio of the cultivars have given in Figure 4.14. It is seen that Banat vs, Diane, Osjecka 99 and Sabrina cultivars are above the average (0.34%), while the remaining cultivars are below the average.

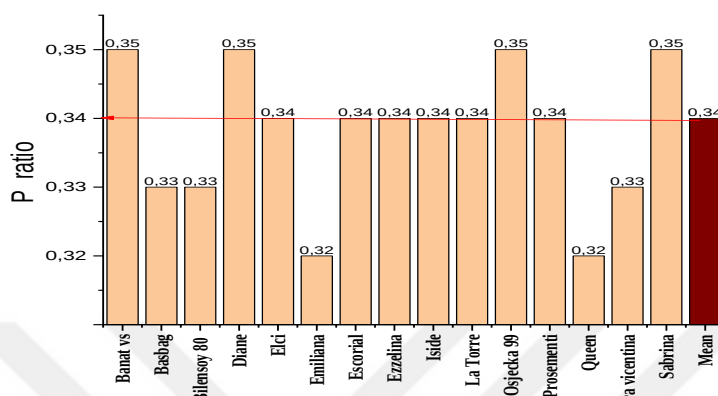


Figure 4.14. P ratio averages of foreign origin alfalfa cultivars

Phosphorus deficiency in plants can be manifested as a decrease in leaf width and number, shortness of plants, dull-blue green leaf color, purple in some parts, reduction in shoot, flower and seed formation, delay in maturation and bursting of buds, decrease in grain and fruit, decrease in product quality (Karaman 2012). Excess phosphorus in plants can lead to deficiencies of micronutrients such as Zn and Fe and other elements such as Ca, B, Cu and Mn (Aktas and Ates 2005; Karaman et al. 2006). In addition, in case of excess phosphorus, the resistance of plants against diseases begins to decrease again (Karaman et al. 2006).

The optimum P ratio in alfalfa should be between 0.25-0.70% (Owen Plank, 1989). It is understood that the P ratio (0.32-0.35%) obtained in alfalfa in the current study is within the optimum level. The P ratio obtained in this study show similarity with P ratio of 0.3-0.6% determined by Ibrikci et al. (1994). The P ratio found in current study was higher than the P ratios (0.13-0.15%) obtained in Van conditions by Turan and Celen (2010) and the P content of the two years average (2.69 g/kg) was obtained by Ozkose (2018) in some alfalfa cultivars in two different locations.

4.3.4. K (Potassium) Ratio (%)

The variance analysis of K ratio of foreign origin alfalfa cultivars have given in Table 4.30. As seen in Table 4.30, the difference between the K ratios of alfalfa cultivars was significant in terms of year ($P \leq 0.01$) and cultivars ($P \leq 0.05$), in terms of year x cultivar interaction was determined to be insignificant.

Table 4.30. The variance analysis of K content of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	0.03	0.01	0.54
Year	1	3.81	3.81	138.25**
Cultivar	14	0.86	0.06	2.22*
Year x Cultivar	14	0.39	0.03	1.00
Error	58	0.03	---	---
General	89	---	---	---
CV	8.17%			

** $P \leq 0.01$, * $P \leq 0.05$.

Two-year averages of K content of different alfalfa cultivars and groupings of these averages have given in Table 4.31. In terms of cultivars, it has seen that the highest K ratio cultivar is Diane (2.22%). The lowest K ratio has detected in La Torre cultivar (1.87%). The other cultivars were included in the group with the highest statistically value. In terms of years, it was determined that the K ratio (2.24%) obtained in 2021 was higher than the K ratio (1.83%) obtained in 2020.

Table 4.31. K content of alfalfa cultivars (%)

Cultivars	2020	2021	Mean
Banat vs	1.84	2.19	2.02 ab
Basbag	1.76	2.04	1.90 ab
Bilensoy 80	1.69	2.30	2.00 ab
Diane	1.91	2.52	2.22 a
Elci	1.77	2.25	2.01 ab
Emiliana	1.76	2.16	1.96 ab
Escorial	1.69	2.19	1.94 ab
Ezzelina	1.88	2.25	2.06 ab

Iside	1.94	2.34	2.14 ab
La Torre	1.82	1.92	1.87 b
Osjecka 99	2.00	2.36	2.18 ab
Prosementi	1.89	2.40	2.15 ab
Queen	1.71	2.24	1.98 ab
Riviera vicentina	1.83	2.27	2.05 ab
Sabrina	1.89	2.15	2.02 ab
Mean	1.83 B	2.24 A	2.03
LSD (0.05)	Year: 0.07	Cultivar: 0.34	Year x Cultivar: ns

ns: none significant.

The averages of the two-year K ratio of the cultivars have given in Figure 4.15. It has seen that Diane, Ezzelina, Iside, Osjecka 99, Prosementi and Riviera vicentina cultivars are above the average (2.03%), while the remaining cultivars are below the average.

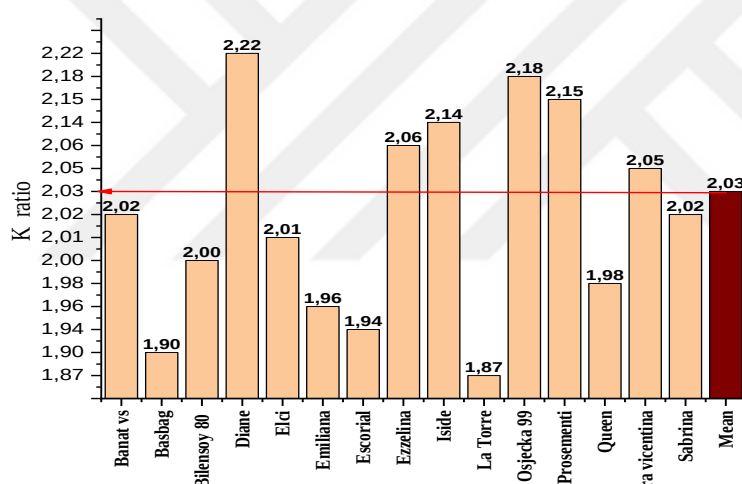


Figure 4.15. K ratio averages of foreign origin alfalfa cultivars

Since K is responsible for water, nutrient and carbohydrate transport in plant tissues, in the deficiency of K, sufficient growth and development cannot achieved in the plant and the product decreases with stunting (Read et al. 2006). In the case of K excess, Ca and Mg deficiency increases considerably in plants (Karaman 2012).

The optimum K ratio in alfalfa should be between 2.00-3.50% (Owen Plank, 1989). It has seen that the K ratio (1.87-2.22%) in this study is within the optimum values. According to the previous studies on the K value; Ibrikci et al. (1994) obtained K content of 2.50-3.80%, Tongel and Ayan (2010) reported that the K content varied from 2.96-5.83% and

Turan and Celen (2010) reported that the K content of some alfalfa cultivars varies between 1.95- 2.20% in Van conditions. It has seen that the K ratios obtained in other studies and the K ratios obtained in the current study are similar to each other.

4.4. Micro Elements

Limit values of micro elements in plants have given in Table 4.32.

Table 4.32. Optimal ratio of micro elements

Micro Elements	Optimal Ratio
Iron (Fe)*	30-250 mg kg ⁻¹ *
Copper (Cu)*	5-30 mg kg ⁻¹ *
Manganese (Mn)*	25-100 mg kg ⁻¹ *
Zinc (Zn)*	20-70 mg kg ⁻¹ *
Aluminum (Al)*	0-200 mg kg ⁻¹ *
Chromium (Cr)**	0.1-1 µg g ⁻¹ dry matter**
Nickel (Ni)**	1-10 µg g ⁻¹ dry matter**
Selenium (Se)**	0.01-1 µg g ⁻¹ dry matter**

*([Owen Plank](#) 1989), ** (Gultakti 2006)

The optimum values in plants have considered being Fe content 30-250 mg kg⁻¹, Cu content 5-30 mg kg⁻¹, Mn content 25-100 mg kg⁻¹, Zn content 20-70 mg kg⁻¹, Al content 0-200 mg kg⁻¹ ([Owen Plank](#) 1989). In plants, Cr content is 0.1-1 µg g⁻¹, Ni content is 1-10 µg g⁻¹ and Se content between 0.01-1 µg g⁻¹ have accepted as the optimum values (Gultakti 2006).

4.4.1. Fe (Iron) Content (mg kg⁻¹)

The variance analysis of Fe content of foreign origin alfalfa cultivars has given in Table 4.33. As seen in Table 4.33, the difference between the Fe content of alfalfa cultivars was significant in terms of cultivars and year x cultivar interaction, in terms of year was determined to be insignificant.

Table 4.33. The variance analysis of Fe content of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	2324.39	1162.20	0.27
Year	1	2734.71	2734.71	0.63
Cultivar	14	245362.79	17525.91	4.04**
Year x Cultivar	14	180562.45	12897.32	2.97**
Error	58	251623.39	---	---
General	89	---	---	---
CV	15.4%			

**: $P \leq 0.01$.

Two-year averages of Fe content of different alfalfa cultivars and groupings of these averages have given in Table 4.34. In terms of cultivars, it has seen that the cultivar with the highest Fe content is in Iside (535 mg kg⁻¹). Banat vs, Bilensoy 80, Elci, Escorial, Ezzelina, Osjecka 99, Prosementi, Riviera vicentina and Queen cultivars are also in the group with the highest value. The lowest Fe content was determined in Basbag (370 mg kg⁻¹), La Torre (356 mg kg⁻¹), Sabrina (366 mg kg⁻¹), Emiliana (370 mg kg⁻¹) and Diane (385 mg kg⁻¹) cultivars. In terms of year x cultivar interaction, it is seen that the highest Fe content was obtained from Iside cultivar (595.8 mg kg⁻¹) in 2021, and the lowest Fe content was obtained from Basbag cultivar (320.3 mg kg⁻¹) in 2020.

Table 4.34. Fe content of alfalfa cultivars (mg kg⁻¹)

Cultivars	2020	2021	Mean
Banat vs	466 abc	336 bc	401 ab
Basbag	320 c	420 abc	370 b
Bilensoy 80	525abc	446 abc	486 ab
Diane	348 bc	421 abc	385 b
Elci	384 abc	486 abc	435 ab
Emiliana	347 bc	393 abc	370 b
Escorial	427 abc	506 abc	466 ab
Ezzelina	355 bc	501 abc	428 ab
Iside	475 abc	595 a	535 a
La Torre	368 bc	345 bc	356 b
Osjecka 99	540 ab	416 abc	478 ab
Prosementi	394 abc	425 abc	409 ab
Queen	531 abc	443 abc	487 ab
Riviera vicentina	440 abc	415 abc	427 ab

Sabrina	398 abc	334 bc	366 b
Mean	421	432	427
LSD (0.05)	Year: ns	Cultivar: 134	Year x Cultivar: 212

ns: none significant.

