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CHANGES IN YIELD AND BOTANICAL COMPOSITION OF NATURAL RANGELANDS DURING GRAZING SEASON AT DIFFERENT ALTITUDES

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Abstract

The aim of this study was to determine the yield, botanical composition, and other characteristics of three natural rangelands located at different elevations (900, 1000, and 1200 m a. sl.) during the grazing season in Uşak province, Türkiye, in 2018 and 2019. From the beginning of the grazing season, cuttings were taken every 15 days to evaluate the green herbage yield, hay yield, necessary rangeland area for an animal unit (NRA), crude protein (CP), crude protein yield (CP yield), and floristic composition of rangelands.

The results showed that many rangeland characteristics were significantly affected by altitude. Rangeland yield, CP, and CP yield were increased with altitude, while NRA was decreased. The highest green herbage yield (1358 kg ha^{-1}) and hay yield (1358 kg ha^{-1}) were determined in the Çamsu rangeland at an altitude of 1200 m. The highest ratio of legumes (49.75%), grasses (59.56%), and other plants (25.58%) in the floristic composition were determined in the rangelands at 1200, 1000, and 900 m altitudes, respectively. Likewise, cutting time also had a significant effect on different characteristics. Rangeland yield was increased from the beginning of the grazing season to July and decreased afterward due to the changing climatic conditions. The highest CP content (15.63%), and CP yield (952.7 kg ha^{-1}) were observed in May which decreased with the advancing season. The legume ratio in the rangeland vegetation reached the maximum value (39.94%) on May 30 with a significant decrease after 15 June as the season progressed. As a result, it was determined that altitude and cutting times have a wide range of effects on rangeland vegetation, hence it would be beneficial to consider these factors into account in rangeland management.

Key words: Rangeland, Altitude, Cutting times, Yield, Botanical composition, CP.

Introduction

Rangelands are among the essential natural wealth of a country. The vegetation of the rangelands consists of many plant species according to their ecology, undertake vital ecological roles such as protecting the soil against erosion, managing water, keeping atmospheric carbon dioxide, and providing a habitat for plants and animals. Apart from these, rangeland areas produce cheap and high-quality roughage for farm animals. From a legal view, everyone engaged in animal husbandry can equally use from rangelands. In this respect, rangelands improve the socio-economic structure of the regions.

Due to factors like uncontrolled grazing and years of neglect, rangelands have reached the point where they are no longer productive. Excessive and uncontrolled grazing causes the reduction of climax plant species in rangelands and the disappearance of various species from the rangelands. Most of the rapidly growing plant communities in degraded pastures are mostly in habited by invasive species, which are not eaten willingly by animals or have difficulty in grazing, and sometimes even contain toxic substances (Balabanlı *et al*., 2006; Louhaichi *et al*., 2019). In addition to correct rangeland management practices, factors such as climate, soil, slope, direction, and elevation can be effective on the yield and floristic composition of vegetation (Adane & Gima, 2008). Increasing altitude causes a decrease in the atmospheric temperature. This temperature decrease affects the rangeland yield positively in some areas and after a certain point, it limits plant growth and causes a decrease in yield (Chollet *et al*., 2014). Rangeland soils at low altitudes contain more organic matter, moisture, and plant nutrients than at higher altitudes. For this reason, it is stated that fast-growing species are more common at low altitudes (Wang *et al*., 2007). The yield of pastures at high altitudes varies greatly due to temperature and precipitation, the diversity of plant species, and animal grazing and management practices (Mpokos *et al*., 2014). Studies have shown that the effect of altitude on the regional climate and soil characteristics causes significant changes in the yield and diversity of vegetation (Bilgin & Özalp, 2016; Özgür *et al*., 2017; Tai *et al*., 2020). Nemara *et al*., (2018); reported that dry matter yield was decreased significantly with increasing altitude and legumes were more affected by altitude than grasses. According to Koidou *et al*., (2019), sub-alpine pastures (1501-2334 m) have higher yields and crude protein ratios than sub-mountainous (480-900 m) and mountainous (901-1500 m) pastures. However, they claimed that pastures at lower elevations were more productive in the early stages of the grazing season. Roukos *et al*., (2017); stated that the elevation significantly affected the physical and chemical properties of the rangeland soil, the floristic composition, and yield and that the rangeland yield was decreased with increasing altitude (Vazquez-de-Aldana *et al*., 2000; Mountousis *et al*., 2011). On the other hand, some researchers (Papanastasis, 1982; Mountousis *et al*., 2008); have also demonstrated that elevation increases rangeland yield.

There are 14.6 million hectares of pasture and meadow in Türkiye. This area corresponds to 18.7% of the total land assets (Açıkgöz, 2021). Most of Türkiye's pastures are located in the Eastern and Central Anatolian regions. Uşak, which has a transitional feature between the continental climate in the Aegean region and the Mediterranean climate, has 29 thousand hectares of rangeland area. The most productive pastures of Uşak are located in the town of Banaz, in the northeast of the province. Banaz district has large pasture areas located on the border of continental climate and Mediterranean climate and located on the foot of Murat Mountain, the highest mountain of the province.

Banaz district, receives more rainfall and has a higher altitude compared to the southern and western regions of the province. It has 27.2% of the total pastures in Uşak with 7.9 thousand ha of pasture. This study was carried out to determine the yield, floristic composition, and some characteristics of three natural rangelands at different elevations in the Banaz district of Uşak province during the grazing season.

Material and Methods

This study was carried out in three natural rangelands at different elevations in the Banaz district of Uşak province, located in the Aegean region of Türkiye in 2018 and 2019 years.

