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DETERMINATION IN FORAGE YIELD AND QUALITY OF CHICORY AND DIFFERENT PLANTS MIXTURES IN GRAZING MATURITY PERIOD

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Abstract: This study was conducted to determine forage yield and quality of chicory (*Cichorium inthybus* L.) in a pure stand and a simple pasture (two-species) in the grazing maturity period. The experiment design was a Randomized Block Design with 3 replications. The experimental site was located on the grounds of the Ondokuz Mayıs University Agricultural Faculty during the 2017 and 2018 growing periods. In this study, chicory (C), orchardgrass (OG), and red clover (RC) were grown as forage plant materials in a rainfed cropping system in North Türkiye. Simple pastures comprised of 80%C + 20%OG, 60%C +40%OG, 40%C + 60%OG, 20%C + 80%OG, 80%C + 20%RC, 60%C + 40%RC, 40%C + 60%RC, 20%C + 80%RC. Five sequential harvests were made when chicory plants reached 25 cm of plant height in both years. The average plant height ranged from 17.3 to 35.6 cm, and 29.1 to 38.3 cm in 2017 and 2018 respectively. The highest fresh forage yield was determined in red clover mixtures (6519-5443 kg/da) in 2017 and 80%C+20%RC mixture (as 7137 kg/da) in 2018. Total dry matter production was ranged from 216 to 1238 and 279 to 1164 kg/da in 2017 and 2018, respectively. In pure stand chicory pasture, dry matter production was evaluated 216 kg/da in 2017 and 908 kg/da in 2018. Considering the calculated area equivalence ratios (LER) of mixed planting plots in both years and in all forms, it was determined that all mixtures were superior to plain plantings (LER≥1).

Keywords: Chicory, Orchardgrass, Red clover, Mixture ratios, Competitive

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1. Introduction

Türkiye has favorable ecological conditions and topography of the environment to grow most of the forage plants. In addition to traditional forage crops, using alternative fodder crops contribute significantly to the solution of the roughage deficit problem (Acar et al., 2020). The compatibility of a forage plant with the ecological conditions and agricultural infrastructure allows becoming widespread in a certain area. Growers prefer forage crops with a shorter economic life, rather than using alfalfa, which has an economic life of 7-8 years, on crop rotation. Chicory (*Cichorium inthybus* L.) is one of the forage crops that can be utilized short economic life pasture plant. Chicory is one of the forage crops that can be utilized as a short economic life pasture plant. It can be used with many traditional pasture plants such as red clover and orchardgrass with its economic life of 4-5 years. (Li et al., 1997; Acar and Ayan, 2000). Chicory is classified high-quality forage plant with high palatability, digestibility, and rich in mineral substances. Also, its good drought-tolerance ability makes it a valuable forage plant, especially warm-season period. In addition to those, chicory helps to reduce bloat hazard and parasite formation in the rumen (Barry, 1998; Athanasiadou et al., 2007; Molle et al., 2008). Thanks to vegetative characteristics such as a low-growing point and deep taproot, it is resistant to intensive grazing. Considering using forage crops from different families in a mixture is substantial to increase yields of high-quality forage in the world due to limited agricultural lands recently. In addition to traditional forage crops, a forb should be used in pasture mixtures. Thus, the nitrogen accumulated by legume plants in the soil is used by forbs that provide balanced feed in terms of nutrients and minerals. However, intermingled mixtures cause interspecies competition for light, energy, and nutrients. Therefore, to achieve the expected benefit from intermingled mixtures, it is necessary to choose appropriate plant species and varieties as well as the most appropriate mixing ratio (Dordas et al., 2012; Uzun and Aşık, 2012). The present study aimed to investigate the most appropriate mixing ratio/ratios and forage yield of chicory with orchardgrass (*Dactylis glomerata* L.) and red clover (*Trifolium pratense* L.) at grazing maturity in ecological conditions of Samsun.