The two-year Fe content averages of the cultivars have given in Figure 4.16. It has seen that Bilensoy 80, Elci, Escorial, Ezzelina, Iside, Osjecka 99 and Queen cultivars are above the average (427 mg kg⁻¹), while the remaining cultivars are below the average.

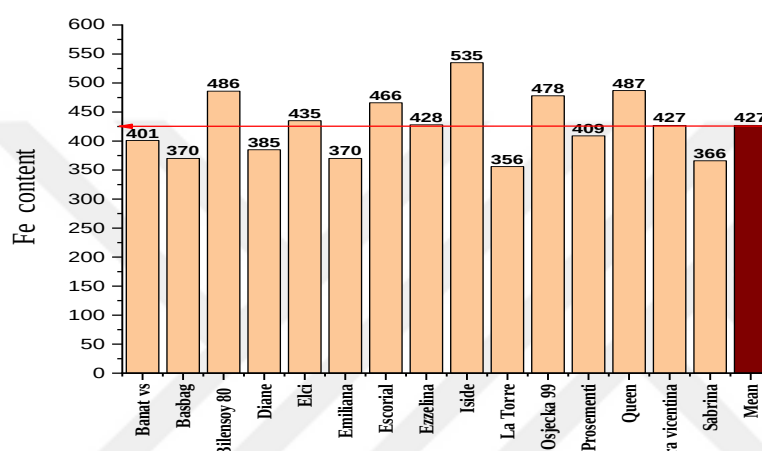


Figure 4.16. Fe content averages of foreign origin alfalfa cultivars

In the first stages of iron deficiency, a general palling occurs on the leaves, including the leaf veins, and turns yellow in cases when the deficiency is very severe. In some plants, brown necrosis may occur on the leaves. Although the critical toxicity level in plants is determined as 500 mg kg⁻¹, the Fe nutritional status and toxicity level of plants vary depending on other factors. Symptoms similar to phosphorus deficiency occur in iron excess (Karaman 2012).

The Fe content in plants should be between 30-250 mg kg⁻¹ (Owen Plank, 1989). It has seen that the Fe content of different alfalfa cultivars have detected in this study are within higher level. Demir (2008) found the average Fe content 42.56 mg kg⁻¹ obtained from some alfalfa cultivars in Diyarbakır province. Turan and Celen (2010) reported that the Fe content varies between 183-232 mg kg⁻¹ as the two-year averages of some alfalfa cultivars in Van conditions. Tongel and Ayan (2010) determined Fe contents of alfalfa between 209.3 and 343.1 mg kg⁻¹. The Fe content of 69.7 mg kg⁻¹ as the two years

average has obtained by Ozkose (2018) in some alfalfa cultivars in two different locations. It has seen that the findings obtained from these studies are lower than the findings obtained from current study.

4.4.2. Cu (Copper) Content (mg kg⁻¹)

The variance analysis of Cu content of foreign origin alfalfa cultivars has given in Table 4.35. As seen in Table 4.35, the difference between the Cu content of alfalfa cultivars was significant in terms of cultivars and year x cultivar interaction ($P \leq 0.01$) and the difference between years was determined to be insignificant.

Table 4.35. The variance analysis of Cu content of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	9.30	4.65	3.65
Year	1	1.37	1.37	1.07
Cultivar	14	87.68	6.26	4.91**
Year x Cultivar	14	56.33	4.02	3.16**
Error	58	73.92	---	---
General	89	---	---	---
CV	11.3%			

** $P \leq 0.01$.

Two-year averages of Cu content of different alfalfa cultivars and groupings of these averages have given in Table 4.36. In terms of cultivars, it has seen that the cultivars with the highest Cu content are Bilensoy 80 (11.25 mg kg⁻¹), Basbag (11.37 mg kg⁻¹), Riviera vicentina (11.32 mg kg⁻¹) and Iside (11.21 mg kg⁻¹). Elci, Emiliana, Escorial and Ezzelina. La Torre, Osjecka 99, Queen and Sabrina cultivars are also statistically in the same group. The lowest Cu content was determined in Banat vs (8.50 mg kg⁻¹), Diane (8.46 mg kg⁻¹) and Prosementi (8.69 mg kg⁻¹) cultivars. In terms of the year x cultivar interaction, the highest Cu content has found in Sabrina cultivars in 2020 and Basbag cultivars in 2021, the lowest Cu content has obtained from Diane cultivars in 2020.

Table 4.36. Cu content of alfalfa cultivars (mg kg⁻¹)

Cultivars	2020	2021	Mean
Banat vs	8.81 abc	8.19 bc	8.50 b
Basbag	10.81 abc	11.94 a	11.37 a
Bilensoy 80	11.60 ab	10.89 abc	11.25 a
Diane	7.69 c	9.24 abc	8.46 b
Elci	11.77 ab	8.70 abc	10.23 ab
Emiliana	8.26 bc	10.65 abc	9.45 ab
Escorial	10.07 abc	10.45 abc	10.26 ab
Ezzelina	9.34 abc	9.83 abc	9.58 ab
Iside	11.32 abc	11.09 abc	11.21 a
La Torre	9.75 abc	8.88 abc	9.31 ab
Osjecka 99	11.63 ab	9.09 abc	10.36 ab
Prosementi	8.40 abc	8.98 abc	8.69 b
Queen	8.98 abc	10.04 abc	9.51 ab
Riviera vicentina	11.38 ab	11.27 abc	11.32 a
Sabrina	11.99 a	8.89 abc	10.44 ab
Mean	10.12	9.87	10.00
LSD (0.05)	Year: ns	Cultivar: 2.3	Year x Cultivar: 3.63

ns: none significant.

The averages of the two-year Cu content of the cultivars have given in Figure 4.17. It is seen that Basbag, Bilensoy 80, Elci, Escorial, Iside, Osjecka 99, Riviera vicentina and Sabrina cultivars are above the average (10.00 mg kg⁻¹), while other cultivars are below the average.

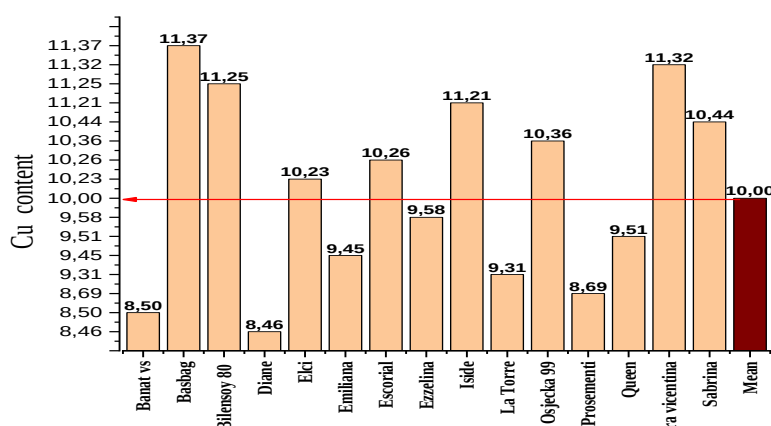


Figure 4.17. Cu content averages of foreign origin alfalfa cultivars

In Cu deficiency, rosettes, bushiness and, in some cases, gum shedding can be observed in plants (Karaman 2012). Another feature of copper deficiency is that the generative development of plants, that is, flower and fruit formation, is affected more than vegetative development (Bergmann 1988). It adversely affects the physiology, protein synthesis, nutrient uptake and respiration of the plant (Alaoui-Sossé et al. 2004). With Cu poisoning, the roots lose their properties and accordingly as well the plant-water balance is negatively affected (Yerli et al. 2020).

It has reported that the Cu ratio in plants should be between 5-30 mg kg⁻¹. It has seen that the Cu ratio detected in different alfalfa cultivars are in the determined values (Owen Plank 1989). Ibrikci et al. (1994) obtained Cu content of 6-15 mg kg⁻¹, Alp et al. (2001) determined Cu content of 5.39 mg kg⁻¹ and Turan and Celen (2010) reported that the Cu content of some alfalfa cultivars changed between 8.3-9.7 mg kg⁻¹ as much as the two-year averages in Van conditions. It has seen that these findings are similar to the results obtained in this study and these results are within the limit values have stated by Owen Plank 1989.

4.4.3. Mn (Manganese) Content (mg kg⁻¹)

The variance analysis of Mn content of foreign origin alfalfa cultivars have given in Table 4.37. As seen in Table 4.37, the difference between the Mn content of alfalfa cultivars was significant in terms of years, cultivars (P≤0.01) and in terms of year x cultivar interaction was determined to be insignificant.

Table 4.37. The variance analysis of Mn content of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	378.78	189.39	2.44
Year	1	12119.37	12119.37	156.06**
Cultivar	14	3605.27	257.52	3.32**
Year x Cultivar	14	1999.72	142.84	1.84
Error	58	4504.30	---	---
General	89	---	---	---
CV	18.9%			

** : P≤0.01.

Two-year averages of Mn content of different alfalfa cultivars and groupings of these averages have given in Table 4.38. In terms of cultivars, it has seen that Iside (54.0 mg kg⁻¹) and Sabrina (54.4 mg kg⁻¹) are the cultivars with the highest Mn content. Diane (34.5 mg kg⁻¹) and Emiliana (35.1 mg kg⁻¹) are the cultivars with the lowest Mn content. The cultivars other than these cultivars were included in the group with the highest value statistically. In terms of years, it was determined that the Mn content (58.3 mg kg⁻¹) detected in 2020 was higher than the Mn content (35.1 mg kg⁻¹) detected in 2021.

