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Research article

Botanical composition of pastures with different plant densities

Fikret Saygin, Kagan Kokten*, Tolga Karakoy, Muhammed Tatar, Meliha Feryal Sarikaya, Ilker Yuce and Guneren Cicek

Sivas University of Science and Technology, Sivas-58000, Turkiye
*Corresponding author email: kahafe1974@yahoo.com

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Abstract

The study was carried out in the Aciyurt pasture of Ulas district of Sivas province in the Central Anatolia region of Turkey to determine the area covered with plants, botanical composition and frequency values of plants in pastures with different plant densities. NDVI data was created using 10 m resolution Sentinel 2A satellite images of April and May 2021 and 4 different vegetation densities (very high, high, medium and very low) were determined. The proportions of the area covered with herbs, grasses, legumes and other family plants, and the proportions of grasses, legumes and other family plants in the covered area varied 57.2-96.9, 16.7-42.4, 4.0-21.3, 33.2-50.8, 29.4-43.9, 5.1-21.9 and 34.2-65.5%, respectively. The most common species in the pasture were *Festuca ovina* (57.51%), *Bromus tectorum* L. (44.65%), *Convolvulus assyricus* (39.23%), *Veronica orientalis* Mill. (26.31%), *Medicago* sp. (22.89%) and *Alyssum pateri* Nyàr (21.43%).

Keywords: Frequency, Grasses, Legumes, Pasture

Introduction

Nowadays, it is not enough for the vegetation of pasture areas to be just high in productivity. Quality data is also needed about the growing environments that will provide this high yield, that is, the variable characteristics of soil and land (Coskun and Dengiz, 2016). When detailed soil properties are evaluated together with appropriate pasture management techniques, it is of great importance to reveal the economic damage caused by production on unsuitable land, as well as to increase productivity and quality.

A soil type occurring in nature acquires character in line with the environmental conditions in which it is found; therefore, each soil type has its own characteristics and management requirements in line with these characteristics (Dengiz *et al*., 2009). Soil, which has more than one characteristic state and a heterogeneous system, can make irreversible mistakes as a result of not making management decisions by considering all the physical, chemical, mineralogical and pedological properties that are closely related to each other but also include individual characteristics (Freeman and Skapura, 1991). On the other hand, due care is not taken when utilizing pastures. These areas; as they lost their productivity potential due to early, heavy and irregular grazing, their floristic compositions also changed. As a result, herbage quality decreased and soil properties changed (Gur and Altin, 2015). According to the data of the Turkish Statistical Institute, there are 13.2 million hectares of pasture in the country (total meadow-pasture area is 14.6 million hectares). Most of this area is located in the inner parts of Turkey, where long or short-term droughts prevail. Eastern, Central and Southeastern Anatolia Regions have 78% (approximately 4/5) of the country's total pastures, with a total pasture area of 10.3 million hectares (Anonymous, 2023; Karadavut *et al*., 2015).

Natural pasture areas, which are of great importance for the country and agricultural economy, are also very important for a sustainable and natural balance. In addition to the wrong and unconscious use of pastures, environmental factors, abnormal climatic conditions and other socio-economic factors significantly damage productivity (Altin *et al*., 2011; Cacan and Kokten, 2019). Pastures in Turkiye and the Sivas region have lost their productivity significantly as a result of grazing with animals approximately 2-3 times more than their grazing capacity. The estimated average herbage yield of pastures in Turkey is 0.7 tons/ha, which is approximately 1/3 of the world average (Babalik, 2008). The average herbage yield of the pastures of Sivas region is around 0.3-0.4 tons/ha.

Vegetation examination and measurements in meadows and pastures had two main objectives. The first was to obtain information about the qualitative and quantitative characteristics of meadows and pasture areas in regions whose vegetation is not well known. The second was to examine the improvement and management methods to be applied in meadows and pastures and their effects on vegetation (Cerit and Altin, 1999). With this background, this study was carried out to determine the botanical composition of pastures with different plant densities in the Ulas district of Sivas province.

