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Research Article

# Effects of Different Mixture Rate of Common Vetch (*Vicia Sativa* L.) and Ryegrass (*Lolium Multiflorum* l.) on Quality

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## ABSTRACT

This research was established in order to determine the quality characteristics of common vetch and ryegrass by testing different mixture ratios in different locations and to measure the effects of mixing ratios. Aneto common vetch and Trinova ryegrass cultivars were used in the trials. The experiment was carried out in the locations of Manisa/Beydere and Ankara/Yenikent in the vegetation period of 2021-2022 according to the randomized blocks trial design.

The highest crude protein ratio was obtained from the 100% V mixture with a value of 20.4% from the Manisa location. The lowest crude protein ratio was obtained from the Ankara location with a value of 11.1% from the 100% G mixture.

As a result of this study, it was found that the legume and grass forage crops planted as a mixture were better for interrestrial and coastal regions in terms of quality compared to pure stand growing. In fact, it has been determined that forage crops planted as a mixture are more advantageous in terms of quality since they are more resistant to lodging than pure legume stands.

**Keywords:** Common vetch, ryegrass, crude protein, dry matter, ADF, NDF.

## 1. INTRODUCTION

Turkey has a high population growth rate, averaging 2.5% per year. However, the country faces a growing challenge of providing adequate and balanced nutrition. Compared to other developed countries, per capita animal protein consumption in Turkish households is quite low. Therefore, it is important to address this issue and increase animal protein consumption in Turkey. It is widely recognized that protein is crucial for human health, and the majority of protein needs should be met through animal proteins. In our country, meat is the primary source of animal protein, followed by animal products such as cheese and eggs. It is important to note that meat production has decreased to approximately 20 kg per person per year, despite being the leading animal product, due to the increasing population. Animal protein production has decreased due to the inability to fully meet the animals' need for quality roughage. This is a result of insufficient supply.

Based on 2018 data should be given, the amount of quality roughage required for the 19 million cattle in the country was 86 million tons, while hay production was only 31 million tons. This means that only 35.7% of the demand for quality roughage must be given. Turkey has a rich vegetation cover that allows for the growth of many fodder crops. Pasture areas can be made more productive through proper and appropriate planting. Turkey's climatic

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conditions are suitable for cultivating a variety of fodder plant species as main, second, or even third crops. The cultivation area of fodder crops in Turkey increased by 32% over the course of 10 years, from 1.48 million hectares in 2009 to 1.96 million hectares in 2018. The most significant increase occurred between 2011 and 2012[1].

Planting a mixture of fodder crops can solve the lodging issue in leguminous plants and increase the feed and quality values of wheatgrasses[2]. To ensure high yield and quality of the plants grown as a mixture, correct mowing times should be adjusted[3,1,4].

When vetch is grown as a mixture with wheat forage crops, the planting rates of the species in the mixture are crucial. In regions with mild winters, vetch develops quickly and can suppress wheatgrass, leading to lodging, difficult mowing, and decreased grass quality. In regions with cold winters, wheatgrass develops better and can suppress vetch. Under these conditions, the grass produces a high yield of dry matter but a low yield of protein[5].

Common vetch has been cultivated in Turkey for a long time. It is grown for winter in coastal areas and is mainly used for hay production. Recently, fodder pea cultivation has become increasingly popular and its production has almost matched that of common vetch. However, the production of annual grass is also increasing day by day. One-year grass has a high yield rate in one-year forage crops and has more varieties than other forage crops. When sown as a mixture with winter legume forage crops grown in the same season, it is possible to obtain high-quality and efficient hay for animal feed.

The aim of this study was to investigate methods for obtaining higher quality hay from mixtures of annual grass and common vetch species, and to determine the optimal mixture ratio with the best quality values under different ecological conditions.

## 2. MATERIALS AND METHODS

The study was carried out during the 2021-2022 vegetation period in the locations of Manisa/Beydere and Ankara/Yenikent, using Aneto common vetch (*Vicia sativa* L.) and Trinova (*Lolium multiflorum* L.) annual grass as plant material.