Table 4.38. Mn content of alfalfa cultivars (mg kg⁻¹)

Cultivars	2020	2021	Mean
Banat vs	49.0	33.2	41.1 abc
Basbag	63.5	41.5	52.5 ab
Bilensoy 80	67.0	33.4	50.2 abc
Diane	40.2	28.8	34.5 c
Elci	69.8	30.4	50.1 abc
Emiliana	39.9	30.3	35.1 bc
Escorial	61.9	39.9	50.9 abc
Ezzelina	50.3	36.5	43.4 abc
Iside	70.1	37.9	54.0 a
La Torre	60.5	38.3	49.4 abc
Osjecka 99	63.4	31.8	47.6 abc
Prosementi	49.7	32.9	41.3 abc
Queen	51.0	35.6	43.3 abc
Riviera vicentina	64.7	41.3	53.0 ab
Sabrina	73.8	35.0	54.4 a
Mean	58.3 A	35.1 B	46.7
LSD (0.05)	Year: 3.72	Cultivar: 18.02	Year x Cultivar: ns

ns: none significant.

The averages of the two-year Mn content of the cultivars have given in Figure 4.18. It is seen that Basbag, Bilensoy 80, Elci, Escorial, Iside, La Torre, Osjecka 99, Riviera vicentina and Sabrina cultivars are above the average (46.7 mg kg⁻¹), while the other cultivars are below the average.

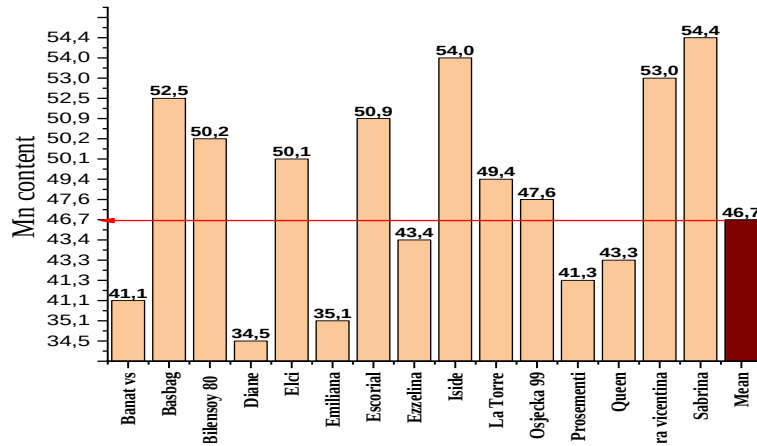


Figure 4.18. Mn content averages of foreign origin alfalfa cultivars

Manganese deficiency due to decreased photosynthesis adequate carbohydrate transfer cannot occur in plant roots and root growth is adversely affected (Karaman 2012). Manganese accumulation can cause atmospheric and environmental pollution by negatively affecting the nitrogen cycle in the soil and atmosphere and the nitrogen movement in plants (Yerli et al. 2020).

The results obtained about Mn; 23.20 mg kg⁻¹ were obtained by Alp et al. (2001), 34.02 mg kg⁻¹ was determined by Demir (2008) in Diyarbakır conditions, 8.0-33.0 mg kg⁻¹ was obtained in alfalfa by Turan and Celen (2010), 13.10-39.54 mg kg⁻¹ was obtained in alfalfa by Tongel and Ayan (2010), 27.6 mg kg⁻¹ was determined in the control group by Orman et al. (2014) in Antalya conditions and 34.6 mg kg⁻¹ as the two years average was obtained by Ozkose (2018) in some alfalfa cultivars in two different locations. The findings obtained from these studies are lower than the findings of the current study. The Mn content of this study show similarity with the Mn contents that were determined by Pirhofer-Walzl et al. (2011) (43.5-47.7 mg kg⁻¹). It has seen that the Mn contents obtained in this study and the results obtained in the previous studies are within the limit values (25-100 mg kg⁻¹) have determined by Owen Plank (1989).

4.4.4. Zn (Zinc) Content (mg kg⁻¹)

The variance analysis of Zn content of foreign origin alfalfa cultivars have given in Table 4.39. As seen in Table 4.39, the difference between the Zn content of alfalfa cultivars was significant in terms of year x cultivar interaction and cultivars ($P \leq 0.01$), and in terms of years was determined to be insignificant.

Table 4.39. The variance analysis of Zn content of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	39.92	19.96	1.94
Year	1	6.14	6.14	0.60
Cultivar	14	3229.58	230.68	22.44**
Year x Cultivar	14	2992.85	213.78	20.80**
Error	58	596.14	---	---
General	89	---	---	---
CV	17.5%			

** $P \leq 0.01$.

Two-year averages of Zn content of different alfalfa cultivars and groupings of these averages have given in Table 4.40. In terms of cultivars, it was determined that Iside (38.3 mg kg⁻¹) was the cultivar with the highest Zn content, Emiliana (11.7 mg kg⁻¹) was the cultivar with the lowest Zn content. In terms of year x cultivar interaction, it was determined that the highest Zn content was obtained from the Iside cultivar in 2020, and the lowest Zn content was obtained from the Emiliana cultivar in 2020.

Table 4.40. Zn content of alfalfa cultivars (mg kg⁻¹)

Cultivars	2020	2021	Mean
Banat vs	11. 6 c-f	18.6 cde	15.1 cd
Basbag	17.9 cde	16.1 cde	17.0 bcd
Bilensoy 80	18.1 cde	19.7 cd	18.9 bc
Diane	8.6 ef	19.0 cd	13. 8 cd
Elci	21.2 bc	17.0 cde	19.1 bc
Emiliana	3.8 f	19.6 cd	11.7 d
Escorial	19.0 cd	19.2 cd	19.1 bc
Ezzelina	15.5 cde	19.2 cd	17.4 bcd
Iside	55.8 a	20. 8 bc	38.3 a
La Torre	15.9 cde	18.1 cde	17.0 bcd
Osjecka 99	30.3 b	16.4 cde	23.4 b

Prosementi	12.8 c-f	16.6 cde	14.7 cd
Queen	9.7 def	18.2 cde	13.9 cd
Riviera vicentina	15.0 cde	20.4 bc	17.7 bcd
Sabrina	15.6 cde	19.7 cd	17.7 bcd
Mean	18.1	18.6	18.3
LSD (0.05)	Year: ns	Cultivar: 6.6	Year x Cultivar:10.32

ns: none significant.

The averages of the two-year Zn content of the cultivars have given in Figure 4.19. It is seen that Bilensoy 80, Elci, Escorial, Iside and Osjecka 99 cultivars were above the average (18.3 mg kg⁻¹) and the other cultivars were below the average.

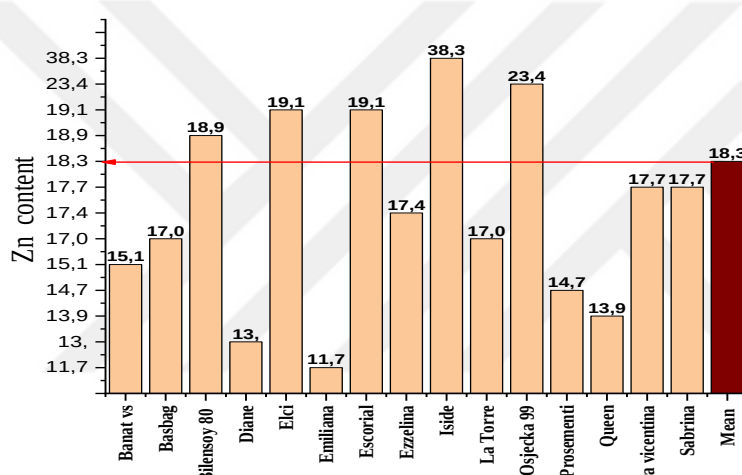


Figure 4.19. Zn content averages of foreign origin alfalfa cultivars

If the zinc deficiency is not very severe, it only affects the leaves, the shoot development continues, if the deficiency is severe, the buds development stops completely or the number of sprout in the buds decreases or remains unopened (Karaman 2012). High amount of zinc causes delayed growth and premature aging of the plant (Asati et al. 2016).

The Zn content of 18.2-21.3 mg kg⁻¹ obtained in some of alfalfa by Turan and Celen (2010) in Van conditions, show similarity with the results of current study. However, the results have determined by other researchers for alfalfa, 45.8-62.7 mg kg⁻¹ (Wilczek and Cwintal 1996), 23-75 mg kg⁻¹ (Scholtz et al. 2009), 24.89-83.01 mg kg⁻¹ (Tongel and Ayan 2010) and 22.9-25.0 mg kg⁻¹ (Pirhofer-Walzl et al. 2011) were higher than the

results in this study. Cevheri et al. (2013) in their study on assessment of the macro and micro element contents of forage plants in natural pasture in Sanliurfa, reported that the Zn content was 11.8 mg kg⁻¹ in the alfalfa. The findings obtained from this study are lower than the findings of the current study. It has reported that the Zn ratio in plants should be between 20-70 mg kg⁻¹(Owen Plank 1989). It has seen that the Zn ratio detected in different alfalfa cultivars and previous studies are within the limit values have determined by Owen Plank (1989).

4.4.5. Al (Aluminum) Content (mg kg⁻¹)

The variance analysis of Al content of foreign origin alfalfa cultivars have given in Table 4.41. As seen in Table 4.41, the difference between the Al content of alfalfa cultivars was determined to be significant ($P \leq 0.01$) in terms of years, cultivars and year x cultivar interaction.

Tablo 4.41. The variance analysis of Al content of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	1219.03	609.52	2.66
Year	1	131095.82	131095.82	571.16**
Cultivar	14	191504.69	13678.91	59.60**
Year x Cultivar	14	200001.29	14285.81	62.24**
Error	58	13312.51	---	---
General	89	---	---	---
CV	15.04%			

** $P \leq 0.01$.

Two-year averages of Al content of different alfalfa cultivars and groupings of these averages have given in Table 4.42. In terms of cultivars, it was determined that the cultivar with the highest Al content was Bilensoy 80 (213.0 mg kg⁻¹), and the cultivar with the lowest Al content was Ezzelina (44.6 mg kg⁻¹). In terms of years, it has seen that the average of Al content (138.9 mg kg⁻¹) detected in 2020 was higher than the average of Al content (62.6 mg kg⁻¹) detected in 2021. In terms of the year x cultivar interaction, the highest Al content was obtained from Bilensoy 80 cultivar in 2020, the lowest Al content was obtained from Prosementi and Ezzelina cultivars in 2020, and Banat, Bilensoy 80, Diane, Elci, Escorial, Ezzelina, La Torre and Sabrina cultivars in 2021.