Materials and Methods

***Study area and climate conditions*:** The study area, located within the borders of Ulaş and Altınyayla districts of Sivas province, mainly covers the pastures of Aciyurt village in Ulaş district. The area extends approximately between 39.35°–39.41° N latitudes and 37.00°–37.17° E longitudes, covering an area of about 1,849.21 ha. The elevation of the study area ranges from 1,635 to 1,938 m above sea level. (Fig 1). The study area is approximately 1849.21 ha, and its altitude varies between 1635 m and 1938 m above sea level. Sivas Province, a large part of which is located in the Central Anatolia Region, also has lands in Eastern Anatolia and the Black Sea Region. A large part of its territory is located in the Kizilirmak and part of it in the Yeşilirmak and Firat basins. In terms of area, it is the 2nd largest city in Turkey after Konya. The average altitude of Sivas province is over 1000 meters. The landforms of the city are the mountains, the valleys stretching between the mountains, the plains formed in the pits, and the plateaus formed in high places. Sivas province, whose landform is mostly formed by plateaus, is covered with 47.6% plateaus, 46.2% with mountains and 6.2% with plains. The province of Sivas, with a harsh continental climate, has cold and harsh winters and lots of snowfall. Summer months are hot and dry for short periods of time. In addition, rain is effective in the spring and autumn months. When long-term climate data was examined, the coldest month was January with -34.6°C. The hottest month was observed as July with 38.3°C. Additionally, the highest monthly rainfall average was recorded in May and the lowest in August. While the average annual rainfall varied between 460 to 470 mm, the average annual temperature varied between 8 to 12°C (Anonymous, 2024).

***Vegetation measurement*:** Pasture vegetation measurements were carried out on 08-09 June 2023 in pasture sections with 4 different plant densities: very high, high, medium and very low. In order to determine vegetation density in the study area, NDVI data were created using 10 m resolution Sentinel 2A satellite images from April and May 2021, and the vegetation density was determined as very high, high, medium and very low. Ten random points were determined in each pasture area with different plant densities, and measurements were made with 4 loop lines of 20 m length at each point. Every 20 cm along the lines, the loop with a diameter of

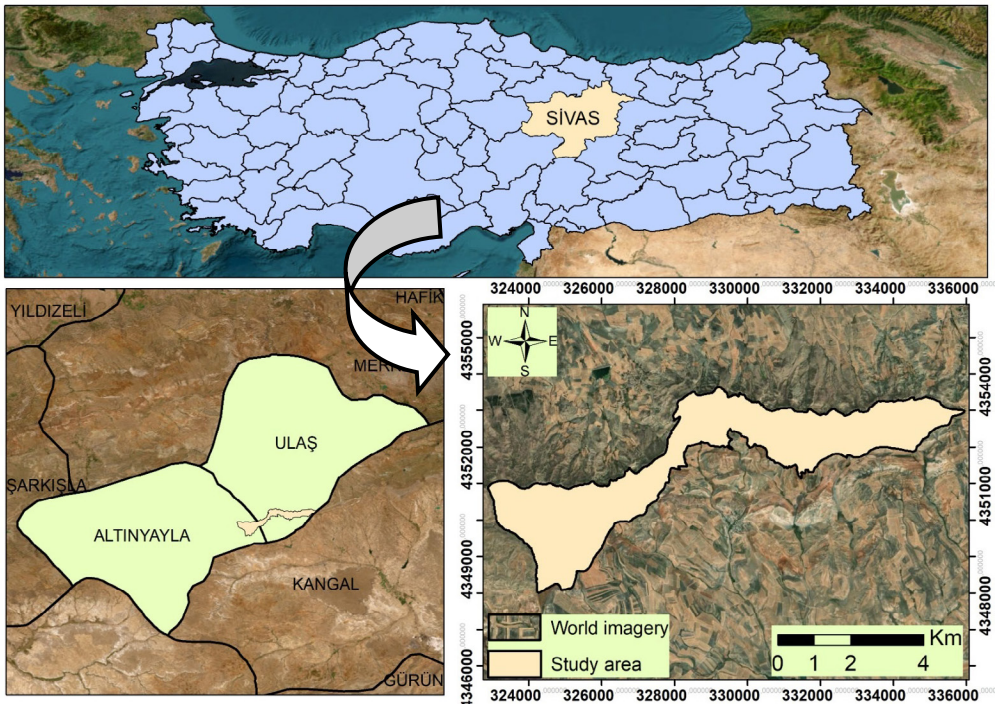

Fig 1. Study area location map

2 cm and a length of 30 cm was lowered to the ground vertically and the plant species entering the loop was recorded. When more than one plant species entered the loop, only the dominant plant species was taken into consideration (Cornelius and Alinoglu, 1962). Thus, 16,000 readings were made in the research area, 100 on each 20 m line, 400 at each point, and 4000 in each area with plant density.