The pastures where the study was conducted (Çamsu 1200 m asl, Küçükoturak 1000 m asl, and Güllüçam 900 m asl) were located at the foothills of Murat Mountain (2309 m asl), the highest mountain in Uşak. In general, the most productive pastures of Uşak in terms of floristic composition and yield are located in the villages around Murat Mountain (Fig. 1).

The study area has a transition-type climate between the continental and the Mediterranean climate. The monthly average temperature data for the years studied were higher than the average of the long term (2013-2021). The highest monthly temperature was recorded in August and the lowest in January. While the annual total precipitation in 2018 was 588.2 mm, which was above the average, it was 500.8 mm in 2019, which was below the long-term normal. In terms of spring precipitation, when pasture growth was at its peak, spring precipitation in 2019 was lower than the normal for 2018 and previous years (Fig. 2).

The results of the soil analysis performed in the rangeland areas are presented in Table 1. Soil analysis indicated that the soils of Güllüçam and Küçükoturak rangelands have a clay texture, whereas Çamsu rangeland has a clay loamy texture. All three rangeland soils have a pH close to neutral, are salt-free, and are high in total nitrogen. On the other hand rangeland soils, differed in terms of lime, organic matter available phosphorus, and potassium (Table 1).

The slope was between 0-10% in all three rangeland sections, which was the research area. In terms of plant species, white clover (*Trifolium repens* L.) among legumes and tall wheatgrass (*Agropyron elongatum* L.) and intermediate wheatgrass (*Agropyron intermedium* (Host) Beauv) species stand out in Çamsu and Küçükoturak rangelands. On the other hand, alfalfa species (*Medicago* sp.) were more common among legumes in the Güllüçam rangeland. Tall wheatgrass (*Agropyron elongatum* L.), sheep fescue (*Festuca ovina* L.), and scented grass (*Chrysopogon gryllus* L.) were among the prominent *Poacea* species.

In order to make a uniform sampling, 100 m^2 nongrazing areas were established with barbed wire in 3 different regions to represent the rangeland. Grazing season starts on May 15 in Banaz. Therefore, starting from May 15, samples were taken from the ungrazed areas every 15 days, with a quadrat (1 x 1 m) with 3 replications. The cuttings for sampling was terminated on 30 July, as the rangeland vegetation was in a dormant state.

The green herbage yields were determined by weighing quadrat samples with a precision scale of 0.01 g sensitivity and proportioning per hectare (Tosun & Altın, 1986). Then, the green herbage samples were separated into legumes, grasses, and other families after cutting. Afterward, the samples were dried at 70ºC until they reached a constant weight to determine the hay yield and botanical composition according to dry weight. After the dried samples were ground to a size that would pass through a 0.01 mm sieve, nitrogen analysis was performed according to the Kjeldahl method, and the CP contents of the samples were determined by multiplying with a constant coefficient of 6.25 (Kacar & İnal, 2008). CP yields were determined by multiplying the CP content with the hay yield of the rangeland. The Necessary rangeland area (NRA) required for 1 animal unit (500 kg live body weight) was calculated according to the equation reported by Bakır (1970).

Hay needed for 1 animal unit per day (HN) (kg): 500 kg x 0.025
Number of grazing days (NGD): 135 days
Utilizable forage amount (UFA) (kg ha^{-1}): Hay yield of rangeland x 0.50

$$\text{NRA (ha)} = \frac{\text{HN (kg day–1) x NGD (day)}}{\text{UFA (kg ha–1)}}$$

The data were subjected to analysis of variance according to the randomized blocks experimental design in the statistical package program JMP 10.0.0 (SAS Institute Inc., Cary, NC, USA). The least significant difference (LSD) test was used to compare the means that were found to be significant.

Results

Based on the study's two-year average findings, changes in elevation and cutting periods had a significant impact on the green herbage yields of the rangelands, with a significance level of $p<0.01$ (Table 2). According to the altitudes, the highest green herbage yield was determined at 18.95 t ha^{-1} in Çamsu rangeland at 1200 m altitude, while the lowest green herbage yield was found in Güllüçam rangeland at 900 m altitude. Based on two years of cutting periods, the highest green herbage yield was determined as 21.43 t ha^{-1} in the cuttings made on 15 June. The lowest green herbage yield was measured on 30 July, when the vegetation was in a dormant stage (Fig. 3).

The cutting times have significant effects on the green herbage yield. The yields ranged between 8.41 t ha^{-1} and 22.24 t ha^{-1} on the average of two years. The highest green herbage yields were determined on 30 May and 15 June, respectively. The lowest green herbage yields were observed in the cuttings made on 30 July and 15 May, respectively (Fig. 3).

Significant differences were observed at the $p<0.01$ level in hay yield regarding the altitude and cutting time (Table 2). The hay yields of the rangelands varied between 3.88 t ha^{-1} and 5.41 t ha^{-1} on the average of two years, depending on the elevations. While the highest hay yield was obtained from Çamsu rangeland (1200 m), the lowest was obtained from Güllüçam rangeland (900 m) (Fig. 3).