2. Materials and Methods

The study was conducted at the Ondokuz May University, Faculty of Agriculture Research Center in Samsun Türkiye (41 ° 21'N, 36 ° 15'E). The site was located on the south–west facing slope (8%) of the hill. The altitude of the site was 120 m and the depth of soil was 23 - 40 cm (Gülser et al., 2003). Soil tests indicated the site had the following conditions: organic matter, 3.37%; clayey soil, 45%; available N, 0.16; available P_2O_5, 65.4; K, 340; Ca, 2.18 meq/100 g; and soil pH, 6.34. The average temperature and total precipitation values were 15.2 ^oC and 657.3 mm in establishment year. In the following year the average temperature and total precipitation data from January to October were determined 17.5 ^oC and 648.5 mm. It was determined that the dry period was between June and September in 2017, and between April and July in 2018.

In the present study, the "Commander" variety of chicory, "Lidacta" of orchardgrass, and "Suez" varieties of red clover were used as plant material. The experiment designed in a randomized complete block design with 3 replications, with 12 pasture treatments. Pasture mixtures were: (1) 80%C + 20%OG; (2) 60%C + 40%OG; (3) 40%C + 60%OG; (4) 20%C + 80%OG; (5) 80%C + 20%RC; (6) 60%C + 40%RC; (7) 40%C + 60%RC; and (8) 20%C + 80%RC. Also, 3 pure stand pasture were used for each of three species. The twelve pasture were sown on 25 February 2017 at 20-cm row spacing by hand. Each plot was 0.8 x 3 m (2.4 m^2). The sowing rates of the pasture treatments were 1 kg chicory + 2 kg red clover + 3 kg orchard grass per hectare in pure stand pastures. A total of 4 kg da^{-1} Ammonium Nitrate, and 8 kg Triple Super Phosphate were applied to each plot. The experiment was rainfed and no irrigation was applied. Plots were harvested when the chicory plants reached an average height of 25 - 35 cm to mimic grazing. A total of six harvests were made between June 14 and July 29 in 2017, and 4 April and 29 May in 2018 (three each). Contrary to planned, plots were harvested earlier than planning cutting height due to the tendency to bolting was observed on chicory plants before reaching 25 cm height. Only chicory plants reached grazing maturity in the plots in the third cutting in 2017 and the first cutting in the second year. Samples were sorted into different botanical species before fresh matter yields were determined. A 500 gram of subsamples forages dried in an oven at 60 °C to a constant weight to determine yield and forage quality. Dried samples were ground for chemical analyses. The significance of differences among treatment means was compared by Duncan test with a significance level of 0.05 (Açıkgöz, 1993). The computations were carried out using SPSS 17.0 statistical software.

3. Results and Discussion

3.1. Plant Height

In terms of plant height, while the highest plant height was measured with 45.4 cm in the red clover in the plot with a mixture ratio of 80%C + 20%OG in the first cutting time, and the lowest plant height was 29.9 cm in pure stand orchard grass. In the pure stand chicory parcel, the plant height was 31.2 cm. In the second cutting, the highest plant heights were determined 30.2 cm in the chicory plant in the 60%C + 40%OG parcel, and 29.5 cm in the pure stand chicory parcel, the lowest plant heights were determined 21.4 cm in the orchard grass in 40% C+ 60%OG the mixture parcel. In the third cutting, only chicory plants thrived in the plots. During this period, since chicory plants started to stem elongation early, the plant was cut without waiting for the plant height to be 25 cm in height. In the third cut, the plant height of the chicory varied between 20.2 cm and 13.2 cm (Figure 1).