Plant-covered area ratio (%): In the vegetation survey in the examined pasture, the bottom cover area was used to determine plant-covered area (Gokkus *et al.*, 2000). Since a loop line consists of 100 measurements, the number of loops with plants in a loop line gives the percentage of the area covered with plants in that loop line. The average of percentage of the area covered with plants determined in the four loop lines at each point was calculated as the percentage of the area covered with plants at that point.

***Pasture coverage rates of plant groups*:** Plant species found in each loop line were divided into three plant groups: grasses, legumes and other family plants, and the bottom cover ratio of each plant group was calculated. The average of bottom cover ratio values determined for a plant group in the four loop lines examined in each parcel was calculated as the average bottom cover ratio of the plant group in question in the parcel.

Botanical composition according to covering area (%): The bottom cover ratio determined for a plant group in each loop line was proportioned to the total plant-covered area, and the ratio of the said plant group in the plant-covered area was calculated as a percentage. The average of botanical composition values determined for a plant group in the four loop lines examined in each parcel was calculated as the ratio of the plant group in the botanical composition in the parcel in question.

***Frequency*:** In pastures with different plant densities, in every 100 loop measurements on a 20 m loop line, 10 loop measurements were accepted as a frequency unit, and the percentage of occurrence of a species in 10 frequency units was calculated as the frequency of that species on the loop line. The average of the frequency values determined in the four loop lines examined at a point for a species was calculated as the frequency of that species at the point.

***Identification of plant species*:** Identification of plants encountered in vegetation measurement was made following the works of Edgecombe (1964), Garms *et al.* (1968), Davis (1969), Polunin and Huxley (1974), Huxley and Taylor (1977), Weymer (1981), Demiri (1983), and Oztan and Okatan (1985).

***Data analyses*:** The data obtained from the trial were analyzed by a randomized complete block design using the JUMP statistical package program (JMP, 2005). Plant-covered area and botanical composition data did not show a normal distribution because they were obtained by proportioning the data obtained by counting. For this reason, angle transformation was applied to these values before applying variance analysis. The LSD test was used to evaluate the significance of differences among the averages.

Results and Discussion

***Area covered with plants, grasses, legumes and other families in pastures*:** While the area covered with plants, grasses and legumes in the researched pastures with different plant densities was statistically significant at 1% level, the area covered with other plant families was found to be statistically significant at 5% level.

The highest area covered with plant ratio was found in the pasture of very high plant densities with 96.9%, and

Table 1. Averages of the ratios of area covered with plants, area covered with grasses, area covered with legumes and areas covered with other family plants of pastures with different plant densities

Plant densities	Area covered with plants (%)	Area covered with grasses (%)	Area covered with legumes (%)	Areas covered with other family plants (%)
Very high	96.9 A** (80.0)$^{+}$	42.4 A** (40.5)$^{+}$	21.3 A** (26.8)$^{+}$	33.2 A* (45.5)$^{+}$
High	89.0 B (71.3)	31.2 B (33.6)	12.1 B (19.8)	45.7 AB (42.4)
Medium	77.3 C (61.6)	22.5 C (27.9)	4.0 C (11.8)	50.8 BC (36.8)
Very little	57.2 D (49.2)	16.7 C (23.9)	4.4 C (10.6)	36.1 C (34.7)
Average	80.1 (65.5)	28.2 (31.5)	10.5 (17.3)	41.4 (39.9)