The study examined the growth of different grass and vetch combinations, including 100% Annual ryegrass, 100% Common Vetch, and various ratios of Common Vetch and Annual ryegrass. The ratios tested were 10/90, 20/80, 30/70, 40/60, and 50/50. No new content has been added to the original text. Different sowing systems were applied, consisting of pure and mixed ratios of common vetch and annual ryegrass species. The ratios used were: 60% common vetch and 40% annual ryegrass, 70% common vetch and 30% annual ryegrass, 80% common vetch and 20% annual ryegrass, and 90% common vetch and 10% annual ryegrass.

Based on the climate data provided by the General Directorate of Meteorology, the long-term average temperature in Ankara was 7.8 °C, while in Manisa it was 12.3 °C. The average precipitation in Ankara was 39.0 mm, whereas in Manisa it was 86.1 mm.

The study was conducted in Ankara/Yenikent and Manisa/Beydere locations using a randomized block design with 3 replications. On October 21, 2021, the species and mixtures were sown using a trial seeder with a row spacing of 25 cm and 6 rows in each plot. Fertilizer was applied at a rate of 3-4 kg $da^{-1}$ N and 8-10 kg $da^{-1}$ P2O5 as specified in the technical instructions of TTSM, 2022. The plot size was 5 m x 1.5 m (7.5 $m^2$), and there were a total of 33 plots (11 treatments x 3 replications). Weeds were controlled manually using a hoe during the spring. Harvesting times were determined based on the common vetch, and the plants in each plot were harvested when the lower pods were fully formed and the seeds were plump.

The study determined the Crude Protein Ratio (%) as HP, which is the sum of nitrogenous substances in the feed, including real protein and nitrogenous substances such as ammonia, amino acids, and nitrates. HP is obtained by multiplying the nitrogen found by the Kjeldahl method in the chemical analysis of feeds by a factor of 6.25. ADF (Acid Insoluble Fiber) Ratio (%): The ADF chemical (Ankom) used in acid detergent fiber determination contains ethyltrimethylammonium bromide (CTAB, CI9H42BrN). The solution was dissolved in distilled water and 1 N sulfuric acid (H2SO4) was added, giving it an acidic property. This solution was then used to determine the total cellulose and lignin values in plant products. NDF Ratio (%): This section reports the percentage of Neutral Insoluble Fiber (NDF) in the dry content of the NDF chemical (Ankom) used for neutral detergent fiber determination. The chemicals used in this process include sodium dodecyl sulfate (C12H25NaO4S), Ethylenediamine tetraacetic acid (EDTA), disodium borate (Na2B4O4), and sodium hydrogen phosphate (Na2HPO4). The sample was dissolved in pure water and then triethylene glycol was added. The addition of disodium borate resulted in a neutral solution. Total cellulose, lignin, and hemicellulose values were determined

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through analysis. The dry matter ratio, which refers to the remaining content after removing all water, was also calculated. When referring to a feed, the term KM (dry matter) ratio indicates the percentage of dry matter it contains. To determine the dry matter ratio, the feed is dried at 70°C for 48 hours and weighed before and after. The difference between the two weights provides the amount of dry matter in kilograms. The values for crude protein, acid detergent cellulose (ADF), neutral detergent cellulose (NDF), and dry matter were obtained using a near-infrared (NIR) spectrophotometer.