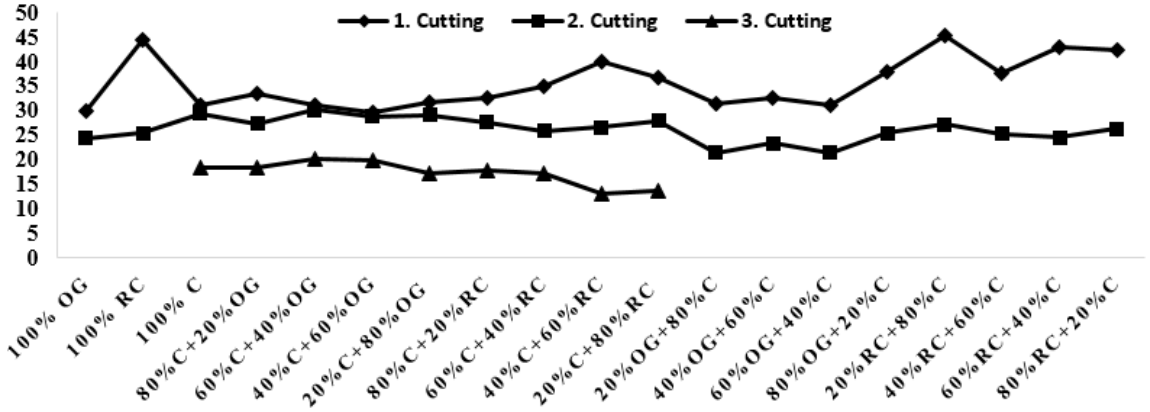

Figure1. Average plant height values determined in 2017 from mixtures at different ratios (cm): OG= orchardgrass, RC= red clover, C= chicory.

As the number of cuttings increased, plant height values decreased in parallel with the increase in temperature and drought. Red clover and orchard grass, which are cool-season grass, were more adversely affected by the increasing temperature and drought. Plant height values were a little low in all plants since it was the establishment year of the study. In addition, the fact that the plant height of the chicory plant in the second and third cuts is higher than the red clover and orchard grass may be due to the fact that the plant starts to develop

again and has good tolerance to drought and heat. In the second year of the study, three cuttings were made, the chicory plant started to develop much earlier than the others and the only chicory was harvested in the first cutting.

While the longest average plant height was measured with 30.7 cm in the mixture of 80%C + 20%RC, the shortest average plant height was stated 26.8 cm in the mixture of 20%C + 80%OG. In the second cutting, the highest plant height was determined at 44.6 cm in the mixture of 80% C+20%OG in orchard grass, while the average plant height was 34.8 cm in the pure stand chicory plot. In the third cutting, plant height values varied between 34.9 - 29.8 cm (Figure 2). Kemp et al. (2002), stated that chicory provides to be spread over a wider period of time of the quality feed period, as it develops in the summer months when many plants dry out or become dormant in pastures. Its qualities and drought tolerance make chicory a valuable forage plant especially in the Mediterranean climate zone (Molle et al. 2008).

3.2. Fresh Yields

The fresh yield of the mixtures of chicory with orchard grass and red clover in different seed ratios are given in Table 1. It was determined that the difference between the treatments in terms of fresh yield was statistically significant. In the first cutting of 2017, the highest fresh yield was obtained in the mixture of 40%C + 60%RC (with 5057 kg/da), and the lowest fresh yield was had from the pure stand orchard grass parcel (with 601 kg/da). In the second cutting, the highest fresh yields were determined in the following mixtures with meadow clover, 20%C+80%RC (1489.8 kg/da), 80%C+20%RC (1467 kg/da), 60%C+40%RC (1369 kg/da), and 40%C+60%RC (1363 kg/da). In the third cutting, only chicory plants developed, so they were cutting and the highest chicory fresh yield was determined in the mixture of 80%C+20%OG (496 kg / da), the lowest fresh yield was measured 98 kg/da in the mixture of 40%C+60%RC.

In the first cutting of 2018, as only chicory plants reached grazing maturity, chicory was harvested and the highest fresh yield was determined in the mixture of 80%C+20%RC (2081 kg/da). The lowest chicory fresh yield was determined in 20%C + 80%OG mixture (525 kg / da). In its second cutting, the highest fresh yield varied between 870-3364 kg/da (Table 1).