$^{+}$ Angle transformation value; ** Significant at P≤0.01 level; * Significant at P≤0.05 level

the lowest area covered with plant ratio was found in the pasture of very low plant densities with 57.2% (Table 1). The average area covered with plants in pastures was 80.1%. In previous studies conducted in pastures in different provinces, it was reported that plant-covered area rates were 83.1-91.2% in Bingol (Cacan *et al*., 2016), 70.1% in Mardin (Seydosoglu *et al*., 2019), 70.75% in Rize (Baykal *et al*., 2020), 78.3-93.3% in Mus (Kokten and Tanriverdi, 2020), 38.2-54.5% in Isparta (Babalik and Kilinc, 2021), 84.8-95.8% (Cacan and Balkan, 2021) and 72.0-80.8% (Cacan and Kortak, 2021) in Elazig, 67.1-76.6% in Siirt (Tasdelen and Ozyazici, 2022), and 90.13% in Diyarbakir (Ok and Cacan, 2023).

The highest rate of area covered with grasses was found to be in the pasture with very high plant densities (42.4%), and the lowest value (16.7%) was found to be in the pasture with very low plant densities. By causing the ratio of area covered with grasses in the pasture with very high plant densities to be higher than in other pastures, It could be shown that soil structure and soil moisture conditions in the pasture with very high plant densities were more suitable than in other pastures. While the highest proportion of area covered with legumes was again obtained in the pasture with very high plant densities (21.3%), the lowest value in terms of this feature (4.0%) was found to be in the pasture with medium plant densities. The fact that the slope and soil conditions in pasture with very high plant densities were more suitable than other pastures and this could be shown as the reason for the higher coverage rate with legumes in this area. It was determined that the highest proportion of area covered with other family plants was in the pastures with medium plant densities (50.8%), followed by high (45.7%) and very little (36.1%) plant densities, respectively. In a study on botanical composition of Rize/Camlihemsin-Palovit plateau, it was reported that the area covered by grasses, legumes and other family plants was 39, 2 and 29.75%, respectively (Baykal *et al*., 2020), while in other study where botanical composition of different areas of the Mus/Kiyibasi village pasture was determined, it was reported to be 33.6-46.6, 2.9-23.0 and 25.0-41.2%, respectively (Kokten and Tanriverdi, 2020). On the other hand, in a study where the botanical composition of the Isparta/Yalvac-Tokmacik village pasture was determined, it was reported that area covered by grasses, legumes and other family plants was 20.7, 8.5 and 12.7%, respectively (Babalik and Kilinc, 2021).

***Botanical composition in plant-covered area*:** While the ratio of legumes in the plant-covered area in the researched pastures with different plant densities was statistically significant at 1% level, the ratios of grasses and other family plants in the plant-covered area was found to be statistically significant at 5% level.

The highest rates of grasses and legumes in covered area (43.9% and 21.9%, respectively) were obtained from the pasture with very high plant densities, followed by high (35.1% and 13.5%, respectively) and very low (29.6% and 7.7%, respectively) plant densities (Table 2). While the highest rates of other family plants in the plant-covered area were found in pastures with medium (65.5%) and very low (62.7%) plant densities. In previous studies conducted in different pastures, it was reported that the rates of grasses, legumes and other family plants in plant-covered areas were 54.98, 2.88 and 42.14%, respectively in Rize (Baykal *et al*., 2020), 49.80, 20.06 and 30.14%, respectively in Isparta (Babalik and Kilinc, 2021), 42.2-89.0, 5.7-25.6 and 5.2-28.6% respectively (Cacan and Balkan, 2021) and 35.5, 0.9 and 63.6%, respectively (Cacan and Kortak, 2021) in Elazig, 38.22-75.28, 12.47-34.72 and 10.10-27.06% in Erzurum (Bilgili, 2022), and 43.13, 14.01 and 42.85%, respectively in Diyarbakir (Ok and Cacan, 2023).