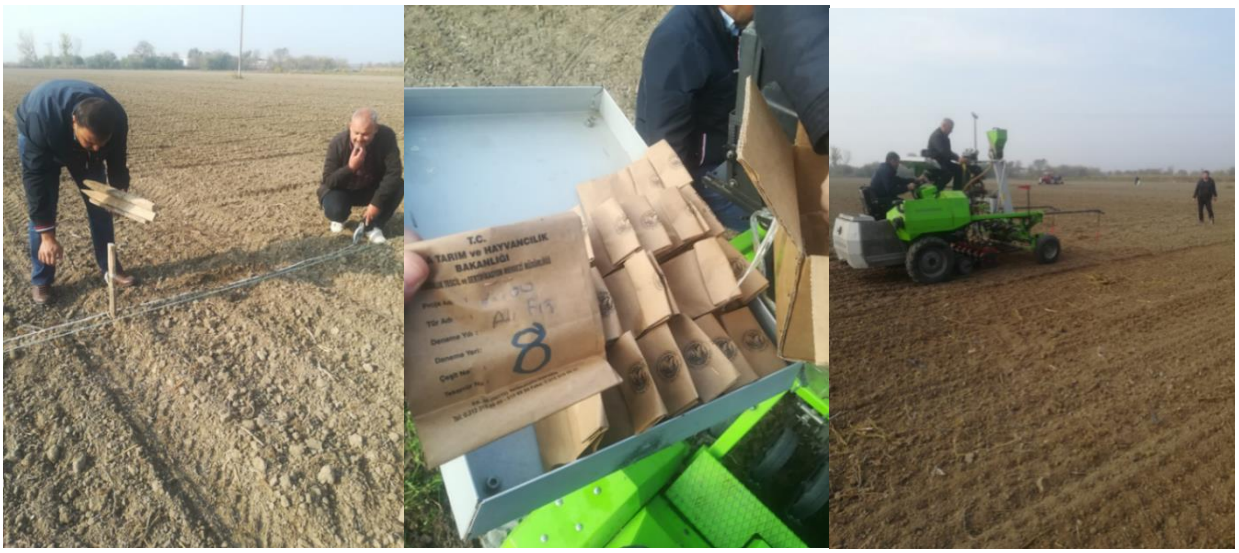

**Figure 1**. Field parcelization and sowing procedures.

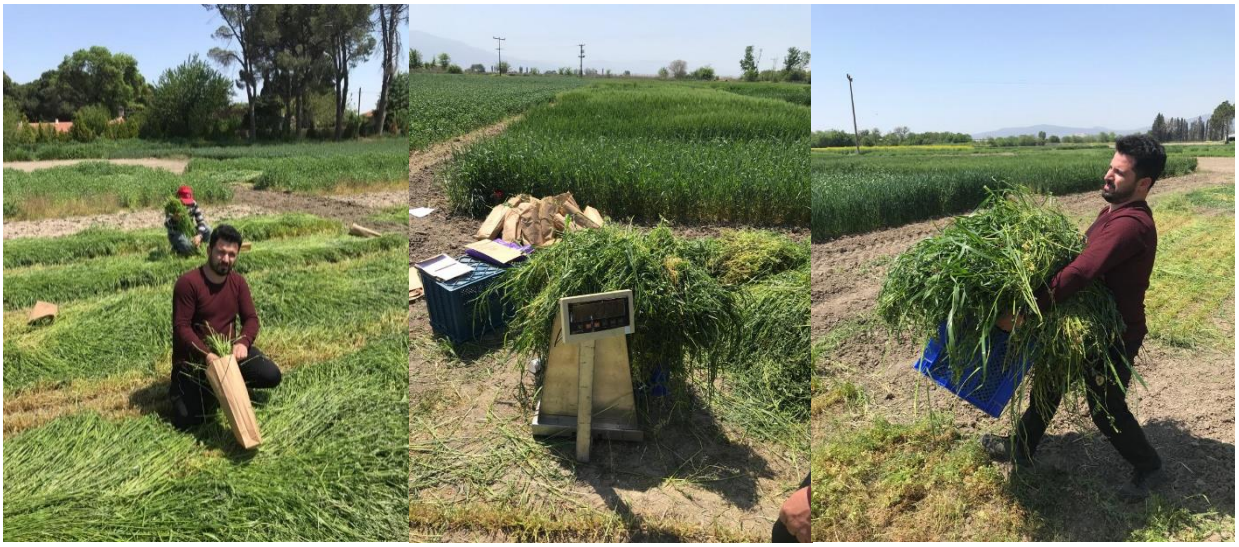

**Figure 2.** Harvesting, weighing and dry herbage sampling.

## 2.1.Statistical Analysis

The research data underwent analysis of variance using the coincidence blocks experimental design in the MSTAT-Cpaket program. To compare statistically significant averages, the Duncan multiple comparison test was employed.