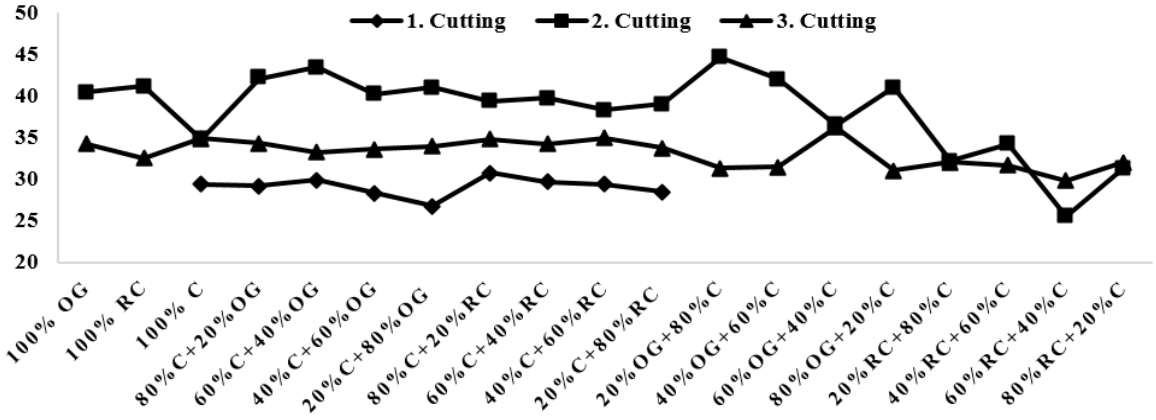

Figure 2. Average plant height values determined in 2017 from mixtures at different ratios (cm): OG= orchardgrass, RC= red clover, C= chicory.

Table 1. Fresh yield values (kg/da) of mixtures of chicory with orchard grass and red clover at different rates

Treatments	Fresh Yields (kg/da)							
	2017				2018			
	1.Cutting	2.Cutting	3.Cutting	Total	1. Cutting	2. Cutting	3. Cutting	Total
100 % OG	601^{d}	286^{d}	--	888^{d}	--	1220^{bc}	306^{e}	1526^{d}
100 % RC	2596^{c}	740^{bc}	--	3336^{b}	--	870^{c}	476^{e}	1347^{d}
100 % C	768^{d}	533^{cd}	285^{bc}	1587^{cd}	1399^{abc}	1500^{bc}	960^{d}	3860^{c}
80%C+20%OG	1349^{d}	800^{bc}	496^{a}	2646^{bc}	1690^{ab}	3010^{a}	1762^{ab}	6462^{ab}
60%C+40%OG	1638^{d}	895^{b}	356^{ab}	2891^{bc}	1741^{ab}	3364^{a}	1375^{bcd}	6481^{ab}
40%C+60%OG	1311^{d}	730^{bc}	286^{bc}	2327^{bc}	1057^{bcd}	2454^{ab}	1421^{bcd}	4933^{bc}
20%C+80%OG	1114^{d}	697^{bc}	130^{c}	1943^{cd}	525^{d}	2174^{abc}	1041^{cd}	3741^{c}
80%C+20%RC	4161^{ab}	1467^{a}	306^{abc}	5934^{a}	2081^{a}	2940^{a}	2116^{a}	7137^{a}
60%C+40%RC	3812^{b}	1369^{a}	261^{bc}	5443^{a}	1738^{ab}	2993^{a}	1682^{ab}	6414^{ab}
40%C+60%RC	5057^{a}	1363^{a}	98^{c}	6519^{a}	1380^{abc}	1997^{abc}	1468^{bc}	4846^{bc}
20%C+80%RC	4684^{ab}	1489^{a}	119^{c}	6293^{a}	802^{cd}	1932^{abc}	1299^{bcd}	4034^{c}
Average	2463	943	260	3619	1379	2223	1264	4616

*There is no difference at the level of 0.05 (P≤0.05) between the values indicated with the same letter in the same column. OG= orchardgrass, RC= red clover, C= chicory.