Table 4.42. Al content of alfalfa cultivars (mg kg⁻¹)

Cultivars	2020	2021	Mean
Banat vs	104.5 d-g	50.5 h	77.5 efg
Basbag	209.1 b	59.5 gh	134.3 c
Bilensoy 80	382.1 a	43.9 h	213.0 a
Diane	62.1 gh	34.9 h	48.6 gh
Elci	208.0 b	53.2 h	130.7 c
Emiliana	67.7 fgh	58.0 gh	62.9 e-h
Escorial	212.3 b	49.7 h	131.1 c
Ezzelina	45.7 h	43.3 h	44.6 h
Iside	132.5 cd	199.1 b	165.8 b
La Torre	79.3 e-h	51.0 h	65.1 e-h
Osjecka 99	123.2 de	57.5 gh	90.3 de
Prosementi	51.27 h	59.1 gh	55.2 fgh
Queen	112.0 def	74.1 fgh	93.0 de
Riviera vicentina	176.9 bc	61.4 gh	119.1 cd
Sabrina	116.3 def	43.3 h	79.9 ef
Mean	138.9 A	62.6 B	100.7
LSD (0.05)	Year: 6.4	Cultivar: 31.0	Year x Cultivar: 48.8

ns: none significant.

The averages of the two-year Al content of the cultivars have given in Figure 4.20. It is seen that Basbag, Bilensoy 80, Elci, Escorial, Iside and Riviera vicentina cultivars are above the average (100.7 mg kg⁻¹), while the other cultivars are below the average.

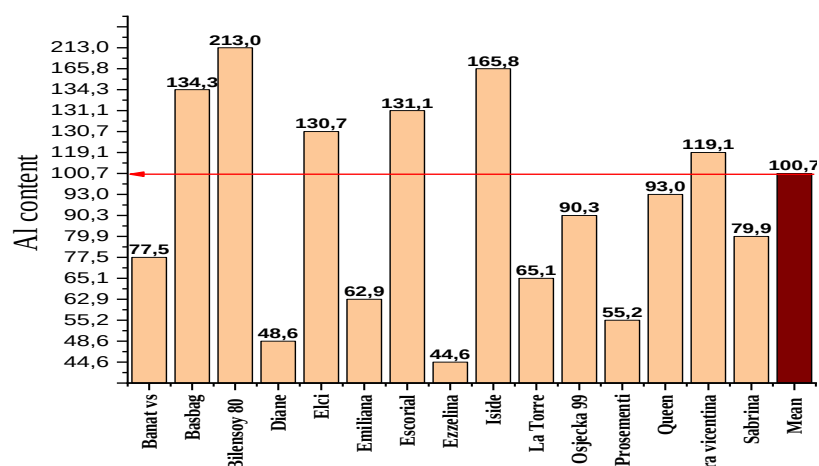


Figure 4.20. Al content averages of foreign origin alfalfa cultivars

It has reported that the Al ratio in plants should be between 0-200 mg kg⁻¹ (Owen Plank 1989). It has seen that the Al contents obtained in this study are within the limit values

have determined by Owen Plank (1989). Cevheri et al. (2013) obtained Al content 382.5 mg kg⁻¹ in alfalfa plant, this value was higher than the findings obtained in this study, Smith (1969) obtained Al contents in alfalfa 41-49 mg kg⁻¹ and Ozkose (2018) obtained Al content in alfalfa cultivars 42.2 mg kg⁻¹ as the two years average and in two different locations, this values were found to be lower than the findings obtained in this study.

4.4.6. Cr (Chromium) Content (mg kg⁻¹)

The variance analysis of Cr content of foreign origin alfalfa cultivars have given in Table 4.43. As seen in Table 4.43, the difference between the Cr content of alfalfa cultivars was determined to be significant in terms of years ($P \leq 0.05$), cultivars and year x cultivar interaction ($P \leq 0.01$).

Table 4.43. The variance analysis of Cr content of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	0.17	0.09	0.25
Year	1	2.21	2.21	6.63*
Cultivar	14	153.98	11.00	32.98**
Year x Cultivar	14	54.45	3.89	11.66**
Error	58	19.34	---	---
General	89	---	---	---
CV	13.6%			

*: $P \leq 0.05$, **: $P \leq 0.01$.

Two-year averages of Cr content of different alfalfa cultivars and groupings of these averages have given in Table 4.44. In terms of cultivars, it was determined that the cultivar with the highest Cr content was Iside (8.22 mg kg⁻¹), and the cultivar with the lowest Cr content was Diane (2.71 mg kg⁻¹). In terms of years, it has been seen that the average of Cr content detected in 2020 (4.41 mg kg⁻¹) is higher than the Cr content detected in 2021 (4.10 mg kg⁻¹). In terms of the year x cultivar interaction, it has seen that the highest Cr content has obtained from the Iside cultivar in 2020, and the lowest Cr content has obtained from the Elci, Prosementi and Sabrina cultivars in 2021.

Table 4.44. Cr content of alfalfa cultivars (mg kg⁻¹)

Cultivars	2020	2021	Mean
Banat vs	3.07 f-i	4.90 c-f	3.98 c-f
Basbag	5.03 cd	4.58 c-g	4.80 bcd
Bilensoy 80	4.82 c-f	3.73 d-i	4.28 b-f
Diane	2.67 hi	2.76 ghi	2.71 g
Elci	4.48 c-h	2.23 i	3.35 efg
Emiliana	3.23 d-i	6.94 ab	5.08 bc
Escorial	4.43 c-h	3.13 e-i	3.78 d-g
Ezzelina	3.33 d-i	3.87 d-i	3.60 efg
Iside	7.87 a	8.58 a	8.22 a
La Torre	4.28 c-h	4.38 c-h	4.33 b-f
Osjecka 99	4.37 c-h	4.43 c-h	4.40 b-e
Prosementi	3.23 d-i	2.02 i	2.63 g
Queen	4.97 cde	3.16 e-i	4.07 c-f
Riviera vicentina	5.98 bc	4.71 c-f	5.34 b
Sabrina	4.36 c-h	2.04 i	3.20 fg
Mean	4.41 A	4.10 B	4.25
LSD (0.05)	Year: 0.24	Cultivar: 1.18	Year x Cultivar: 1.86

ns: none significant.

The averages of the two-year Cr content of the cultivars have given in Figure 4.21. It is seen that Basbag, Bilensoy 80, Emiliana, Iside, La Torre, Osjecka 99 and Riviera vicentina cultivars are above the average (4.25 mg kg⁻¹), while the other cultivars are below the average.

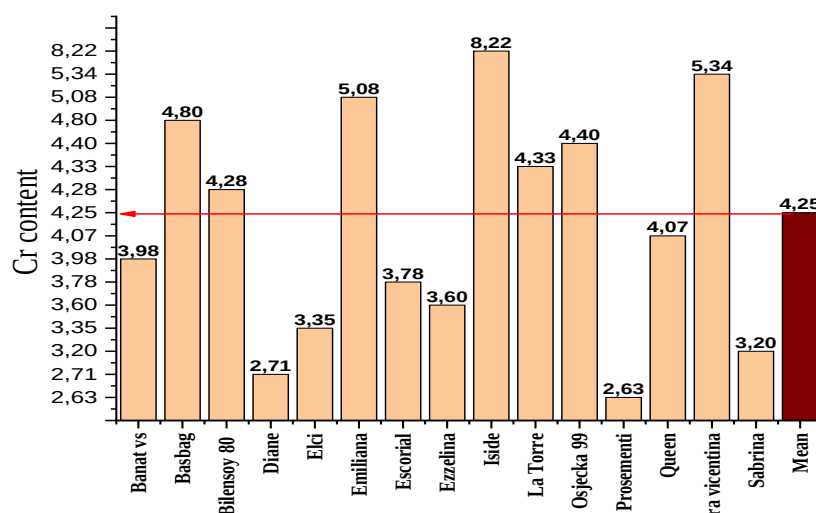


Figure 4.21. Cr content averages of foreign origin alfalfa cultivars

Blocking the nutrient and water supply mechanism through the roots of plants exposed to chromium stress, causes degradation of photosynthetic pigments and abnormalities in enzyme activity (Sallah-Ud-Din et al. 2017).

Pirhofer-Walzl et al. (2011) determined Cr content of 0.2 mg kg^{-1} in alfalfa, Orman et al. (2014) in their study examining the effect of sewage sludge application on the macro, micro and heavy element content of alfalfa, found the Cr content in the alfalfa plant 1.75 mg kg^{-1} in the control group. Colak Esetlili (2016) cultivated alfalfa by applying different doses of lead (Pb), cadmium (Cd) and chromium (Cr) in sandy and clayey textured soils in a pot experiment. The Cr content of alfalfa has found to be between $0.16\text{-}0.44 \text{ mg kg}^{-1}$ in sandy loam soil and between $0.17\text{-}0.23 \text{ mg kg}^{-1}$ in clayey soil. Rezaeian et al. (2020) cultivated alfalfa plant at different distances in industrial areas in Tehran province. They determined the Cr content in alfalfa is minimum 0.3, maximum 1.2 mg kg^{-1} and an average of 0.57 mg kg^{-1} . The Cr content of 1.19 mg kg^{-1} as the two years average has obtained by Ozkose (2018) in some alfalfa cultivars in two different locations. It has seen that the findings obtained in these studies are lower than the findings of the current study.

It has reported that the Cr content in plants should be between $0.1\text{-}1 \mu\text{g g}^{-1}$ (Gultakti 2006). It has understood that the Cr content obtained in this study within the higher level (Tablo 4.44).

4.4.7. Ni (Nickel) Content (mg kg^{-1})

The variance analysis of Ni content of foreign origin alfalfa cultivars have given in Table 4.45. As seen in Table 4.45, the difference between the Ni content of alfalfa cultivars was significant in terms of cultivars and year x cultivar interaction ($P \leq 0.01$), and in terms of years was determined to be insignificant.

Table 4.45. The variance analysis of Ni content of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	0.0004	0.0002	0.0008
Year	1	0.0006	0.0006	0.002
Cultivar	14	102.9	7.35	26.19**

Year x Cultivar	14	50.67	3.62	12.90**
Error	58	16.28	---	---
General	89	---	---	---
CV	13.3%			

** $P \leq 0.01$.

Two-year averages of Ni content of different alfalfa cultivars and groupings of these averages have given in Table 4.46. In terms of cultivars, it was determined that the cultivar with the highest Ni content was Iside (7.07 mg kg⁻¹), and the cultivar with the lowest Ni content was Diane (2.45 mg kg⁻¹). In terms of the year x cultivar interaction, it has seen that the highest Ni content has obtained from the Iside cultivar in 2021, the lowest Ni content has obtained from Sabrina, Prosementi and Diane cultivars in 2021.