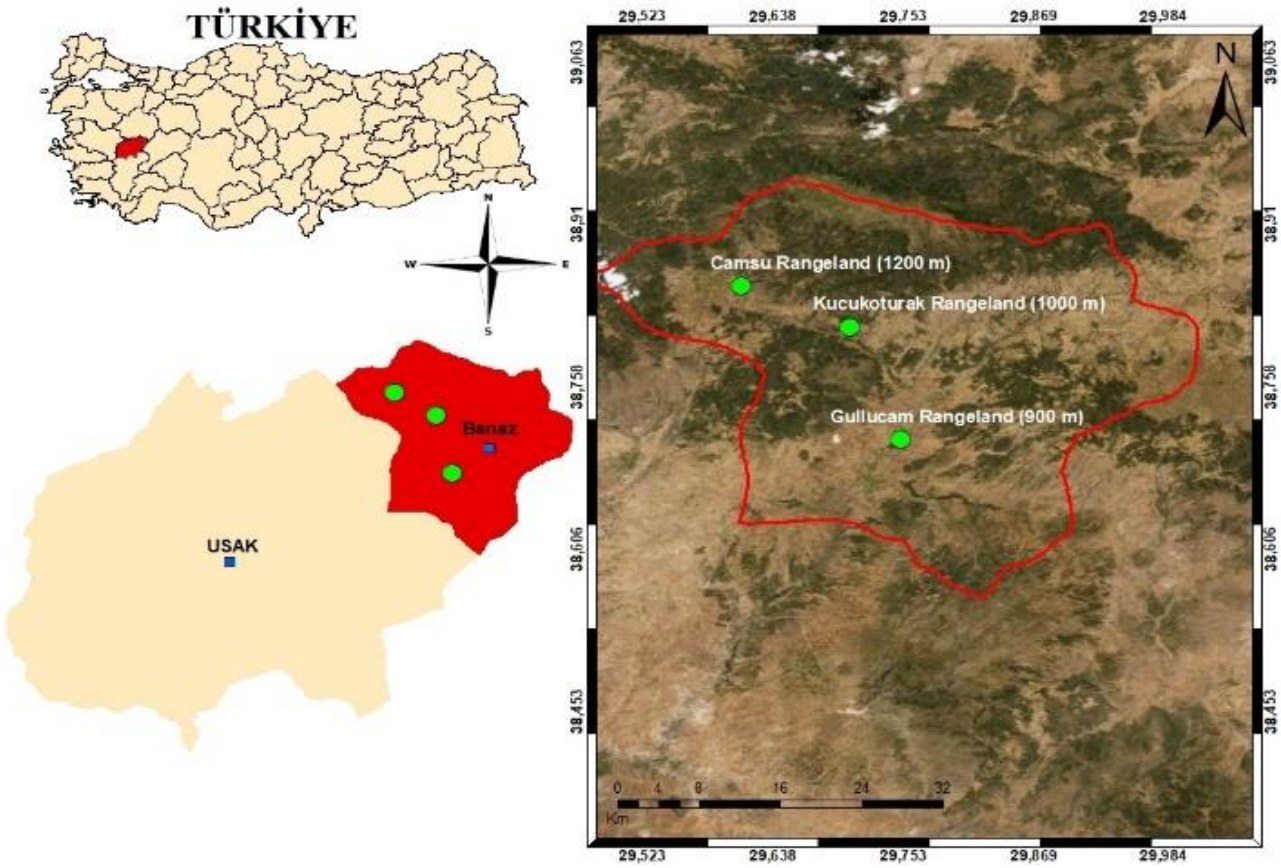

Fig. 1. Locations of the rangelands in the research area.

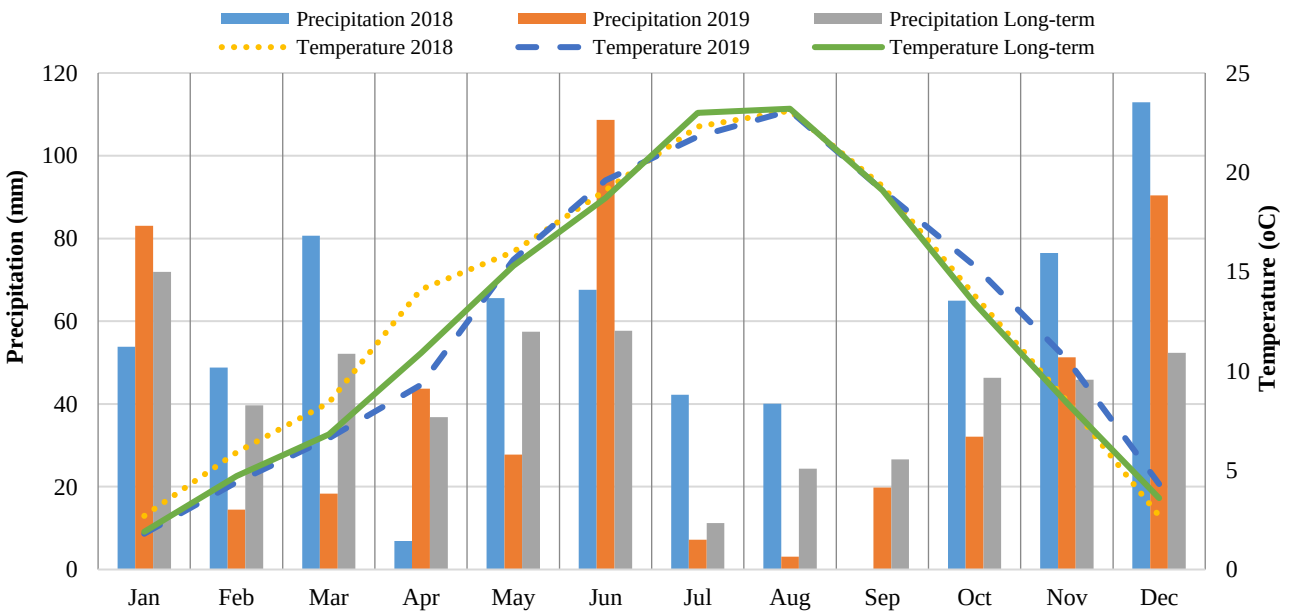

Fig. 2. Monthly total precipitation and mean temperature values of the Banaz district (Anon., 2019). Different color bars represent precipitation in different years while lines represent temperature.

Table 1. The Soil properties of the rangelands at 0-30 cm soil depth (Anon., 2019a).