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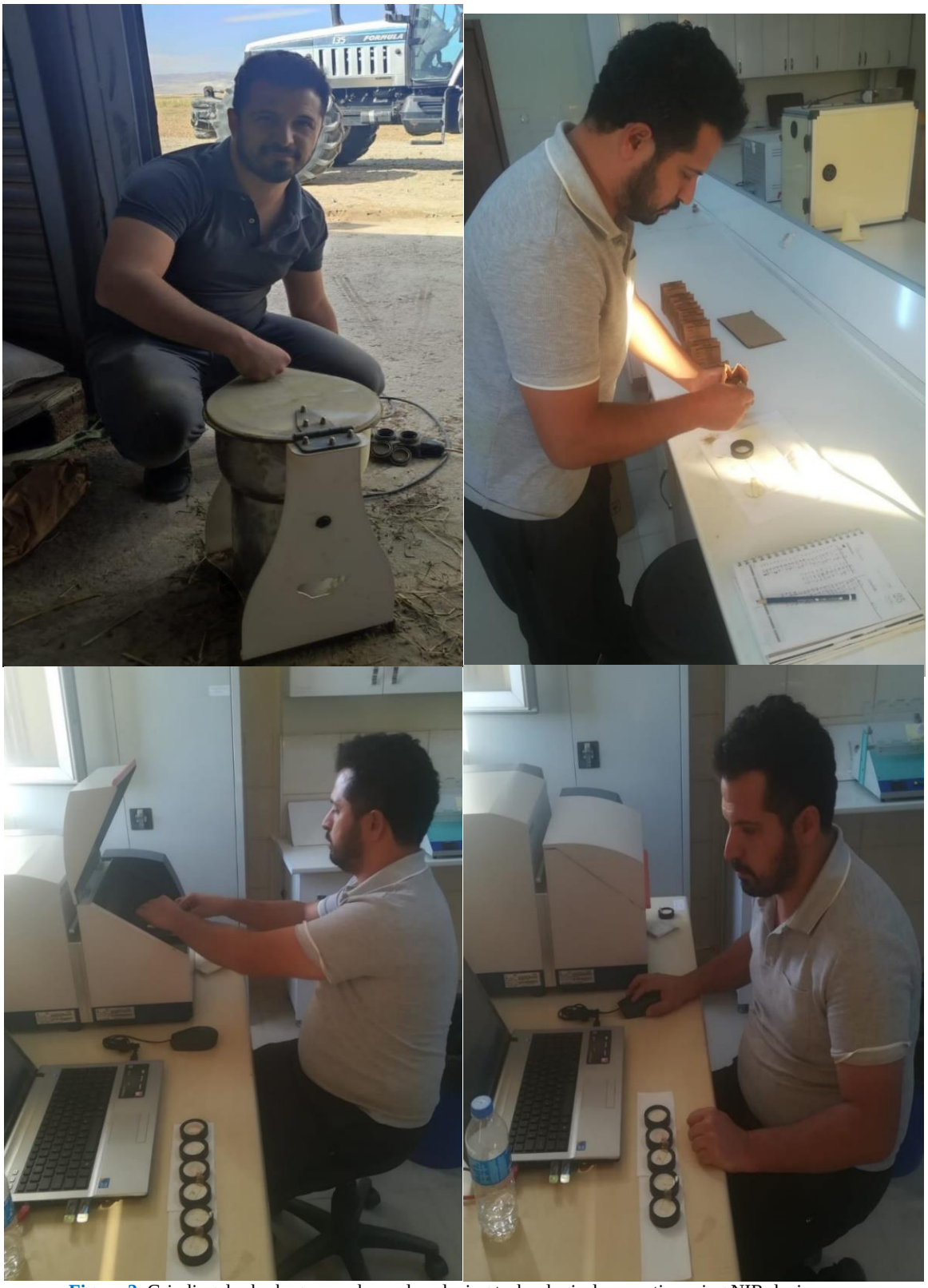

**Figure 3.** Grinding dry herbage samples and analyzing technological properties using NIR device.

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## 3. RESULTS AND DISCUSSION

### 3.1 Crude Protein Rate (%)

Crude protein analyses were conducted on common vetch and annual grass hay samples obtained from Ankara/Yenikent and Manisa/Beydere locations using the NIR device. The hay samples were ground separately for each replicate. The average values obtained for lean sowing and mixtures are presented in Table 1. Upon analyzing Table 1, a statistically significant difference of 0.01% was observed between the mean values of crude protein ratios of common vetch and annual grass obtained from Ankara/Yenikent and Manisa/Beydere locations. Furthermore, a statistically significant difference of 0.01% was found between the mean values of crude protein ratios in common vetch and annual grass lean and mixture sowing application in terms of location mean values.
Upon analyzing the data for crude protein ratios, it was observed that the mixture containing 100% V had the highest crude protein ratio at 19.30% in the Ankara/Yenikent location. Conversely, the mixture containing 100% G had the lowest crude protein ratio at 11.14%. In the Manisa/Beydere location, the mixture containing 100% V had the highest crude protein ratio at 20.44%, while the mixture containing 100% G had the lowest crude protein ratio at 10.78%.