Table 2. Averages of the ratios of grasses, legumes and other family plants in plant-covered area of pastures with different plant densities

Plant densities	Ratio of grasses (%)	Ratio of legumes (%)	Ratio of other family plants (%)
Very high	43.9 A* (41.4)$^{+}$	21.9 A** (27.3)$^{+}$	34.2 C* (35.4)$^{+}$
High	35.1 AB (36.1)	13.5 B (20.9)	51.4 B (45.9)
Medium	29.4 B (32.4)	5.1 C (11.9)	65.5 A (54.4)
Very little	29.6 B (32.7)	7.7 BC (15.7)	62.7 AB (52.5)
Average	34.5 (35.7)	12.1 (19.0)	53.4 (47.1)

$^{+}$ Angle transformation value; ** Significant at P≤0.01 level; * Significant at P≤0.05 level

***Frequency values of plant species*:** The frequency values of plants were recorded in pastures with different plant densities (Table 3).

The most common species in the pasture with very high plant densities were *Bromus tectorum* L. (68.61%), followed by *Festuca ovina* (67.78%), *Medicago* sp. (53.06%), *Poa bulbosa* var. *vivipera* (36.39%), *Galium verum* (34.44%) and *Ebenus laguroides* (29.72%). In the pasture with high plant densities, the most common species were *Festuca ovina* (76.75%), followed by *Bromus tectorum* L. (54.25%), *Globularia trichosantha* Fisch (39.25%), *Verbascum* sp. (38.00%), *Medicago* sp. (36.75%), *Alyssum pateri* Nyàr (30.25%), *Scorzonera papossa* (20.50%) and *Convolvulus assyricus* (20.00%), respectively. The most common species in the pasture with middle plant densities were *Convolvulus assyricus* (70.00%), followed by *Festuca ovina* (66.00%), *Veronica orientalis* Mill. (57.50%), *Marribium cephalanthum* (38.00%), *Bromus tectorum* L. (36.50%),

Table 3. Frequency values of plant species of pastures with different plant densities

Plant name / species	Plant densities				
	Very high	**High**	**Medium**	**Very little**	**Average**
Acantholimon sp.	1.11	2.75	0.75	0	**1.15**
Alyssum pateri Nyàr	4.72	30.25	35.75	15	**21.43**
Alyssum strigosum	7.50	8.50	7.25	2.75	**6.50**
Amaranthus retroflexus	3.89	0	0	0	**0.97**
Anthemis cretica	0	0	0	1.25	**0.31**
Anthemis sp.	0.28	1.00	9.00	29.50	**9.94**
Astragalus hamosus	0	0	2.00	0	**0.50**
Astragalus caspicus	4.17	10.75	15.25	5	**8.79**
Bromus tectorum L.	68.61	54.25	36.50	19.25	44.65
Capsella bursa-pastoris	0.28	0.00	0	0	**0.07**
Carduus sp.	0	7.50	0	0	**1.88**
Centaurea appendicigera	0	0	0	6.75	**1.69**
Centaurea sp.	0	0	2.00	0	**0.50**
Ceratocephalus falcatus	3.06	1.25	2.75	5.5	**3.14**
Cirsium sp.	6.94	8.75	2.25	0.25	**4.55**
Convolvulus arvensis	1.11	0	0	0	**0.28**
Convolvulus assyricus	9.17	20.00	70.00	57.75	**39.23**
Crepis paludosa	3.33	0	0	0	0.83
Cruciata taurica	0	0.25	0.25	0.25	**0.19**
Dactylis glomerata	0.56	0.50	0	0.25	**0.33**
Daphne oleoides	0	0.25	2.25	0	**0.63**
Descurainia sophia	0.56	0.50	0	0.5	**0.39**
Dorycnium sp.	0.83	2.50	0	0	0.83
Ebenus laguroides	29.72	0	7.00	22.25	**14.74**
Euphorbia cheiradenia	7.50	3.75	2.00	1	**3.56**
Euphorbia sp.	0.56	0	1.25	0	**0.45**
Festuca ovina	67.78	76.75	66.00	19.50	**57.51**
Festuca sp.	0	0	5.50	43.25	12.19
Galium verum	34.44	14.25	1.25	0.25	**12.55**
Globularia trichosantha Fisch.	18.06	39.25	10.25	3	**17.64**
Helianthemum canum	0.28	0.75	8.25	19.25	**7.13**
Helichrysum sp.	0	2.25	0	0	**0.56**
Hypericum sp.	0	0	0	6.75	1.69
Juncus effusus L.	2.78	0.50	0	0	**0.82**

