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Full Length Research Paper

Effect of sowing techniques and harvesting treatments on the performances of some rotation pasture mixtures

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The objective of this study was to test the performances of some promising forage crop mixtures for rotation pastures under Mediterranean ecological conditions. The study was conducted in the experimental area of Field Crops Department of Agriculture Faculty, Aegean University, Turkey in 2004 and 2005. *Festuca arundinaceae* Schreb., *Cynodon dactylon* (L.) Pers., *Medicago sativa* L., *Trifolium repens* L. and *Lotus corniculatus* L. seeds were mixed and sown in same or alternate rows in different combinations (Fa 75% + Ms 25%, Fa 75% + Tr 25%, Fa 70% + Lc 30%, Cd 65% + Tr 35%, Cd 35% + Tr 30% + Fa 35%). Harvesting treatments were carried out by cutting at the 25% blooming stage of legume component and grazing the sward height when it reached 15 - 20 cm. The results indicated that grazing was more favourable compared to cutting in terms of various sowing technologies and harvest treatments. Fa + Ms mixture sown in alternate rows performed better than other applications with regards to the average fresh biomass and hay yield.

Key words: Pasture mixture, sowing technique, grazing, cutting.

INTRODUCTION

In Turkey and similar Mediterranean developing countries, especially in rural areas, a deficiency of animal protein is highly evident in human diet. In order to raise the level of living of the rural population and the import-export situation, an increase in animal production is needed. The main source of these countries' livestock feed is pasture lands and very limited forage crop production. Uncontrolled over-grazing practices are the most significant problems in these environmentally significant natural lands (Çomaklı et al., 2008). As a striking example, the greatest potential for increased livestock production in Turkey lies in more effective and efficient utilization of lands already devoted to livestock production, primarily by cattle and sheep. Because livestock numbers are greatly in excess for the available feed supply, severe overgrazing has caused deterioration of the existing grazing land resource in many regions. Since high quality grassland is a reliable source of biomass with high nutritive value for animal feeding (Todorova et al., 2003), pasture rehabilitation and sustainability are urgently required in these areas.

In addition to pasture improvement studies, rotation pasture establishment practices under field conditions also have great potential to increase high quality roughage production. In the Mediterranean ecologies, rotation pastures are effective sources, since they have legumes and grasses in mixtures which have favourable characteristics in terms of nitrogen fixation, high nutritive value, palatability for ruminants and adaptability to seasonal climatic changes and soil types (Avcıoğlu, 1979). Since the information related to rotation pastures has been very limited in above mentioned ecologies, this study was conducted to determine the favourable mixture alternatives for rotation pastures in addition to seeding techniques and harvest treatments.

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Abbreviations: Fa, *Festuca arundinecea*; **Cd,** *Cynodon dactylon*; **Ms,** *Medicago sativa*; **Tr,** *Trifolium repens*; **Lc,** *Lotus corniculatus*.

MATERIALS AND METHODS

The rotation pasture trial was performed in the experimental area (38°27.236 N, 27°13.576 E at about 2 m a.s.l) of the Field Crop

Table 1. Monthly average temperatures, total precipitations and average humidity recorded at Bornov, Turkey location.

Months	Temperature (ºC)			Total Precipitations (mm)			Average Humidity (%)		
	2004	2005	1960 2000	2004	2005	1960 2000	2004	2005	1960 2000
January	7.1	9.4	8.1	189.1	111.4	109.7	65.6	59.9	68.0
February	8.2	7.8	8.6	26.8	191.8	89.8	55.9	62.9	67.0
March	12.2	11.6	10.8	12.9	71.5	72.3	49.2	58.3	65.0
April	15.7	15.9	15.0	29.6	13.8	48.9	50.0	50.1	62.0
May	20.3	21.1	20.2	10.7	71.7	32.2	48.4	51.6	58.0
June	26.5	24.9	25.0	1.6	40.0	8.2	45.1	40.4	50.0
July	29.0	29.1	27.6	1.8	0.3	3.6	37.3	45.1	47.0
August	27.8	28.5	27.0	-	0.5	2.1	45.6	45.6	50.0
September	23.8	23.5	22.2	-	5.5	17.0	49.0	50.9	56.0
October	19.8	17.1	18.0	1.6	9.2	46.8	54.2	52.6	63.0
November	13.2	12.3	13.2	72.6	129.8	80.3	56.8	59.9	68.0
December	10.7	11.1	9.9	45.7	54.3	122.3	57.5	54.7	70.0
X – Σ	17.9	17.7	17.1	392.4	699.8	633.2	51.2	52.7	60.3

Department of Agriculture Faculty in Ege University, Bornova, Izmir, Turkey under Mediterranean climatic conditions in 2004 - 2005. The soil was heavy textured with 30.2% sand, 32.5% silt, 37.3% clay, 1.1% organic matter and pH of 7.8. Meteorological data are summarized in Table 1.