Rangelands	Soil properties							
	Texture	pH	Salinity (dS/m)	Lime (%)	Organic matter (%)	Total N (%)	Available P (mg/kg)	Available K (mg/kg)
900 m (Güllüçam)	Clay	7.13	2.140	17.5	3.66	0.183	3.32	500
1000 m (Küçükoturak)	Clay	7.24	0.668	6.6	5.35	0.267	1.22	300
1200 m (Çamsu)	Clay loam	6.76	0.826	2.2	5.06	0.253	2.52	140

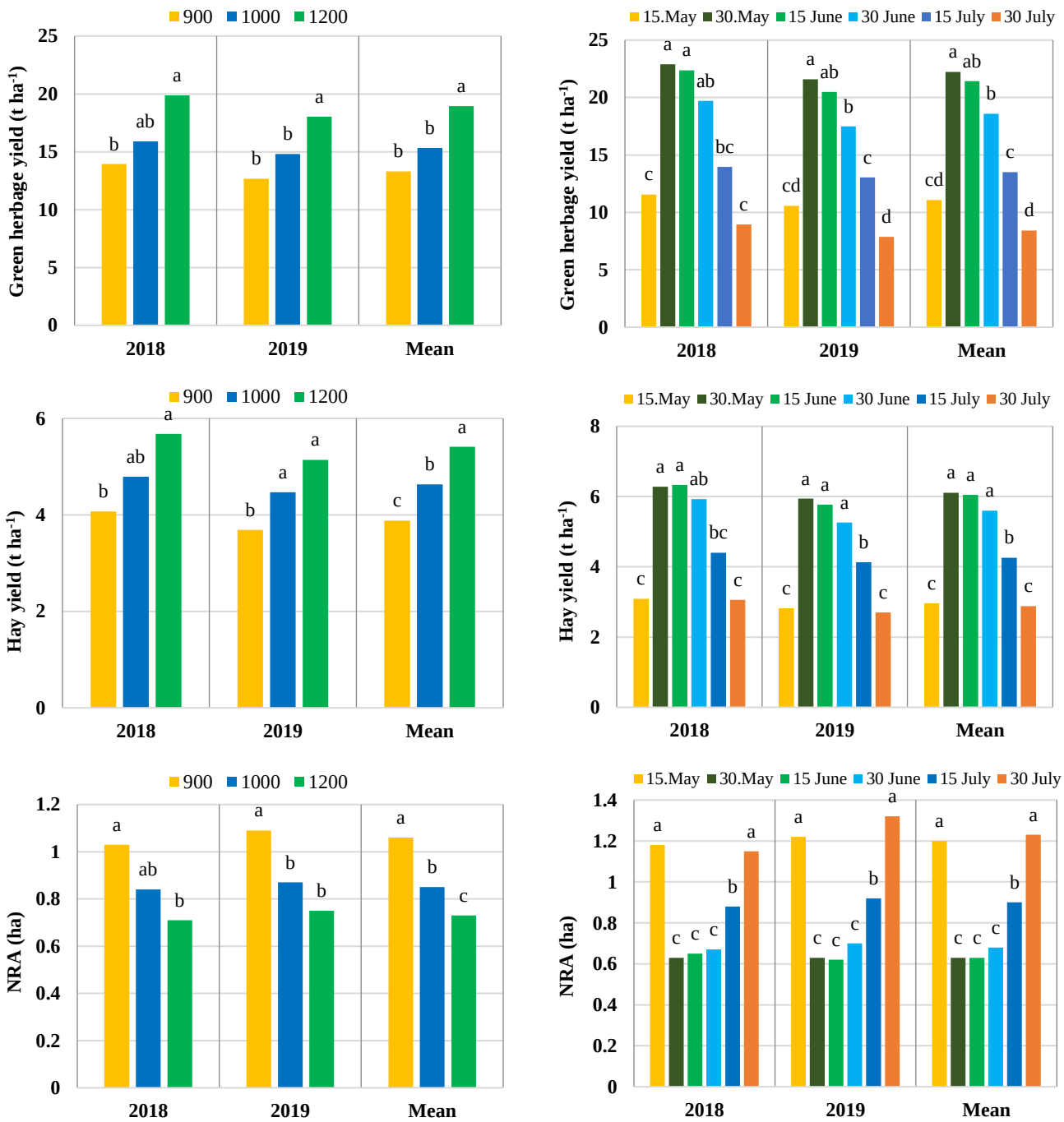

Fig. 3. The means of green herbage yield, hay yield, and necessary rangeland area (NRA). The differences between the means of 2018 and 2019 years and combined years marked with the same letter are statistically insignificant at the $p<0.05$ level.

Table 2. Results of analysis of variance and mean squares of the traits determined.

Source of variation	DF	Mean square							
		Green herbage yield	Hay yield	Necessary rangeland area	CP content	CP yield	Lugume ratio	Grass ratio	Other families ratio
Year (Y)	1	521667	46373	4.83	9.31**	1755	334.3	120.3	62.26
Block (Year)	4	596576	48204	11.01	1.52	531.6	159.5	412.4	173.2
Altitude (A)	2	2942787**	211769**	101.3**	92.59**	10737**	8958**	7818**	603.2**
Y x A Int.	2	13740	1093	0.18	1.01	9.01	558.2*	664.1	100.01
Cuttings (C)	5	5879148**	401517**	139.9**	87.04**	11176**	845.6**	795.6**	110.9
Y x C Int	5	13200	1240	2.02	1.80	99.77	174.6	104.3	22.37
A x C Int.	10	293927	25721	5.79	2.37	509.7	231.1	199.8	160.2
Y x A x C Int.	10	4263	305	0.85	1.74	33.54	78.5	86.9	28.49
Error	68	283231	23796	6.52	1.23	485.03	174.6	226.6	107.5
CV (%)		33.53	32.88	29.05	8.63	35.96	41.90	31.59	49.59