In 2017, while the highest fresh yields were determined in the mixtures containing red clover, in 2018, it was determined in the mixtures with 20%-40% of both red clover and orchard grass. The contribution of chicory to the yield of these mixtures is quite high. In the second year of the experiment, while the total fresh yields of both chicory and orchard grass were higher, the yield of red clover was quite low. Red clover plants were adversely affected by drought in the summer of 2017, and many plants died. This proportional decreasing negatively reflected on fresh yield. Chicory fresh yield increased significantly in 2018, and it reached the highest value with the mixture of 80%C + 20%RC (Table 1).

3.3. Hay Yield

It was determined that the difference between treatments in both years in terms of hay yield was statistically significant (Table 2). In the first cutting of 2017, the highest hay yield was found in the mixture of 40%C + 60%RC (919 kg/da), and the lowest hay yield was found in the pure stand chicory (90 kg/da) parcel.

In the second form of the same year, the highest hay yield was determined in the following mixtures containing red clover, 20%C+80%RC (325 kg/da), 40%C+60%RC (296 kg/da), 60%C+40%RC (289 kg/ha) and 80%C+20%RC (276 kg/da). In the third cutting, only chicory plants were cutting, and the highest chicory hay yield was found in mixtures of 80%C+20%OG and 60%C+40%OG (108 and 71 kg / da, respectively).

In 2018, only chicory plants reached grazing maturity in the first cutting of mixtures of chicory, orchard grass + red clover. In this cutting, only chicory was cut, and the highest chicory hay yield was determined in the pure stand chicory treatment (570 kg/da). In the second cutting, many treatments were included in the same statistical group in terms of the highest hay yield, and yields varied between 176 - 719 kg/da. The highest hay yield obtained in the third cutting in 2018 was determined in the mixture of 80%C+20%RC with 318 kg/da. When the hay yields obtained from chicory were examined in both years, the yield of chicory hay increased significantly in 2018 and reached the highest value in the mixture of 80%C+20%RC (858 kg/da). While the total hay yield of the pure stand chicory parcel was 216 kg/da in 2017, it was 908 kg/da in 2018. The lowest chicory hay yield in both years was determined in the mixture of 20%C + 80%OG (Table 2).

When the total hay yields obtained are examined, it is seen that the total hay yields obtained in 2018, the second year of the experiment, were higher. In 2017, the highest hay yields were determined in mixtures containing red clover, and in 2018, in mixtures containing 20 - 40% of both red clover and orchard grass. The hay yields obtained from chicory during the grazing maturity period were found approximate or higher value than the hay yields were determined by Sanderson (2010) and Piluzza et al. (2014) and reported by Tan and Temel (2012). This situation varied according to the soil, environment, type of variety used and the maintenance process applied.

3.4. Land Equivalent Ratio (LER)

The land Equivalent Ratio (LER) indicates the area required to obtain the exact yield from a unit area when crops are grown in a mixed planting compared to when they are grown in a monoculture (Kızılşimşek and Erol 2000). According to Boz (2006), mixed cropping is equivalent to monoculture if the resulting LER value is 1. If the LER value is less than 1, then mixed cropping is unnecessary, and if the LER value is greater than 1, then mixed cropping is superior to monoculture. This conclusion is based on comparing yields obtained from mixed cropping and monoculture. In the first harvest of the year 2017, the average LER values ranged from 0.95 to 2.05. In the second harvest, the average LER value was between 2.02 and 2.19 for mixtures with orchard grass and between 2.06 and 2.19 for mixtures with red clover.