Table 4.46. Ni content of alfalfa cultivars (mg kg⁻¹)

Cultivars	2020	2021	Mean
Banat vs	3.32 e-i	3.62 d-i	3.47 def
Basbag	4.11 c-h	6.58 b	5.34 b
Bilensoy 80	4.70 c-g	3.21 e-i	3.96 cd
Diane	2.64 hi	2.26 i	2.45 f
Elci	4.77 c-f	3.57 d-i	4.17 cd
Emiliana	2.84 hi	4.67 c-g	3.76 cde
Escorial	4.03 c-h	5.11 bcd	4.57 bc
Ezzelina	3.10 f-i	3.34 e-i	3.22 def
Iside	5.53 bc	8.61 a	7.07 a
La Torre	4.06 c-h	4.03 c-h	4.04 cd
Osjecka 99	4.09 c-h	3.99 c-h	4.04 cd
Prosementi	3.14 f-i	2.27 i	2.71 ef
Queen	4.03 c-h	3.00 ghi	3.52 c-f
Riviera vicentina	4.86 cde	3.59 d-i	4.22 cd
Sabrina	4.72 c-f	2.21 i	3.47 def
Mean	4.00	4.00	4.00
LSD (0.05)	Year: ns	Cultivar: 1.08	Year x Cultivar:1.71

ns: none significant

The two-year Ni content averages of the cultivars have given in Figure 4.22. It is seen that Basbag, Elci, Escorial, Iside, La Torre, Osjecka 99 and Riviera vicentina cultivars are above the average (4.25 mg kg⁻¹), while the other cultivars give values below the average.

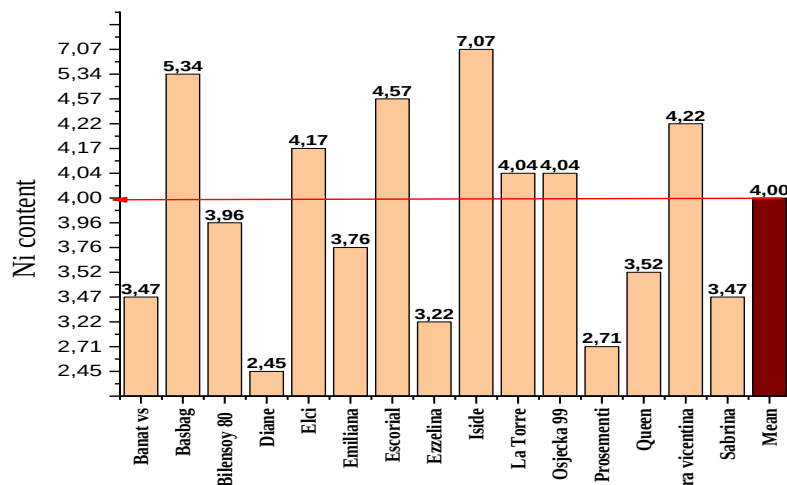


Figure 4.22. Ni content averages of foreign origin alfalfa cultivars

In nickel deficiency, the development of the aboveground and underground organs of the plants decreases, the green color of the plant gradually disappears, chlorosis and necrosis occur between the leaf veins. However, nickel deficiency has not seen in plants generally (Guzel et al. 2002; Kacar and Katkat 2006). High nickel content has a toxic effect, negatively affecting plant physiology and biochemical processes, leads to inhibition of chlorophyll synthesis and fat metabolism (Asri and Sonmez 2006).

It has reported that the Ni ratio in plants should be between 1-10 $\mu\text{g g}^{-1}$ (Gultakti 2006). It has seen that the Ni content detected in this study is within the limit values have determined by Gultakti (2006). Orman et al. (2014), in their study examining the effect of sewage sludge application on the macro, micro and heavy element content of alfalfa, found that the Ni content in the alfalfa plant is 3.18 mg kg^{-1} in the control group. It has seen that the findings obtained from this study are in parallel with the findings of the current study.

4.4.8. Se (Selenium) content (mg kg^{-1})

The variance analysis of Se content of foreign origin alfalfa cultivars have given in Table 4.47. As seen in Table 4.47, the difference between the Se content of alfalfa cultivars was determined to be significant ($P \leq 0.01$) in terms of years, cultivars and year x cultivar interaction.

Table 4.47. The variance analysis of Se content of alfalfa cultivars

Source of variance	Degrees of freedom	Sum of squares	Mean of squares	F value
Repetition	2	0.001276	0.000638	0.03
Year	1	69.54	69.54	3368.84**
Cultivar	14	39.64	2.83	137.15**
Year x Cultivar	14	39.51	2.82	136.70**
Error	58	1.20	---	---
General	89	---	---	---
CV	14.9%			

**: $P \leq 0.01$.

Two-year averages of Se content of different alfalfa cultivars and groupings of these averages have given in Table 4.48. In terms of cultivars, it has been determined that the cultivar with the highest Se content was Escorial (2.01 mg kg^{-1}), the cultivar with the lowest Se content was Sabrina (0.59 mg kg^{-1}). The Elci and Queen cultivars are also in the group with the highest value. In terms of years, it has seen that the average of Se content (1.84 mg kg^{-1}) detected in 2020 was higher than the average of Se content (0.09 mg kg^{-1}) detected in 2021. In terms of the year x cultivar interaction, it has seen that the highest Se content has obtained from Escorial cultivar in 2020, the lowest Se content has obtained from Banat, Basbag, Prosementi and Riviera vicentina cultivars in 2020 and all cultivars in 2021.

Table 4.48. Se content of alfalfa cultivars (mg kg^{-1})

Cultivars	2020	2021	Mean
Banat vs	0.01 h	0.07 h	0.04 f
Basbag	0.01 h	0.07 h	0.04 f
Bilensoy 80	1.74 f	0.12 h	0.93 d
Diane	3.13 cd	0.08 h	1.60 bc
Elci	3.64 ab	0.07 h	1.85 ab
Emiliana	2.63 e	0.10 h	1.37 c
Escorial	3.94 a	0.08 h	2.01 a
Ezzelina	1.31 fg	0.10 h	0.70 de
Iside	2.80 de	0.10 h	1.45 c
La Torre	1.75 f	0.08 h	0.92 d
Osjecka 99	1.73 f	0.10 h	0.92 d
Prosementi	0.01 h	0.09 h	0.05 f
Queen	3.45 bc	0.09 h	1.77 ab
Riviera vicentina	0.41 h	0.09 h	0.25 f
Sabrina	1.11 g	0.08 h	0.59 e

Mean	1.84 A	0.09 B	0.97
LSD (0.05)	Year: 0.06	Cultivar: 0.29	Year x Cultivar: 0.46

ns: none significant.

The two-year Se content averages of the cultivars have given in Figure 4.23. It is seen that Diane, Elci, Emiliana, Escorial, Iside and Queen cultivars are above the average (0.97 mg kg⁻¹), while the other cultivars are below the average.

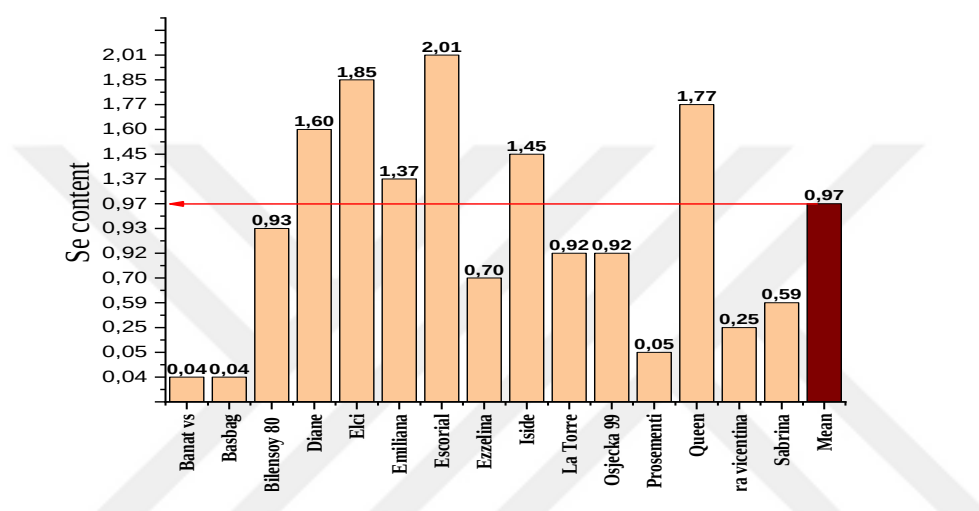


Figure 4.23. Se content averages of foreign origin alfalfa cultivars

Plant growth promoting effects of low selenium concentrations have reported. However, the toxic effects of high levels of selenium results in shortness of plants and signs of chlorosis become more common. In selenium poisoning, plant growth stops and the selenium content of the plant increases. Selenium can accumulate up to 1500 mg kg⁻¹, especially in growth tips and seeds. pH, amount of organic matter, amount of sulfate and iron are important for the uptake of selenium by plants (Anonymous, 2021d).

It has reported that the Se ratio in plants should be between 0.01-1 µg g⁻¹ (Gultakti, 2006). In this study, it has understood that the Se content have detected in 2021 is within the limit values have determined by Gultakti (2006). However, it has seen that the Se contents detected in 2020 are above the limit values. Carter et al. (1972) investigated the effect of phosphorus fertilization on the selenium content of alfalfa, in the control group of the selenium content has obtained 0.036-0.051 mg kg⁻¹. Owusu-Sekyere et al. (2013) in their study on selenium formation and growth of nodules by alfalfa carbohydrate

metabolism, reported that the Se content in the stem of alfalfa varies between 0.03-0.07 $\mu\text{g g}^{-1}$. The results from these studies appear to be lower than those from the current study. The Se content of 0.70 mg kg^{-1} as the two years average has obtained by Ozkose (2018) in some alfalfa cultivars in two different locations. It is seen that the results obtained from this study are similar than the results of the current study.