Upon analyzing the crude protein ratio data from the combined locations, it was found that the mixture with the highest crude protein ratio was the 100% V mixture, with a ratio of 19.87%. Conversely, the 100% G mixture had the lowest crude protein ratio at 10.95% and ranked last. This finding is consistent with the results reported[6], who found an average crude protein rate of 26.30% kg $ha^{-1}$ in common vetch trials planted under irrigated conditions in Erzurum. Tükel and Yılmaz[7] found that the highest protein yield in legume and wheatgrass mixture ratios under Çukurova conditions was obtained from a 75% vetch + 25% barley mixture, with a yield of 48.24 kg $ha^{-1}$. Similarly, Bayram[8] reported that the highest crude protein yield under Bursa conditions was obtained from a 50% oat + 50% common vetch mixture ratio, with a yield of 121.8 kg $ha^{-1}$.

**Tablo 1.** Crude protein ratio values (%) for common vetch and annual grass mixtures in 2021-2022.

| Planting Systems | Ankara/Yenikent | Manisa/Beydere | General Average |
|---|---|---|---|
| **%100 G** | 11.1 g | 10.8 f | 11.0 f |
| **%100 V** | 19.3 a | 20.4 a | 19.9 a |
| **%90 V/ %10 G** | 16.6 b | 18.0 b | 17.3 b |
| **%80 V/ %20 G** | 15.4 bc | 15.4 c | 15.4 c |
| **%70 V /%30 G** | 14.9 cd | 15.3 c | 15.1 cd |
| **%60 V /%40 G** | 15.4 bc | 15.1 c | 15.2 cd |
| **%50 V/ %50 G** | 14.3 cd | 14.4 dc | 14.4 cd |
| **%40 V/ %60 G** | 12.6 efg | 12.1 fe | 12.3 f |
| **%30 V/ %70 G** | 14.1 cde | 14.8 c | 14.5 cd |
| **%20 V/ %80 G** | 13.5 def | 14.3 cde | 13.9 d |
| **%10 V /%90 G** | 12.3 fg | 12.4 def | 12.3 e |
| **FCV (%)** | ** | ** | ** |
| **LSD** | **6.2** **1.53** | **9.2** **2.32** | **7.9** **1.34** |

### 3.2. ADF (Acid Detergent Cellulose) Rate (%)

ADF (Acid Detergent Cellulose) is cellulose that is insoluble in acid detergent. It contains both cellulose and lignin, with ligninized parts having low digestibility rates. It is important to note that ADF is inversely proportional to digestibility. The digestibility of roughage and concentrate feeds decreases as the amount of ADF increases.

The ADF (Acid Detergent Cellulose) analyses for common vetch and annual grass were obtained by grinding hay samples separately from each replicate from Ankara/Yenikent and Manisa/Beydere locations in an NIR device.

The average ADF values are presented in Table 2. Upon examining Table 2, a statistically significant difference of 0.01% is observed between the mean values of ADF (Acid Detergent Cellulose) ratio in Ankara/Yenikent, Manisa/Beydere locations and location averages in common vetch and annual grass lean and mixture sowing practice.

Upon analyzing the mean values of the Acid Detergent Cellulose (ADF) ratio, it was found that the mixture with the highest ADF ratio in Ankara/Yenikent location was the 40% V/60% G mixture, with a ratio of 38.4%. Conversely, the mixture with the lowest ADF ratio was the 90% V/10% G mixture, with a ratio of 33.4%. In the Beydere location of Manisa, the mixture of 80% V and 20% G had the highest ADF (Acid Detergent Cellulose) ratio at 41.4%, while the mixture of 10% V and 90% G had the lowest ADF ratio at 35.2%.

Upon analyzing the data from the combined locations, it was found that the mixture of 80% V/20% G had the highest ADF (Acid Detergent Cellulose) rate at 38.7%, while the mixture of 90% V/10% G had the lowest ADF rate at 35.2% and ranked last.