Table 2. Hay yield values (kg/da) of mixtures of chicory with orchard grass and red clover at different rates

Treatments	Hay Yields (kg/da)							
	2017				2018			
	1.Cutting	2.Cutting	3.Cutting	Total	1. Cutting	2. Cutting	3. Cutting	Total
100 % OG	179de	72^{c}	--	252^{cd}	--	327^{cd}	83^{c}	411^{ef}
100 % RC	408^{c}	175^{b}	--	583^{b}	--	176^{d}	102^{c}	279^{f}
100 % C	90^{e}	72^{c}	53^{bc}	216^{d}	570^{a}	207^{d}	130^{c}	908^{abc}
80%C+20%OG	228de	143^{b}	108^{a}	480^{bcd}	193^{bc}	613^{ab}	257^{ab}	1064^{ab}
60%C+40%OG	290de	156^{b}	71^{ab}	518^{bc}	201^{bc}	719^{a}	243^{b}	1164^{a}
40%C+60%OG	248de	145^{b}	61^{bc}	455^{bcd}	120^{cd}	565^{ab}	250^{b}	935^{abc}
20%C+80%OG	229de	151^{b}	27^{c}	407^{bcd}	75^{d}	553^{ab}	212^{b}	841^{bcd}
80%C+20%RC	707^{ab}	276^{a}	62^{bc}	1046^{a}	241^{b}	486^{bc}	318^{a}	1046^{ab}
60%C+40%RC	647^{b}	289^{a}	62^{bc}	998^{a}	196^{bc}	476^{bc}	251^{b}	924^{abc}
40%C+60%RC	919^{a}	296^{a}	22^{c}	1238^{a}	144^{cd}	319^{cd}	219^{b}	683^{cde}
20%C+80%RC	804^{ab}	325^{a}	27^{c}	1157^{a}	96^{d}	284^{cd}	214^{b}	595de
Average	432	191	27	668	204	429	207	804

*There is no difference at the level of 0.05 (P≤0.05) between the values indicated with the same letter in the same column. OG= orchardgrass, RC= red clover, C= chicory.

In the third harvest, no LER value was calculated as no growth was observed in the orchard grass and red clover plants. These results suggest that mixed cropping can be beneficial in some cases, depending on the plant species and the specific growing conditions. In the first harvest of 2018, no LER value was calculated as no growth was observed in the orchard grass and red clover plants. In the second harvest, the highest average LER value of 2.74 was obtained from a 60%C+40% OG mixture, while in the third harvest, the average LER value ranged from 1.88 to 2.60 (Table 3). In both years, it was determined that all mixtures were superior to monoculture (LER>1.0) when the land equivalent (LER) ratios of mixed planting plots were examined. This suggests that plants utilize environmental factors more effectively in mixed cropping than in monoculture (Albayrak et al., 2004).

3.5. Aggressivity

Aggressivity is used to determine the interspecific competition in mixtures. If aggressivity=0, it is assumed that both species have the equal competitive ability. If the aggressivity value is positive, the plant is supposed to be the dominant species. If the aggressivity value is negative, the plant is considered the suppressed species (Dhima et al., 2007; Lithourgidis et al., 2011). In the first and second harvests of 2017, it was determined that in the 80%C+20%OG and 60%C+40%OG mixtures of chicory with sow thistle and in the 80%C+20%RC mixture of chicory with red clover, chicory was the suppressed species (Aother ≥ positive), while in other mixtures, chicory was the dominant species (Acichory ≥ positive). Aggressivity was not calculated in the third harvest of 2017 and in the first harvest of 2018 because there was no growth of orchard grass and red clover plants. In the second harvest of 2018, it was determined that in the 40%C+60%OG and 20%C+80%OG mixtures with orchard grass and the 20%C+80%RC mixture with red clover, chicory was the dominant species (Achicory ≥ positive), while in the other mixtures, the suppressed species was dominant (Aother ≥ positive). In the third harvest of the same year, it was found that chicory was the suppressed species in the 80%C+20%OG mixture with orchard grass, while it was the dominant species in the 20%C+80%RC mixture with red clover (Table 4).