5. CONCLUSIONS AND SUGGESTIONS

The results obtained in this study were carried out in Bingöl ecological conditions regarding yield, quality and mineral content of a total of 15 alfalfa cultivars, 12 of which are of foreign origin (Iside, Osjecka 99, Ezzelina, Diane, Prosementi, Queen, Emiliana, Riviera vicentina, Banat vs, La Torre, Sabrina and Escorial) and 3 of which are as the standard types (Elci, Bilensoy 80 and Basbag), summarized as follows.

5.1. Yield Related Results

The plant heights of alfalfa cultivars varied between 87.6-106.2 cm and the average was 97.6 cm, the number of stems varied between 13.8-18.1 and the average was 15.8, stem thickness varied between 2.25-3.31 mm and the average was 2.80 mm, the forage yield varied between 9706-14069 kg da⁻¹ and the average was 11018 kg da⁻¹, the dry matter yield varied between 2841-3955 kg da⁻¹ and the average was obtained as 3228 kg da⁻¹. Statistically, the highest plant height and stem thickness were obtained from Emiliana, while the highest forage yield and dry matter yield were obtained from Ezzelina. Emiliana and Ezzelina cultivars gave higher values than both standard and foreign cultivars. The number of stems of the cultivars did not differ statistically.

5.2. Quality Related Results

Crude protein ratios of alfalfa cultivars vary between 19.14-21.32%, and the average is 20.40%, ADF ratios vary between 31.0 and 36.1% in average, with an average of 33.0%, NDF ratios vary between 39.70-45.82%, with an average of 42.41%, DDM ratios between 60.80-64.74%, with an average of 63.18%, the DMI ratios varied between 2.64-3.04%, with an average of 2.85%, and RFV between 125.0-152.2, with an average of 140.3. Alfalfa cultivars in terms of quality parameters did not differ statistically.

5.3. Macro Elements Related Results

The Ca ratios of alfalfa cultivars vary between 1.50-1.64%, with an average of 1.57%, Mg ratios varying between 0.38-0.41%, with an average of 0.39%, the P ratio varied between 0.32-0.35%, the average was 0.34%, and the K ratios ranged between 1.87-2.22%, with an average of 2.03%. Alfalfa cultivars did not differ statistically in terms of macro elements except potassium. The highest K ratio has obtained from Diane cultivar and the lowest K ratio has obtained from La Torre cultivar statistically.

5.4. Micro Elements Related Results

Fe content of alfalfa cultivars varied between 366-535 mg kg⁻¹ with an average of 427 mg kg⁻¹, Cu content varied between 8.46-11.37 mg kg⁻¹ with an average of 10.00 mg kg⁻¹, the Mn content varied between 34.5-54.4 mg kg⁻¹ and the average was 46.7 mg kg⁻¹, the Zn content varied between 11.7-38.3 mg kg⁻¹ and the average was 18.3 mg kg⁻¹, Al content varied between 44.6- 213.0 mg kg⁻¹ with an average of 100.7 mg kg⁻¹, Cr content between 2.71-8.22 mg kg⁻¹ with an average of 4.25 mg kg⁻¹, Ni content varied between 2.45-7.07 mg kg⁻¹ with an average of 4.00 mg kg⁻¹ and Se content between 0.59- 2.01 mg kg⁻¹ with an average of 0.97 mg kg⁻¹.

The highest Fe content was Iside, the lowest Fe content was in Basbag, Diane, La Torre and Sabrina cultivars, the highest Cu contents were obtained from Bilensoy 80, Basbag, Riviera vicentina and Iside, the lowest Cu contents were obtained from Banat vs, Diane and Prosementi cultivars, the highest Mn content was in Iside and Sabrina, the lowest Mn content was from Diane cultivar, the highest Zn content is in Iside, the lowest Zn content is from Emiliana cultivar, the highest Al content Bilensoy 80, the lowest Al content from Ezzelina cultivar, the highest Cr content was in Iside, the lowest Cr content from Diane cultivar, the highest Ni content was obtained from Iside, the lowest Ni content was obtained from Diane cultivar, the highest Se content was obtained from Escorial, and the lowest Se content was obtained from Sabrina cultivar.

When these two-year results are evaluated together; It has been determined that Emiliana and Ezzelina cultivars stand out in terms of yield, and there is no statistical difference

between cultivars in terms of quality and macro elements. In terms of microelements, it was determined that Iside cultivar generally gave higher values than other cultivars.



REFERENCES

Anonymous (2021a) <http://www.bingol.gov.tr> (28.12.2021)

Anonymous (2021b) Tarımsal Değerleri Ölçme Denemeleri Teknik Talimatı, Yonca Türleri (*Medicago* species). Tarım ve Köy işleri Bakanlığı, Tohumluk Tescil ve Sertifikasyon Merkezi Müdürlüğü, Ankara (30.11.2021)

Anonymous (2021c) <http://www.smart-fertilizer.com/articles/calcium> (30.11.2021)

Anonymous (2021d) https://plantprobs.net/plant/nutrientImbalances_(11.10.2021)

Açıkbas S, Albayrak S, Mevlut T (2017) Doğal vejetasyondan toplanan bazı yonca (*Medicago sativa* L.) genotiplerinin ot verim ve kalitelerinin belirlenmesi. Türkiye Tarımsal Araştırmalar Dergisi 4(2): 155-162

Açıkgöz E (2001) Yem Bitkileri (3. Baskı). Uludağ üniversitesi güçlendirme vakfı, yayın (182): 584-587

Açıkgöz E, Altınok S, Sancak C, Uraz K (2005) Yem bitkileri üretimi ve sorunları 29(1): 503-518

Ak İ (1997). Hayvan Yetistirme, Yemler ve Hayvan Besleme. Uludağ üniversitesi Ziraat Fakültesi Ders Notları (71): 143-146

Akbari N, Avcıoğlu R (1992) Ege Bölgesine uygun bazı yonca (*Medicago sativa* L.) çeşitlerinin agronomik özellikleri ile yem kaliteleri üzerinde araştırma. Doktora Tezi, Bornova-İzmir 71-76

Akman N, Aksoy F, Sahin O, Kaya Ç, Erdogdu G (2006) Cumhuriyetimizin 100. Yılında Türkiye'nin Hayvansal Üretimi. Türkiye Damızlık Sığır Yetiştiriciliği Birliği Yayınları (4): 89-95

Aktaş M, Ateş M (2005) Bitkilerde beslenme bozuklukları: nedenleri ve tanınmaları, Engin Yayınevi 1(2): 120-122

Akyıldız A (1969) Yemler Bilgisi. Ankara üniversitesi, Ziraat Fakültesi Yayınları 380: 158-159

Alaoui-Sosse B, Genet P, Dunand-Vinit F, Toussaint LM, Epron D, Badot PM (2004) Effect of copper on growth in cucumber plants (*Cucumis sativus*) and its relationships with carbohydrate accumulation and changes in ion contents. Plant Science (166): 1213-1218

Albayrak S, Ekiz H (2005) An investigation on the establishment of artificial pasture under ankara's ecological conditions. Turkish journal of Agriculture and Forestry 29(1): 69-74

Alp M, Kahraman R, Kocabagli N, Özçelik D, Eren M, Turkmen İ, Yavuz M, Dursun S (2001) Marmara Bölgesi'ndeki yem bitkilerinin mineral madde düzeylerinin saptanması ve koyunlarda beslenme bozuklukları ile ilişkisi. Turkish Journal of Veterinary and Animal Sciences 25(4): 511-520

Altınok S, Karakaya A (2002) Forage yield of different alfalfa cultivars under Ankara conditions. Turkish Journal of Agriculture and Forestry 26(1): 11-16

Asati A, Pichhode M (2016) Effect of heavy metals on plants: an overview 5(3): 56-66

Asri FO, Sonmez S (2006) Ağır metal toksisitesinin bitki metabolizması üzerine etkileri 23(2): 36-45

Avci MA, Özkose A, Tamkoc A (2013) Determination of yield and quality characteristics of alfalfa (*Medicago sativa* L.) varieties grown in different locations. Journal of Animal and Veterinary Advances 12(4): 487-490

Başbağ M, Çağan E, Sayar M, Fırat M (2020) Determining forage quality properties of alfalfa (*Medicago sativa* L.) collected from natural areas of the southeastern anatolia region and assessment with biplot analysis 7-9

Başbağ M, Demirel R, Avcı M (2009) Determination of some agronomical and quality properties of wild alfalfa (*Medicago sativa* L.) clones in Turkey. Journal of Food, Agriculture and Environment 7(2): 357-359

Başbağ M, Gul İ, Saruhan V (2002) Diyarbakır Sulu Koşullarında Yonca ve Üçgül Çesit Verim ve Adaptasyonlarını Araştırma Projesi. TUBİTAKTARP-2261 no'lu Proje Kesin Sonuç Raporu, Ankara

Bayraktar E (2005) Tekirdağ koşullarında bazı yem bitkilerinin farklı gelişme dönemlerinde kök ve gövdelerinde biriktirilen kimi besin maddelerinin değişimi. Yüksek Lisans, Tekirdağ 25-28

Bergmann W (1988) Ernährungsstörungen bei Kulturpflanzen, Entstehung, Visuelle und Analytische Diagnose. VEB G. Fischer-Verlag, Jena 5(1): 135-150

Beyaz F (2018) Aydın-Karacasu koşullarında yonca (*Medicago sativa* L.) çeşitlerinin verim ve kalite özelliklerinin belirlenmesi, Yüksek Lisans Tezi, Tarla Bitkileri Anabilim Dalı, Aydın

Bıçakçı E, Balabanlı C (2016) Çoklu melez parsellerinde yer alan yonca genotiplerinin tohum tutma özelliklerinin belirlenmesi. Suleyman Demirel Üniversitesi Fen Bilimleri Enstitüsü Dergisi 20(3): 587-591

Çağan E, Arslan İ (2021) Bingöl Ovası'nda Yetistiriciliği Yapılan Yoncaların (*Medicago sativa* L.) Verim ve Kalitelerinin Belirlenmesi. Türk Doğa ve Fen Dergisi 10(1): 18-24

Çağan E, Aydın A, Başbağ M (2015) Bingöl Üniversitesi yerleşkesinde yer alan bazı baklagil yem bitkilerine ait kalite özelliklerinin belirlenmesi. Türk Tarım ve Doğa Bilimleri Dergisi 2(1): 105-111

Çağan E, Başbağ M, Aydın A (2012) The determination of quality characters of some annual alfalfa species (*Medicago* spp.) collected in natural rangelands in Diyarbakır.Tr. Doğa Fen Derg. 1(1): 34-38