Kuşvuran et al.[9] conducted experiments to determine row spacing and grass mixture ratios using Hungarian vetch and annual grass species. They reported ADF values of 35% for Hungarian vetch, 39.7% for annual grass and 36.7-38.5% for the mixtures. These findings are consistent with our own.

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**Tablo 2.** ADF results of common vetch and annual grass mixtures in 2021-2022.

| Planting Systems | Ankara/Yenikent | Manisa/Beydere | General Average |
|---|---|---|---|
| **%100 G** | 35.4 a-d | 38.8 ab | 37.8 abc |
| **%100 V** | 37.4 ab | 38.1 bc | 37.1 a-d |
| **%90 V/ %10 G** | 33.4 d | 37.0 bcd | 35.2 d |
| **%80 V/ %20 G** | 36.1 a-d | 41.4 a | 38.7 a |
| **%70 V /%30 G** | 33.7 d | 38.8 ab | 36.2 cd |
| **%60 V /%40 G** | 35.2 bcd | 38.1 bc | 36.7 bcd |
| **%50 V/ %50 G** | 33.7 cd | 37.9 bc | 35.8 cd |
| **%40 V/ %60 G** | 38.4 a | 38.5 b | 38.4 ab |
| **%30 V/ %70 G** | 35.3 bcd | 35.5 cd | 35.4 d |
| **%20 V/ %80 G** | 36.3 a-d | 36.5 bcd | 36.4 cd |
| **%10 V /%90 G** | 36.7 abc | 35.2 d | 35.9 cd |
| **FCV (%)** | * | ** | ** |
| **LSD** | **4.9** | **4.1** | **4.5** |
| | **2.97** | **2.66** | **1.93** |

### 3.3. NDF (Neutral Detergent Cellulose) Ratio (%)

Neutral Detergent Cellulose (NDF) is a component of the plant wall that is partially digestible. It contains cellulose, hemicellulose, and lignin, and is insoluble in neutral detergent. It contains cellulose, hemicellulose, and lignin, and is insoluble in neutral detergent. Dry matter consumption is inversely proportional to the NDF ratio, meaning that an increase in NDF ratio results in a decrease in dry matter consumption.

Table 3 presents the average NDF (Neutral Detergent Cellulose) values obtained from grinding the dry samples of common vetch and annual grass taken separately from each replication at Ankara/Yenikent and Manisa/Beydere locations and analyzing them using an NIR device.

Upon examining Table 3, a statistically significant difference of 0.01% is observed between the average NDF (Neutral Detergent Cellulose) ratio values in Ankara/Yenikent and Manisa/Beydere locations, and the location average values in common vetch and annual grass plain and mixture sowing applications. Upon examining the NDF (Neutral Detergent Cellulose) analysis data, it was found that the 80% V / 20% G mixture in the Ankara/Yenikent location had the highest NDF ratio at 62.1%, while the 60% V / 40% G mixture had the lowest at 47.3%. It is evident that the mixture with the highest NDF ratio is the 80% V / 20% G mixture. In the Manisa/Beydere location, the NDF (Neutral Detergent Cellulose) rate was highest for the 100% G mixture at 66.98%, and lowest for the 100% V mixture at 52.7%.

Upon examination of the combined location data, it was found that the mixture containing 80% V and 20% G had the highest NDF (Neutral Detergent Cellulose) rate at 64.0%, while the mixture containing 60% V and 40% G had the lowest NDF rate at 53.8%. It is important to note that this was a mixture and it ranked last in terms of NDF rate.

Similar to Kuşvuran et al.'s[9] study, our experiments aimed to determine row spacing and grass mixture ratios using Hungarian vetch and annual grass species. The NDF values were found to be 52.5% for Hungarian vetch, 60.68% for annual grass, and 53.7-55.9% for the mixtures.