3.6. Competitive Ratio

The competition ratio is a parameter that expresses how a species interacts with other species and how it uses ecological resources compared to other species, taking into account the planting rate and yield of a species in a mixture (Kızılşimşek and Erol, 2000).

Table 3. LER values of chicory, red clover, and orchard grass in different proportions

Treatments	2017 year cuttings			2018 year cuttings		
	1. cutting	2. cutting	Average	2. cutting	3. cutting	Average
80%C+20%OG	2.34	2.30	2.32	2.34^{ab}	2.31	2.32
60%C+40%OG	2.54	2.36	2.45	2.74^{a}	2.39	2.56
40%C+60%OG	2.35	2.28	2.32	2.18^{ab}	2.48	2.33
20%C+80%OG	1.78	1.52	1.65	2.04^{ab}	2.32	2.18
80%C+20%RC	2.14	2.22	2.18	2.44^{ab}	2.60	2.52
60%C+40%RC	2.02	2.12	2.07	2.46^{ab}	2.10	2.28
40%C+60%RC	1.96	2.32	2.14	1.59^{b}	1.88	1.73
20%C+80%RC	1.68	2.30	1.99	1.54^{b}	2.03	1.78
Average	2.10	2.18	2.14	2.16	2.26	2.21

*There is no difference at the level of 0.05 (P≤0.05) between the values indicated with the same letter in the same column. OG= orchardgrass, RC= red clover, C= chicory.

Table 4. Aggresivity values of chicory, red clover, and orchard grass in different proportions

Treatments	2017 Year				2018 Year			
	1. Cutting		2. Cutting		2. Cutting		3. Cutting	
	Chicory	Other	Chicory	Other	Chicory	Other	Chicory	Other
80%C+20%OG	-0.19^{c}	0.19^{a}	-0.06^{c}	0.06^{a}	-0.07^{cd}	0.07^{ab}	-0.051^{d}	0.051^{a}
60%C+40%OG	-0.03^{bc}	0.03^{ab}	-0.01^{c}	0.01^{a}	-0.01^{bc}	0.01^{bc}	0.002^{c}	-0.003^{b}
40%C+60%OG	0.01^{bc}	-0.01^{ab}	0.01^{c}	-0.01^{a}	0.01^{b}	-0.01^{c}	0.018^{bc}	-0.018^{bc}
20%C+80%OG	0.13^{ab}	-0.13^{bc}	0.15^{ab}	-0.15^{bc}	0.10^{a}	-0.10^{d}	0.118^{a}	-0.118^{d}
80%C+20%RC	-0.02^{bc}	0.02^{ab}	-0.03^{c}	0.03^{a}	-0.10^{d}	0.10^{a}	-0.057^{d}	0.057^{a}
60%C+40%RC	0.01^{bc}	-0.01^{ab}	0.01^{c}	-0.01^{a}	-0.02^{bc}	0.02^{bc}	-0.017^{cd}	0.017^{ab}
40%C+60%RC	0.04^{b}	-0.04^{b}	0.04^{bc}	-0.04^{ab}	-0.03^{bcd}	0.03^{abc}	-0.009^{c}	0.009^{b}
20%C+80%RC	0.24^{a}	-0.24^{c}	0.19^{a}	-0.19^{c}	0.03^{ab}	-0.03^{cd}	0.046^{b}	-0.046^{c}
Average	0.02	-0.02	0.04	-0.04	-0.01	0.01	0.006	-0.006

*There is no difference at the level of 0.05 (P≤0.05) between the values indicated with the same letter in the same column. OG= orchardgrass, RC= red clover, C= chicory.