Lactuca serriola	8.33	3.50	1.50	0	**3.33**
Lotus corniculatus	3.61	0	0	0	**0.90**
Malva sylvestris	0.56	0	0	0	**0.14**
Marrubium cephalanthum	9.72	12.50	38.00	5.75	16.49
Medicago sp.	53.06	36.75	1.75	0	**22.89**
Minuartia sp.	0	0	1.00	0.5	**0.38**
Paronychia kurdica	0	0	0	0.25	**0.06**
Phlomis sp.	4.17	13.00	3.75	0.5	**5.35**
Pilosello sp.	0	1.75	0	6.25	2.00
Plantago lanceolata	14.72	5.50	0.75	0	**5.24**
Poa bulbosa var. *vivipera*	36.39	9.50	2.50	0.75	**12.28**
Polygonum cognatum	7.50	1.00	0	0	**2.13**
Poterium sanguisorba	16.11	19.00	1.25	0.5	**9.22**
Ranunculus cuneatus	2.50	0.75	0	0	0.81
Rhamphospermum arvense	1.39	0.75	0	0	**0.53**
Scorzonera papposa	0	20.50	0.50	0.25	**5.31**
Scutellaria orientalis	7.22	0.25	21.25	9.25	**9.49**
Stipa sp.	0.28	0.50	6.00	15	**5.44**
Thymus sp.	0	0	1.00	2.5	0.88
Tragopagon dubis	0	0	0	3.25	**0.81**
Trifolium pratense	0.83	0	0	0	**0.21**
Verbascum sp.	1.11	38.00	0.25	0.75	**10.03**
Veronica orientalis Mill.	10.00	2.25	57.50	35.50	**26.31**

Alyssum pateri Nyàr (35.75%) and *Scutellaria orientalis* (21.25%). In the pasture with very little plant densities, the most common species were *Convolvulus assyricus* (57.75%), followed by *Festuca* sp. (43.25%), *Veronica orientalis* Mill. (35.50%), *Anthemis* sp. (29.50%) and *Ebenus laguroides* (22.25%). The most common species in the pasture where the study was conducted were *Fectuca ovina* (57.51%), *Bromus tectorum* L. (44.65%), *Convolvulus assyricus* (39.23%), *Veronica orientalis* Mill. (26.31%), *Medicago* sp. (22.89%) and *Alyssum pateri* Nyàr (21.43%).

Similarly, the most common plant species in the Mus/Kiyibasi village pasture were *Aegilops umbellulata* (50.56%), *Minuartia hamata* Mattf. (23.75%), *Medicago minima* L. (13.00%), *Stipa lagascae* L. (10.75%) and *Festuca rubra* (10.50%) (Kokten and Tanriverdi, 2020), while the most common plant species in the Elazig/Karakocan-Bulgurcuk village pasture were *Aegilops triuncialis* (35.80%), *Trifolium campestre* (14.56%), *Hordeum bulbosum* (9.49%), *Taeniatherum caput-medusae* (5.49%) and *Gundelia tournefortii* (4.65%) (Cacan and Balkan, 2021), and the most common plant species in the Elazig/Karakocan-Basyurt village pasture were *Gundelia tournefortii* (19.62%), *Hordeum bulbosum* (18.28%) and *Eremopoa persica* (13.29%) (Cacan and Kortak, 2021). On the other hand, it was observed that the most common plant species in the Diyarbakir/Ovunduler village pasture were *Bromus squarrosus, Trifolium repens* and *Cichorium pumilu* (Ok and Cacan, 2023). In a study conducted in a pasture area in Nigeria, it was reported that out of 45 different plant species, 22 were legumes and 23 were wheatgrass (Oussein *et al*., 2025).

Conclusion

According to the study in Aciyurt village of Sivas Province, the ratios of the area covered with plants, grasses, legumes and other family plants were 80.1, 28.2, 10.5 and 41.4%, respectively, while the ratios of grasses, legumes and other family plants in the covered area were 34.5, 12.1 and 53.4%, respectively. Since the relationships between NDVI data obtained by analyzing the satellite

image and the botanical composition of the pasture were linear, it will be useful to use satellite images to make effective and correct decisions in pasture vegetation studies.

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