Çaçan E, Kökten K, Kaplan M (2018) Determination of yield and quality characteristics of some alfalfa (*Medicago sativa* L.) cultivars in the East Anatolia Region of Turkey and correlation analysis between these properties. Ecology and Environmental Research 16(2):1185-1198

Cacan E, Kökten K, Seydoşoğlu S (2020) Determining the Performance of Alfalfa Population Collected from a Narrow Agroecological Zone of Turkey 50(11): 1–11

Canbolat Ö, Kara H, Filya İ (2013) Comparison of In vitro Gas Production, Metabolizable Energy, Organic Matter Digestibility and Microbial Protein Production of Some Legume Hays. Uludağ üniversitesi Ziraat Fakültesi Dergisi 27(2): 71-82

Canbolat Ö, Karaman Ş (2009) Comparison of in vitro gas production, organic matter digestibility, relative feed value and metabolizable energy contents of some legume forages. Tarım Bilimleri Dergisi 15(02): 188-196

Carter D, Robbins C, Brown M (1972) Effect of phosphorus fertilization on the selenium concentration in alfalfa (*Medicago sativa* L.) Soil Science Society of America Journal (1): 10-12

Cevheri C, Kuçuk Ç, Avcı M, Atamov V (2013) Element content, botanical composition and nutritional characteristics of natural forage of Sanliurfa, Turkey. Journal of Food, Agriculture and Environment 11(3-4): 790-794

Çinar S (2012) Çukurova taban koşullarında bazı çok yıllık sıcak mevsim buğdaygil yem bitkilerinin yonca (*Medicago sativa* L.) ile uygun karışımlarının belirlenmesi. Çukurova üniversitesi, Adana 75-80

Çinar S, Hatipoğlu R, Gündel FD, Aktas A, Mustafa A (2014) Performances of some perennial warm season grasses alfalfa (*Medicago sativa* L.) mixtures under Mediterranean conditions. Turkish Journal of Field Crops 19(2): 212-218

Colak Esetlili B (2016) Farklı banyeli topraklarda yetistirilen ayçiçeği ve yonca bitkilerinin ağır metal absorpsiyonları. Ege üniversitesi, Ziraat Fakültesi Dergisi 53(3): 333-341

Demir R (2008) Diyarbakir il sinirlari içerisinde yayilis gosteren bazi yonca (*Medicago* L.) turlerinde ağır metal düzeylerinin belirlenmesi. Dicle üniversitesi Ziya Gokalp Eğitim Fakültesi Dergisi (10): 148-154

Demiroğlu G, Avcioglu R (2010) Bazı yeni baklagil yembitkileri çeşitlerinin Akdeniz iklim koşullarındaki performansları üzerinde bir araştırma. Ege üniversitesi Ziraat Fakültesi Dergisi 47(2): 151-159

Demiroğlu G, Geren H, Avcioglu R (2008) Farklı yonca (*Medicago sativa* L.) genotiplerinin Ege Bölgesi koşullarına adaptasyonu. Ege üniversitesi Ziraat Fakültesi Dergisi 45(1): 1-10

Dumlu SE, Çakal S, Aksakal E, Mustafa U, Ozgoz M M, Terzioğlu K, Uysal P, Atici M, Mentese O (2017) Erzurum ekolojik koşullarında yonca (*Medicago sativa* L.) çeşit adayının performansının belirlenmesi. Alinteri Journal of Agriculture Science 32(2): 55-61

Engin B, Mut H (2017) Farklı yonca çeşitlerinin ot verimi ve bazı kalite özelliklerinin belirlenmesi. Yuzuncu Yıl üniversitesi Tarım Bilimleri Dergisi 27(2): 212-219

Erbeyi B (2017) Bursa ekolojik koşullarında bazı yonca (*Medicago sativa* L.) çeşitlerinin ot verimi ve kalite özelliklerinin belirlenmesi, Yüksek Lisans Tezi Bursa 90-92

Eren B (2019) Iğdır ekolojik koşullarında toplanan adi yonca (*Medicago sativa* L.) genotiplerinin bitkisel, verim, kalite ve moleküler karakterizasyon özelliklerinin belirlenmesi, Doktora Tezi, Iğdır Üniversitesi 120-125

Geçit H, Çiftçi C, Emeklier H, İkincikarakaya S, Adak M, Kolsarıcı O, Ekiz H, Altınok S, Sancak C, Sevimay CS, Kendir H (2009) Tarla Bitkileri. Ankara üniversitesi Ziraat Fakültesi Yayınları. Yayın No:1569, Ankara, Ders Kitabı: 521

Geleti D, Hailemariam M, Mengistu A, Tolera A (2014) Biomass yield potential and nutritive value of selected alfalfa (*Medicago sativa* L.) cultivars grown under tepid to cool sub-moist agro-ecology of Ethiopia. Journal of Agricultural Research 4(1): 7-14

Gençkan MS (1992) Yembitkileri tarımı. Ege üniversitesi Ziraat Fakültesi 132-138

Gökalp S, Yazici L, Çankaya N, İspirli K (2017) Bazı yonca (*Medicago sativa* L.) çeşitlerinin tokat-kazova ekolojik koşullarında ot verimi ve kalite performanslarının belirlenmesi. Gaziosmanpaşa üniversitesi Ziraat Fakültesi Dergisi 34(3): 114-127

Gökkaya G (2019) önemli bazı yonca çeşitlerinde (*Medicago sativa* L.) biçim zamanının verim ve kalite özellikleri üzerine etkilerinin saptanması. Yüksek Lisans Tezi, Tekirdağ Namik Kemal Üniversitesi 62-67

Gündel FD, Karadağ Y, Çınar S (2014) Çukurova ekolojik koşullarında bazı sıcak mevsim baklagil yem bitkilerinin verim, kalite ve adaptasyonu üzerine bir araştırma. Gaziosmanpaşa üniversitesi Ziraat Fakültesi Dergisi 31(3): 10-19

Güzel N, Gulut Y, Büyük Y (2002) Toprak Verimliliği ve Gübreler ÇU Ziraat Fak (246)

Gültakti Y (2006) Van Gölü Havzasında Yetiştirilen Bazı Tahıl ve Baklagillerin Ağır Metal İçeriklerinin Araştırılması.Yüzüncü Yıl Üniversitesi Fen Bilimleri Enstitüsü Yüksek Lisans Tezi, Van 95-98

Hansen JM (1988) Agriculture in the prehistoric Aegean: data versus speculation. American Journal of Archaeology 39-52

Harmanlıoğlu Ö (2019) Kayseri koşullarında farklı yonca çeşitlerinin ot verim ve kalitesinin belirlenmesi, Erciyes Üniversitesi Fen Bilimleri Enstitüsü Tarla Bitkileri Anabilim Dalı, Yüksek Lisans Tezi, Kayseri, S. 24-32

Horner JL (1983) Nutritional value of eastern gamagrass hay compared with alfalfa hay. Oklahoma State University

İbrikçi H, Gulut K, Güzel N, Büyük G (1994) Gübrelemede Bitki Analiz Teknikleri. ÇU Ziraat Fak. Genel Yayın (95)

İnal N (2015) Kırşehir koşullarında bazı yonca (*Medicago sativa* L.) çeşitlerinin verim ve kalite özelliklerinin belirlenmesi. Fen Bilimleri Enstitüsü, Tarla Bitkileri Anabilim Dalı, Yüksek Lisans Tezi, Kırşehir 47-50

JMP (2018) Statistical Discovery from SAS, USA

Kacar B, Katkat Y (2006) Bitki Besleme. Nobel Yayın Dağıtım. Ankara 130-137

Karakurt E, Firincioğlu HK (2005) Some Important Properties and Between Relations In Alfalfa (*Medicago sativa* L.) Population Which Are Obtained From Different Researches, Tarla Bitkileri Merkez Araştırma Enstitüsü-Ankara 20-23

Karaman M (2012) Bitki Besleme. Gubretas Rehber Kitaplar Dizisi: 2. Editor: Zengin, M., Toprak ve Bitki Analiz Sonuçlarının Yorumlanmasında Temel İlkeler (Bolum 12), S. 874

Karaman MR, Sahin S, Coban S, Sert T (2006) Spatial Variability of P/Zn Ratios on Calcareous Soil Under. Asian Journal of Chemistry Vol 18(3): 2067-2073

Kavut YT, Çelen AE, Topçu GD, Behçet K.(2014) Bazı yonca (*Medicago sativa* L.) genotiplerinin farklı lokasyonlardaki verim ve verim özellikleri üzerinde bir araştırma.Ege Üniversitesi Ziraat Fakültesi Dergisi 51(1): 23-29

Kır B (2006) Kimi yonca çeşitlerinde tohum ve otverimi ile kalite özellikleri üzerinde bir araştırma. Doktora Tezi, Ege Üniversitesi, Bornova-İzmir 80-85

Kır B, Soya H (2008) Kimi mera tipi yonca çeşitlerinin bazı verim ve kalite özellikleri üzerinde bir araştırma. Ege Üniversitesi Ziraat Fakültesi Dergisi 45(1): 11-19

Kır B, Karadağ Y (2010) Tokat-Kazova Şartlarında Bazı Yonca Çeşitlerinin Performanslarının Belirlenmesi. Yüksek Lisans Tezi, Tokat Üniversitesi 67-68

Kiraz AB (2011) Determination of relative feed value of some legume hays harvested at flowering stage. Asian Journal of Animal and Veterinary Advances 6(5): 525-530

Kökten K, Çınar S, Hatipoğlu R (2011) Research on the Forage Yields and Forage Qualities of some perennial Grasses and Legumes under irrigated Conditions of Çukurova Region, Türkiye IX. Tarla Bitkileri Kongresi, Bursa 53-54

Kuşvuran A, Tansı V, Sağlamtimur T (2005) Determination of Adaptation of Alfalfa (*Medicago sativa* L.) and Some Grasses Under The Irrigated Conditions of Turkish Republic of Northern Cyprus, Türkiye VI. Tarla Bitkileri Kongresi, Antalya 82-85

Marinova DH, Ivanova II, Zhekova ED (2018) Evaluation of Romanian alfalfa varieties under the agro-environmental conditions in northern Bulgaria. Banat's Journal of Biotechnology 9(18): 11-13

Marschner, H. (2008) Mineral nutrition of higher plants. Digital Print, Academic Press 87-93