DF: Degrees of freedom; CV: Coefficient of variation; *: $p\leq0.05$ and **: $p\leq0.01$

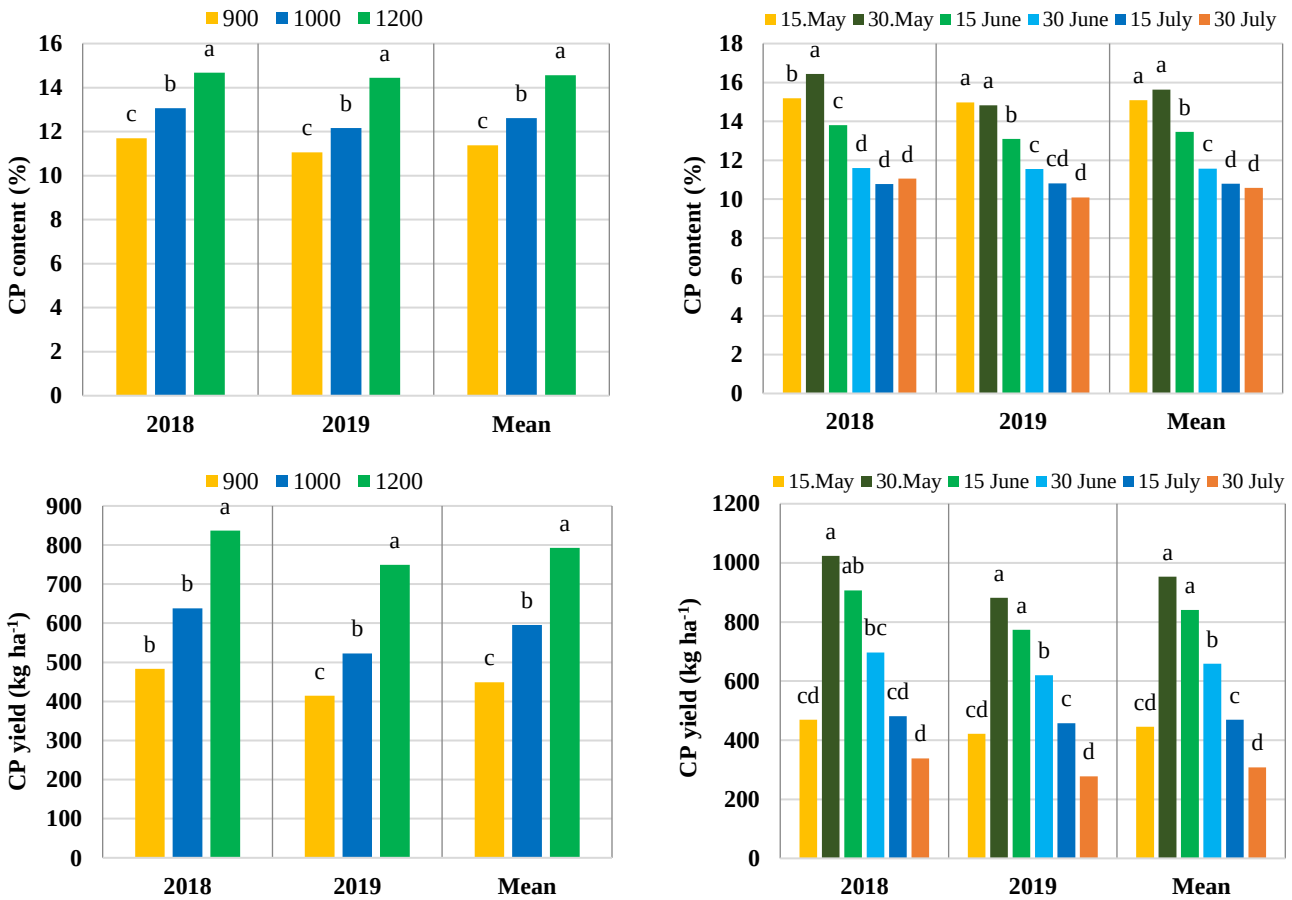

Fig. 4. The averages of CP content and CP yield of the rangelands. The differences between the means of 2018 and 2019 and combined years marked with the same letter are statistically insignificant at the $p<0.05$ level.

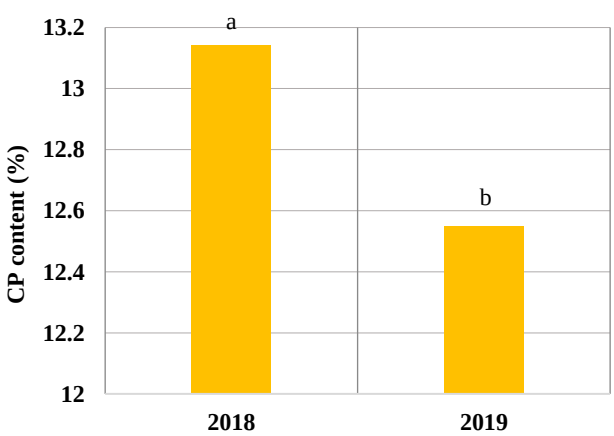

Fig. 5. The mean CP contents according to year interaction. The values with different columns differ significantly at the $p<0.05$ level.

Hay yields showed a similar change in terms of cutting times in both study years. The average hay yields of two years varied between 2.88 t ha^{-1} and 6.11 t ha^{-1}. The highest hay yield was determined in the harvests on 30 May, 15 June, and 30 June, respectively. The lowest hay yields were recorded in the cuttings on 30 July and 15 May.