**Tablo 3.** NDF ratio values (%) of common vetch and annual grass mixtures in 2021-2022.

| Planting Systems | Ankara/Yenikent | Manisa/Beydere | General Average |
|---|---|---|---|
| **%100 G** | 52.8 e | 67.0 a | 59.9 bc |
| **%100 V** | 58.3 a-d | 52.7 f | 55.5 de |
| **%90 V/ %10 G** | 56.2 b-e | 56.2 ef | 56.2 de |
| **%80 V/ %20 G** | 62.1 a | 66.0 ab | 64.1 a |
| **%70 V /%30 G** | 53.6 cd | 61.6 bcd | 57.6 cd |
| **%60 V /%40 G** | 47.3 f | 60.3 cde | 53.8 e |
| **%50 V/ %50 G** | 53.7 de | 60.9 cde | 57.3 cd |
| **%40 V/ %60 G** | 60.6 a | 65.2 abc | 62.9 ab |
| **%30 V/ %70 G** | 55.3 cde | 57.3 def | 56.3 de |
| **%20 V/ %80 G** | 60.3 abc | 59.6 de | 60.0 bc |
| **%10 V /%90 G** | 57.7 a-e | 59.5 de | 58.6 cd |
| **FCV (%)** | ** | ** | ** |
| **LSD** | **5.4** | **4.8** | **5.1** |
| | **5.11** | **4.99** | **3.46** |

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### 3. 4. Dry Matter (%)

Dry matter analyses were conducted on common vetch and annual grass samples. The grass samples were ground and analyzed separately from each replication from Ankara/Yenikent and Manisa/Beydere locations using the NIR device. The average dry matter values are presented in Table 4.

Upon examination of Table 4, a statistically significant difference of 0.01% was found between the average values obtained from Ankara/Yenikent location. In the locations of Manisa/Beydere and their respective averages, the difference between the average values of the dry matter ratio in common vetch and annual grass plain and mixture sowing applications was found to be statistically insignificant.

Upon examining the dry matter analysis data, it was found that in the Ankara/Yenikent location, the 100% G mixture had the highest dry matter ratio at 90.7%, while the 100% V mixture had the lowest dry matter ratio at 89.6%. In the Beydere location of Manisa, the mixture of 80% V and 20% G had the highest dry matter ratio at 88.0%, while the mixture of 70% V and 30% G had the lowest dry matter ratio at 86.1%.

Upon examining the data from all locations, the mixture of 20% V and 80% G had the highest dry matter ratio at 89.1%, while the mixture of 100% V had the least dry matter ratio at 88.1% and ranked last.

**Tablo 4.** Dry matter ratio values (%) of common vetch and annual grass mixtures in 2021-2022.

| Planting Systems | Ankara/ Yenikent | Manisa/ Beydere | General Average |
|---|---|---|---|
| **%100 G** | 90.7 a | 87.0 | 88.8 |
| **%100 V** | 89.6 d | 86.6 | 88.1 |
| **%90 V/ %10 G** | 90.2 c | 87.4 | 88.8 |
| **%80 V/ %20 G** | 90.3 bc | 88.0 | 89.1 |
| **%70 V /%30 G** | 90.5 abc | 86.1 | 88.3 |
| **%60 V /%40 G** | 90.5 abc | 87.2 | 88.8 |
| **%50 V/ %50 G** | 90.5 abc | 86.5 | 88.5 |
| **%40 V/ %60 G** | 90.6 ab | 87.4 | 89.0 |
| **%30 V/ %70 G** | 90.3 abc | 86.3 | 88.3 |
| **%20 V/ %80 G** | 90.4 abc | 87.8 | 89.1 |
| **%10 V /%90 G** | 90.5 abc | 87.4 | 88.9 |
| **FCV (%)** | ** | N.S | ** |
| **LSD** | 0.2 | 1.7 | 1.2 |
| | 0.34 | - | - |

## 4.CONCLUSION

The objective of this study was to determine the yield and quality characteristics of mixtures of annual grass and common vetch in different proportions under ecological conditions in Ankara/Yenikent and Manisa/Beydere. The study was conducted for one year during the 2021-2022 vegetation periods.

The study concluded that common vetch, a legume forage plant, has a higher protein yield than annual grass, a grassy forage plant. It also suggests that animal rations should include both legume and grassy forage plants.

Based on the combined analysis results, it has been determined that a mixture of 90% common vetch and 10% annual grass is the most advantageous forage plant combination. It is recommended to plant forage plants as a mixture rather than plain plantings.

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## Authors' Contributions

This research is Hüseyin Çağlar's master thesis work. Serap Kızıl Aydemir also served as a consultant in this research.

## Conflict of interests

*I declares that there is no a conflict of interest with any institute, person, company, etc.*

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