Table 5. Competition index values of chicory, orchard grass, and red clover in different proportions

Treatments	2017 Year				2018 Year			
	1. Cutting		2. Cutting		2. Cutting		3. Cutting	
	Chicory	Other	Chicory	Other	Chicory	Other	Chicory	Other
80%C+20%OG	1.07^{abc}	1.43^{b}	0.51	0.78	0.60^{b}	2.33^{a}	3.80^{a}	2.91^{a}
60%C+40%OG	1.64^{a}	0.87^{b}	0.83	1.29	0.69^{b}	1.51^{ab}	3.36^{a}	2.65^{ab}
40%C+60%OG	1.51^{ab}	0.71^{b}	1.42	1.64	1.49^{b}	0.83^{b}	1.03^{b}	1.21^{bc}
20%C+80%OG	1.61^{a}	0.76^{b}	1.30	1.90	1.93^{b}	0.90^{b}	1.01^{b}	1.22^{bc}
80%C+20%RC	0.29^{c}	5.98^{a}	0.22	2.36	0.92^{b}	1.38^{ab}	0.57^{b}	1.76^{abc}
60%C+40%RC	0.38^{bc}	2.84^{b}	0.37	3.12	1.19^{b}	0.96^{b}	1.04^{b}	1.00^{c}
40%C+60%RC	0.03^{c}	2.29^{b}	0.58	3.90	0.71^{b}	0.19^{b}	0.44^{b}	0.40^{c}
20%C+80%RC	0.70^{abc}	2.35^{b}	1.00	5.31	8.47^{a}	0.18^{b}	0.40^{b}	0.36^{c}
Average	0.91	2.16	0.78	2.54	2.00	1.04	1.46	1.44

*There is no difference at the level of 0.05 (P≤0.05) between the values indicated with the same letter in the same column. OG= orcard grass, RC= red clover, C= chicory.

When the competition ratio values calculated for both chicory and other plants (red clover and orchard grass) are examined together in the first version of 2017, chicory has a negative effect (RI>1) in mixtures containing 40, 60 and 80% of orchard grass.

It was determined that chicory had a positive impact (RI<1) in all mixtures created with red clover. In other words, it is beneficial to grow chicory together with red clover. In the second cutting, chicory reached its highest competition ratio value in a mixture containing 60% orchard grass. In the second cutting conducted in 2018, chicory reached its highest competition ratio value in a mixture containing 80% red clover. In the third cutting conducted in 2018, chicory reached its highest competition ratio value in mixtures containing 20% and 40% orchard grass. To make a general evaluation for both 2017 and 2018, it can be said that chicory has a positive effect in mixtures with red clover (Table 5). However, considering that the red clover plants were negatively affected by drought during the summer months of 2017 and many plants died, more reliable interpretations regarding the competition ratio can be made based on the results of future studies.

4. Conclusion

The wild forms of chicory, which are very suitable for our country's ecology, are frequently encountered in every region. Considering the fact that chicory is rich in minerals and its preventive properties against swelling and parasite formation in animals, it can make a significant contribution to increase the yield and quality of artificial pasture mixes in our region and to spread the green fodder period over a wider period. According to the results obtained from this study, which was carried out for two years, the highest total fresh and hay yield was determined in the mixtures of 40%C+60%RC, 20%C+80%RC, and 80%C+ 20%RC. Considering the calculated area equivalence ratios (LER) of mixed planting plots in both years and in all forms, it was determined that all mixtures were superior to plain plantings (LER≥1). However, a red clover variety that can overcome the summer drought with the least damage in non-irrigated conditions should be selected. In order to reduce the quality roughage deficit and increase the yield and quality of pastures, especially in summer, the genotypes should be collected and examined in terms of forage yield and quality, and studies for the development of new varieties should be started as soon as possible.

Author Contributions

The percentage of the author(s) contributions is present below. All authors reviewed and approved final version of the manuscript.

	E.Ö.	İ.A.
C	50	50
D	100	
S		100
DCP	50	50
DAI	100	
L	50	50
W	70	30
CR	40	60
SR	60	40
PM	60	40
FA	50	50

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

Ethics committee approval was not required for this study because of there was no study on animals or humans.

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