NRA values in the study were significantly influenced by rangeland elevation and cutting times at $p<0.01$ (Table 2). The average of the two years, the amount of NRA varied between 1.06 ha and 0.73 ha based on elevations. Increasing rangeland elevation had positively affected the productivity of rangelands and increased yield, thus reducing the amount of NRA. Regarding cutting periods, the NRA amount values varied between 0.63 ha and 1.23 ha (Fig. 3). The lowest NRA values were determined in May and June when the highest yields were recorded, while the highest NRA values were determined in early May and at the end of July when rangeland yields were low.

Based on the results, the average CP content of the rangelands over two years varied between 11.38% and 14.56%, depending on the elevation. Similar trend was observed in both years, with an increase in CP content with the increase of rangeland elevation. These findings showed a significant ($p<0.01$) correlation between rangeland elevation and CP content (Table 2).

In the study, the year effect caused statistically significant differences in CP content at the $p<0.01$ level (Table 2, Fig. 5). The average CP content in 2018 was 13.14%, compared to 12.55% in the following year. Differences between CP contents in terms of cutting times were found to be significant at the level of $p<0.01$ (Table 2). With the advancing cutting time, significant decreases were observed in CP contents. CP contents varied between 15.63% and 10.08% according to the cutting times. The highest CP content was determined in the cuttings made on 30 and 15 May, while the lowest was measured in the cuttings made on 30 and 15 July (Fig. 4).

CP yield was affected by altitude in both years of the study; it varied between 448.8 kg ha^{-1} and 793.0 kg ha^{-1}. The Çamsu rangeland located at an altitude of 1200 m had the highest yield, while the Güllüçam rangeland at 900 m had the lowest. It was found that CP yields were increased

with altitude when the rangelands were compared according to their altitude (Fig. 4). Furthermore, the study revealed that CP yields varied between 308.4 kg ha^{-1} and 952.7 kg ha^{-1} depending on the cutting times. The highest CP yield was observed in cuttings made on May 30th and June 15th, whereas the lowest was recorded in harvests made on July 30th and May 15th.

Based on a two-year average, it was found that the elevation of the rangeland had a significant effect (p<0.01) on the proportions of legumes, grasses, and other plant families (Table 2). The ratio of legumes ranged from 22.19% to 49.75%, grasses from 31.17% to 52.22%, and other plant families varied from 17.97% to 25.58% (Fig. 6). The highest ratio of legumes was observed in Çamsu rangeland at an altitude of 1200 m, the highest percentage of grasses was found in Küçükoturak at an altitude of 1000 m, and the highest ratio of other plant families was determined in Güllüçam rangeland at an altitude of 900 m. Throughout the grazing season until July 30, the proportion of legumes ranged from 22.56% to 43.44%, grasses ranged from 40.83% to 57.28%, and other plant families ranged from 17.17% to 24.67%. The change in legumes and grasses was statistically significant (p<0.05) while the change in other plant families was not significant.

In the second year of the study, the interaction between the year and altitude was found to be significant (p<0.05) (Table 2). This was due to a decline in the legume ratio in the floristic composition of Çamsu rangeland, as shown in Fig. 7.