Mengel K, Kirkby E, Kosegarten H, Appel T (2001) Principles of plant nutrition. Kluwer Academic Publishers: Dordrecht, The Netherlands 145-152

Mohammed AS (2008) Farklı lokasyonlarda bazı yonca çeşitlerinin yem verimleri ve bitkisel özellikleri, Yüksek Lisans Tezi, Ankara Üniversitesi Fen Bilimleri Enstitüsü Tarla Bitkileri Anabilim Dalı, S.55

Morrison J (2003) Hay and Pasture Management, Chapter 8.Extension Educator, Crop Systems Rockford Extension Center 81-90

Orman S, Ok H, Kaplan M (2014) Application of Sewage Sludge for Growing Alfalfa, Its Effects on the Macro-Micronutrient Concentration, Heavy Metal Accumulation, and Translocation. *Ekoloji Dergisi* 23(90): 10-19

Owusu-Sekyere A, Kontturi J, Hajiboland R, Rahmat S, Aliasgharzad N, Hartikainen H, Seppänen MM (2013) Influence of selenium (Se) on carbohydrate metabolism, nodulation and growth in alfalfa (*Medicago sativa* L.) 373(1): 541-552

Owen Plank C, Kissel E (1992) Plant Analysis Handbook for Georgia, The Georgia Agricultural Experiment Stations College of Agricultural and Environmental Sciences, The university of Georgia, Southern Cooperative Series Bulletin 368

Öten M , Albayrak S (2016) Molecular Characterization of Alfalfa (*Medicago sativa* L.) Populations Collected From West Mediterranean Coastal Zone. Süleyman Demirel Üniversitesi Fen Bilimleri Enstitüsü Dergisi Cilt 20, 220-225

Özkose A (2018) Effect of environment× cultivar interaction on protein and mineral contents of Alfalfa (*Medicago sativa* L.) in Central Anatolia, Turkey. *Sains Malaysiana* 47(3): 551-562

Pirhofer-Walzl K, Søgaard K, Høgh-Jensen H, Eriksen J, Sanderson M, Rasmussen J, Rasmussen G (2011) Forage herbs improve mineral composition of grassland herbage 66(3): 415-423

Pop I, Radu-Rusu CG, Simeanu D, Albu A, Popa V (2010) Characterization of the nutritional value of alfalfa harvested at different stages of vegetation using cell walls content based methods. *Lucrări Stiințifice-Seria Zootehnie* 53: 350-354

Read JJ, Reddy KR, Jenkins J (2006) Yield and fiber quality of upland cotton as influenced by nitrogen and potassium nutrition. *European Journal of Agronomy* 24(3): 282-290

Rezaeian M, Moghadam MT, Kiaei MM, Zadeh HM (2020) The effect of heavy metals on the nutritional value of alfalfa: comparison of nutrients and heavy metals of alfalfa (*Medicago sativa*) in industrial and non-industrial areas. 36(2): 183-193

Sallah-Ud-Din R, Farid M, Saeed R, Ali S, Rizwan M, Tauqeer HM, Bukhari S (2017) Citric acid enhanced the antioxidant defense system and chromium uptake by *Lemna minor* L. grown in hydroponics under Cr stress. 24(21): 17669-17678

Saruhan V, Kuşvuran A (2011) Güneydoğu Anadolu Bölgesi koşullarında bazı yonca (*Medicago sativa* L.) çeşitleri ve genotiplerinin verim performanslarının belirlenmesi. *Ege üniversitesi Ziraat Fakültesi Dergisi* 48(2): 133-140

Sayar MS (2017) Ülkemiz ve bölgemizdeki yem bitkisi tarımına genel bir bakış. *Diyarbakır Tarım Dergisi* 28: 30-34

Sayar MS, Anlarsal M, Başbağ M (2010) Güneydoğu Anadolu Bölgesinde Yem Bitkileri Tarımının Mevcut Durumu sorunları ve Çözüm önerileri. 14(2): 59-67

Sayar MS, Han Y, Başbağ M, Gul İ, Polat T (2015) Rangeland improvement and management studies in the Southeastern Anatolia Region of Turkey. *Pakistan Journal of Agricultural Sciences* 52(1): 9-18

Sayar MS, Yavuz H, Yolcu H, Yücel H (2014) Yield and quality traits of some perennial forages as both sole crops and intercropping mixtures under irrigated conditions. *Turkish Journal of Field Crops* 19(1): 59-65

Scholtz G, Van der Merwe H, Tylutki T (2009) The nutritive value of South African *Medicago sativa* L. hay. *South African Journal of Animal Science* 39(1): 179-182

Şeker H (2003) Bazı yeni yonca çeşitlerinin Erzurum ekolojik şartlarına uyum ve verim denemesi. *Atatürk üniversitesi Ziraat Fakültesi Dergisi* 34(3): 217-221

Şengul S, Tahtacıoğlu L, Mermer A. (2003) Doğu Anadolu bölgesi şartlarına uygun yonca (*Medicago sativa* L.) çeşit ve hatlarının belirlenmesi. *Atatürk Üniversitesi Ziraat Fakültesi Dergisi* 34(4): 321-325

Serin Y, Tan M (2001) Forage Legumes. Ataturk University, Faculty of Agriculture Publication No.190, Erzurum, Turkey

Sevimay CS (1992) Ankara Koşullarında Elçi Yonca Klonlarının Tohum Teşekkülü ve Seçilen Klonların İleriki Döllerinde Yeşil Yem Üretimine Etki Eden Faktörler. Fen Bilimleri Enstitüsü, Doktora Tezi, Ankara 83-85

Skládanka J, Doležal P, Nedělník J, Moravcová H, Poštulka , Vyskočil I (2014) Influence of species and preservations on the quality and safety of grass silages 58: 38-40

Smith D (1969) Influence of Temperature on the Yield and Chemical Composition of 'Vernal' Alfalfa at First Flower. Agronomy Journal 61(3): 470-472

Soya H (1997) Türkiye'nin doğal yem kaynakları. Hayvansal Uretim Dergisi 37: 84-93

Soya H, Avcıoğlu R, Geren H (1997) Yembitkileri, Hasad Yayıncılık Ltd. 153-160

Soya H, Kavut Y, Avcıoğlu R (2005) Bornova-İzmir Koşullarında Ekim Yonca (*Medicago sativa* L.) Çesitlerinin Performansları üzerinde Araştırmalar. Tarla Bitkileri Kongresi, S. 5-9

Tamkoç A (1992) Kayseri yoncasından seçme elçi klonlarının Konya şartlarında diğer varyetelerle karşılaştırılması. Doktora Tezi, Selçuk üniversitesi Fen Bilimleri Enstitüsü, Konya S. 66-68

Taşkın E, Sevimay C (2012) Effects of gypsum application and mixture rates on forage yields of alfalfa (*Medicago sativa* L.) and smooth brome (*Bromus inermis* Leyss). KSU Doğa Bilimleri Dergisi 15(1): 59-61

Töngel MO, Ayan I (2010) Nutritional contents and yield performances of Lucerne (*Medicago sativa* L.) cultivars in Southern Black Sea shores. Journal of Animal and Veterinary Advances 9(15): 2067-2073

Tosun F, Manga İ, Altın M (1979) Erzurum ekolojik şartlarında bazı önemli yonca varyetelerinin adaptasyon ve verim denemeleri. Ataturk Üniversitesi Ziraat Fakültesi Dergisi 10(3-4)

Turan N, Çelen AS (2010). Bazı Yonca (*Medicago sativa* L.) Çesitlerinin Farklı Ekim Zamanlarında Verim ve Verim Unsurlarının Belirlenmesi üzerinde Bir Araştırma. Doktora Tezi, Yüzüncü yıl üniversitesi, Van 56-58

Ünal S, Mutlu Z, Fırıncıoğlu H (2012) A study on some phenologic, morphologic and agronomic characters of Hungarian Alfalfa (*Medicago sativa* L.) entries in The Central Anatolian highlands of Turkey. Journal of Field Crops Central Research Institute, Ankara, (21): 32-38

Wilczek M, Cwintal M (1996) Wplyw nawozenia [P, K] i liczby pokosow na zawartosc Mn, Cu i Zn w tetraploidalnej koniczynie czerwonej 434(1): 145-149

Yerli C , Çakmakci T , Sahin U, Tufenkçi S (2020) Ağır metallerin toprak, bitki, su ve insan sağlığına etkileri. Turk Doğa ve Fen Dergisi, 9: 103-114

Yeşil M, Şengul S (2009) Türkiye'nin değişik yorelerinden toplanan yonca ekotiplerinin bazı morfolojik özelliklerinin belirlenmesi üzerine bir araştırma. Alinteri Journal of Agriculture Science 16(1): 1-6

Yılmaz M (2011) Isparta Ekolojik Koşullarında Bazı Yonca (*Medicago sativa* L.) Çesitlerinin Ot ve Verim Kalitelerinin Belirlenmesi. S.D.U. Fen Bilimleri Enstitüsü Tarla Bitkileri Anabilim Dalı Yüksek Lisans Tezi, Isparta 73-75

Yılmaz M, Albayrak S (2016) Isparta ekolojik koşullarında bazı yonca (*Medicago sativa* L.) çesitlerinin ot verim ve kalitelerinin belirlenmesi. Tarla Bitkileri Merkez Araştırma Enstitüsü Dergisi 42-47

Yılmaz M, İnal İ, Kara R, Dalkılıç Y, Avcı M (2015) Kahramanmaraş Şartlarında Farklı Ekim Sıklıklarının Yoncada (*Medicago sativa* L.) Ot ve Tohum Verimi üzerine Etkileri. 11. Tarla Bitkileri Kongresi 2: 103-106

Yucel H, Avcı M, Çınar S, Aktas AF, Kokasık D (2013) Farklı yonca (*Medicago sativa* L.) çesitlerinin verim ve kalite özelliklerinin belirlenmesi. IX. Türkiye Tarla Bitkileri Kongresi Bursa, 12-15 Eylül 2011

Yuksel O, Albayrak S, Mevlut T, Sevimay C (2016) Dry matter yields and some quality features of alfalfa (*Medicago sativa* L.) cultivars under two different locations of Turkey. Suleyman Demirel Üniversitesi Fen Bilimleri Enstitüsü Dergisi 20(2)

Zang, WM, Wang CZ , Yang R (2005) Production performance of different lucerne varieties in China. New Zealand Journal of agricultural research 48(4): 481-488