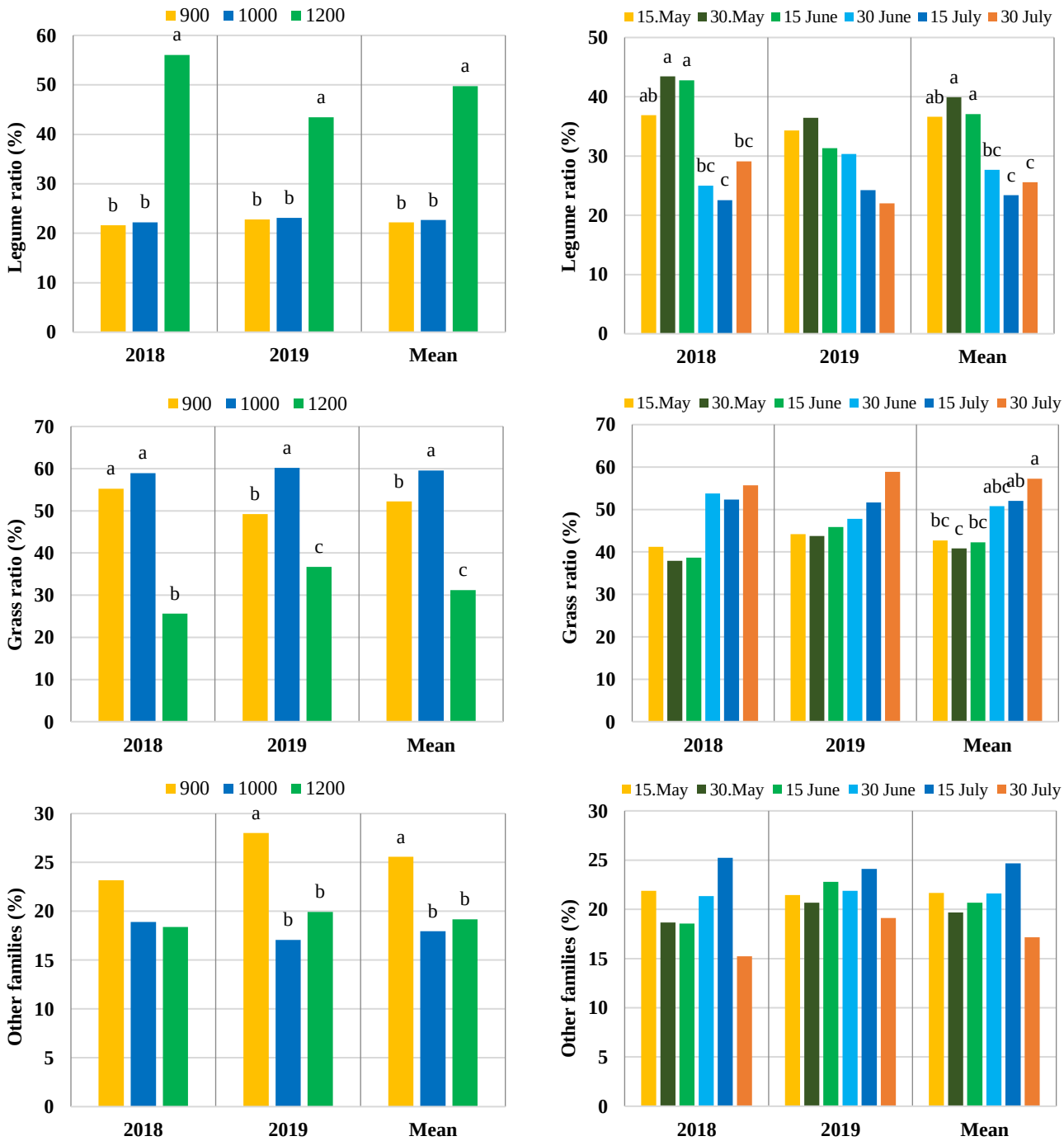

Fig. 6. Botanical composition ratios of the rangelands. The differences between the means of 2018 and 2019 and combined years marked with the same letter are statistically insignificant at the p<0.05 level.

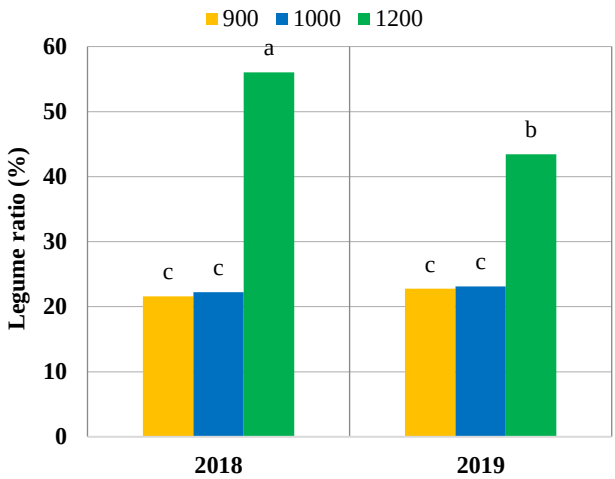

Fig. 7. The mean legume ratios of the year-altitude interaction. Different lowercase letters on the columns indicate significant interaction at the level of $p<0.05$.

Discussion

The study found that higher altitudes led to an increase in green herbage production in both years. Holechek *et al*., (2010); reported that altitude affects climate and topographic features, therefore, the change in altitude directly affects vegetation. Özgür *et al*., (2017); stated that no statistically significant difference was observed between the green herbage yields of three different natural pastures in Alanya at an altitude of 1100, 1300, and 1500 m, and the green herbage yields vary between 2.55 and 2.94 t ha^{-1}. On the other hand, Bilgin & Özalp (2016); determined that the green herbage yield of the natural rangeland in Artvin Ardanuç was increased from 4.78 t ha^{-1} to 9.99 t ha^{-1} with the increasing altitude from 1900 m to 2200 m. These results are lower than the green herbage yields determined in this study. Nevertheless, they are similar in terms of variation in altitude.

The study showed that as the cutting time progressed, there were notable increases in the number of green herbage yields. That is an expected result due to the good plant growth in response to suitable soil and climatic conditions. Increasing air temperature and decreasing precipitation (Fig. 2) since July limited plant growth and caused a decrease in green herbage yields. In studies conducted on different forage crops and rangelands, it was found that yield was increased with the advancement of harvest time (Türk *et al*., 2007; Jang *et al*., 2022). Altın *et al*., (2010); stated that green herbage yields differed between 8.45 and 25.30 t ha^{-1} on the base and barren pasture. On the other hand, Aydın *et al*., (2014); stated that it varied between 4.56 and 7.69 t ha^{-1}. The variations between these results and the findings of our study could be attributed to regional changes in climate, soil properties, and rangeland quality levels.

The study revealed that hay production was increased with higher elevations, probably due to the prevalence of cool-season in these areas. The lower average air temperature at high altitudes may have positively affected the development of cool-season plants. Similar to our findings Taşdelen & Özyazıcı (2022) also reported that hay yield was increased with increasing altitude in the pasture. Koidou *et al*., (2019); found that the yield was increased with increasing rangeland altitude in a study conducted in Greece at three different altitudes where cool season plants were dominant. Dibari *et al*., (2020); emphasized that some pasture plants can find the appropriate temperature values for growth at higher altitudes in summer. On the other hand, Pérez & Frangi, (2000); reported that in Argentina on pastures dominated by warm-season pasture plants, the above-ground dry matter production was declined with increasing rangeland elevation (from 500 m to 1100 m).

The hay yields of rangelands were increased with the advancement of harvesting time. The availability of adequate precipitation in the soil and the appropriate climatic conditions for plant growth contributed to this increase. Decreases in hay yields from 15 June continued until 30 July, when the lowest hay yield was recorded. The reason for this situation can be shown as the increased air temperature since June and the accompanying drought, which limited the growth and development of cool season plants. Araya *et al*., (2013); reported that several factors including management techniques, water, nutrients, light, and temperature, had an impact on the productivity and botanical composition of permanent rangelands. Türk *et al*., (2015); found in their study that hay yield was increased until the beginning of June in the rangeland and that the yield began to decrease after this date due to changing climatic conditions. These results are similar to our findings. However, some other researchers also stated that hay yield was increased with advancing harvesting time (Sankhyan *et al*., 1999; Türk *et al*., 2007).

The term "necessary rangeland area" (NRA) refers to the amount of pasture required to graze one cattle unit weighing 500 kg (Gökkuş *et al*., 1993). The grazing season in the rangelands covers the 135-day period between 15 May and 30 September, and NRA values were calculated for this period. NRA was reduced with increasing altitude throughout the study. This can be explained by increasing elevation better climatic conditions for plant development and the quantity of water, and improved pasture productivity. Relevantly, Sayar *et al*., (2015); reported that pasture improvement and management practices allowed the NRA to decrease. In some studies conducted in Türkiye, it has been reported that the amount of NRA varies between 1.04 ha and 2.21 ha (Gökkuş *et al*., 1993; Taşdemir & Kökten, 2015). The NRA values determined in this study are in agreement with the results reported above.

Many factors affect the CP contents of rangelands. Such as floristic compositions and development stages of plants. Increasing legumes ratio in the botanical composition also increases the CP contents of pasture hay. In addition, the development periods of the plants also affect the CP content. As in many other forage crops, advanced maturity in plants causes a decrease in CP (Mountousis *et al*., 2011; Türk *et al*., 2015; Koidou *et al*., 2019). In this study, the ratio of legumes in the botanical composition was increased with the rangeland elevation. This situation can be shown as the main reason for the increased CP due to the rangeland elevation (Fig. 4). On the other hand, changing climatic conditions with increasing rangeland altitude restricted plant growth, causing tissues to be smaller, poor in structural carbohydrates, but richer in intracellular elements, and this

increased the ratio of CP. As in this study, it has been reported by some researchers that crude protein contents increase with increasing rangeland altitude (Mountousis *et al*., 2011; Koidou *et al*., 2019). Moreover, according to Han *et al*., (1997); plants growing at higher altitudes improve their resistance to cold environments by increasing the substances like CP, fat, starch, and sugars.

The highest CP contents of the study were measured at the beginning of the grazing season however, as the grazing season progressed, it tended to decline. The high mitotic activity and the resulting nitrogen requirement during periods of rapid growth in plants caused the CP contents to be high (Ammar *et al*., 2004). On the other hand, increasing carbohydrate synthesis with advancing maturity, increase in cell wall components, and, aging of tissues caused a decrease in CP contents (Koç & Gökkuş, 1996). Similar to the results of this study, other studies also support that CP decreases with the progression of the maturity stage (Mountousis *et al*., 2011; Türk *et al*., 2014; Sayar *et al*., 2022).

CP yield is a parameter calculated by multiplying hay yield and CP content. Therefore, hay yield, CP content, and legume ratio increase CP yields. Mountousis *et al*., (2011); reported that CP content increase from 900-1300 m altitude to 1300-1700 m altitude in a natural pasture, Nemera *et al*., (2018); emphasized that elevation increases the proportion of legumes in the botanical composition.

CP yield is directly related to hay yield and the CP ratio of rangeland. Therefore, the change in these two parameters affects the CP yield of the rangeland. With the advancing maturity of the plants, the yield increases up to a certain point, while the N and related CP decrease. As a result, CP yield also decreases with time. Similar to our results determined in this study, Kabaş & Türk (2019) also determined that the CP yield of natural rangeland in Uşak varied between 259.8 - 610.5 kg ha^{-1}, the highest CP yield was determined on May 15, and the lowest CP yield was determined on July 5. Additionally, it has been reported by many researchers that the CP content decreases with the advancing vegetation period in pasture plants (Mountousis *et al*., 2011; Türk *et al*., 2015).

As the altitude of the rangeland was increased, there was a corresponding increase in the legume ratio in the range land. Alemeyahu (2006); stated that the increasing or decreasing ratio of legumes according to the altitude was dependent on the grazing intensity, therefore the rate of legumes might be higher at higher altitudes. According to Wang *et al*., (2007); increased water content and plant nutrients resulting from the soil's organic matter caused an increase in grass ratios but a decrease in legume ratios in low-altitude areas. Nemera *et al*., (2018); reported that the ratio of legumes was increased from 31.58% to 37.58% when the altitude was increased from 1650-2000 m to 2300-2700 m in natural rangeland, whereas the ratio of grasses was decreased from 59.92% to 53.92%. These reported results are in agreement with our findings.

The interaction between years in terms of legume ratio may have resulted from factors such as rangeland management practices and water conditions. Araya *et al*., (2013); reported that management practices and site characteristics such as altitude, topography, water, nutrient availability, and light conditions influence species composition and richness in permanent rangeland. Robert *et al*., (1991); found that alternating grazing did not affect the species composition, whereas short-term and heavy grazing reduced the proportion of grasses in high-altitude rangeland. Similarly, Gutman *et al*., (1990); it was determined that while the proportion of grasses in the rangeland was decreased with increasing grazing pressure, the proportion of plant species belonging to other families was increased.

Conclusions

Based on a study conducted on natural rangelands in the Banaz district of Uşak province, it was found that altitude had a significant impact on various rangeland characteristics. These include rangeland yield, CP content, CP yield, rangeland vegetation, and NRA amount. During the grazing season, raising the altitude led to better quality hay and greater yield from rangeland. However, it also resulted in a decrease in the NRA for grazing animals. The rangeland yield was highest in July but decreased as the season progressed. The content of CP was highest in May but was decreased with time. The study revealed that the rangelands under investigation were able to provide enough high-quality feed for grazing animals. Overall, altitude and grazing season have a significant impact on rangeland vegetation, and it is essential to consider these factors while managing rangeland.

Acknowledgments

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