The field experiment was carried out with a split-split plot design (harvest treatments main plot, sowing methods sub plots and mixtures being sub-sub plots) in four replications. Two grasses (*Festuca arundinecea*, Fa and *Cynodon dactylon*, Cd) and three legumes (*Medicago sativa*, Ms; *Trifolium repens*, Tr and *Lotus corniculatus*, Lc) were seeded in different rate of mixture (Fa 75% + Ms 25%, Fa 75% + Tr 25%, Fa 70% + Lc 30%, Cd 65% + Tr 35%, Cd 35% + Tr 30% + Fa 35%) in same or alternate rows. Seeding rates were 20 kg ha^{-1} for Fa, and Ms and 10 kg ha^{-1} for other species. Individual plot size was 2 x 5 m = 10 m^2. Sowing was done in 20 cm row spacing, in same or alternate rows by hand, on October 18th, 2003. The soil was harrowed 10 days before planting, after which 50 kg ha^{-1} N, 50 kg ha^{-1} P_2O_5 and 50 kg ha^{-1} K_2O, respectively, were broadcasted and disked to produce a smooth seed bed. Grazing plots were separated from cutting plots by fencing. Since there were no significant problems of pests, diseases or weeds in the study, no chemical was applied. None of the legume seeds were inoculated with *Rhizobium* bacteria, which existed naturally in the soil. All plants were irrigated throughout the growing season according to morphological appearance of plants in both years.

The plots were cut at the 10 - 25% flowering stage of legumes with 2 - 4 cm stubble height (6 cuts in the first year and 7 cuts in the second experimental year). Plots were grazed by 30 - 35 Saanen goats for 6 h when the sward height reached 15 - 20 cm. Sampling cages (50 x 50 x 80 cm^3) in all plots were also employed for observations and measurements.

The total average results of the two years study were statistically analyzed using ANOVA (analysis of variance) with the statistical analysis system (SAS, 1990) and differences between treatment means were compared using the least significant difference (LSD) test at 5% probability.

RESULTS AND DISCUSSION

Cover

Highest cover rate (82.1%) was obtained from Fa + Tr mixture plots (Table 2). Significant effect of sowing methods on the cover rate was also recorded and average cover rate in same-rows was better than that of alternate-rows. Cover characteristic of vegetations is a significant indicator of successful agronomic performances of individual plants in the vegetation which reflects a dense canopy in the sward (Brown, 1957). Our results confirmed this approach. Harvesting methods were also significantly effective on average cover rate. Also grazing treatment provided better covers (83.1%) than cutting (73.5%). Some researchers have proved that some of the crops in the vegetation could get rid of detrimental effects of grazing and go on with living and biomass producing, unlike in cutting (Matthes, 1968; Avcıoğlu, 1979). Our results were in accordance with these findings. On the contrary, D'Ottavio et al. (2003) declared that there were no significant differences between its use as pasture or meadow in Italian alpine regions.

Vegetation height

The highest vegetation was obtained in Fa and Ms mixture as a result of the morphological structure of these forage crops which had erect growing habit with intensive tillers. Previous researchers confirmed that Ms and Fa have many morphological advantages such as vigorous

Table 2. Effect of sowing techniques and harvesting treatments on cover, vegetation height, botanical composition (legume, grass and other family), fresh biomass and hay yield traits of some rotation pasture mixtures.

Mixtures	Cover (%)	Vegetation height (cm)	Botanical Composition (%)			Fresh biomass yield (kg ha^{-1})	Hay yield (kg ha^{-1})
			Legume	Gramineae	Other families		
Fa + Ms	79.8	66.02	32.79	65.00	2.21	51870	13504
Fa + Tr	82.1	38.25	16.04	80.44	3.52	43790	11170
Fa + Lc	75.7	40.74	11.48	84.63	3.89	42570	11076
Cd + Tr	79.2	31.22	20.63	62.57	16.80	35960	9353
Cd+Fa+Tr	74.9	37.66	32.63	43.94	23.43	37440	9748
LSD	2.6	0.66	0.95	0.89	1.00	780	588
F-test	**	**	*	*	*	**	**
Sowing techniques							
Same-rows	79.5	44.32	22,78	67.63	9.36	41775	10567
Alternate-rows	77.2	41.19	22.64	67.00	10.41	42865	11373
LSD	1.6	0.40	ns	ns	0.87	280	372
F-test	**	**	ns	ns	*	**	**
Harvest techniques							
Grazing	83.1	44.92	24.72	66.20	8.84	43400	11336
Cutting	73.5	40.60	20.70	68.43	10.93	41250	10604
LSD	1.2	0.11	0.61	0.24	0.80	430	234
F-test	**	**	*	*	*	**	**

ns: Not significant.

growth with erect stems and rich tillering (Avcıoğlu, 1979; Hubard and Nicholson, 1964). Cd and Tr mixture had lower vegetation heights. This was due to the prostrated growing habits of this grass and legume crops (Beard, 1973; Avcıoğlu et al., 2009), although Cd was a fast growing warm season grass.

There was also significant difference in terms of average vegetation height between sowing techniques; same-rows (44.32 cm) being higher than alternate-rows (41.19 cm). This result revealed that the accompanying crops had better conditions for competing for light in same-rows (Avcıoğlu et al., 2009b).

Effects of harvest treatments (grazing and cutting) on vegetation height were also significant. Average vegetation height of grazing treatment (44.92 cm) was higher than cutting (40.60cm), indicating, most probably, more adverse effects of cutting than grazing on the mixture crops. It is a fact that cutting versus grazing or vice versa has been discussed by scientist for many years (Bubar, 1964; Smith and Nelson, 1967; Matthes, 1968). Some researchers pointed out the advantages of grazing over cutting (Sawnhey and Anderson, 1963; Avcıoğlu, 1979), although others indicated controversial results. Our results confirmed favourable impacts of grazing on this type of vegetation.

Botanical composition

Botanical composition data also indicated significant difference among the mixtures mainly in terms of rate of legume component. Higher average legume rates were recorded in Fa + Ms and Cd +Fa + Tr mixtures.

There was no significant difference between same or alternate-row sowings with regards to the legume component but average legume rates in grazing were higher than in cutting. In an attempt to compare the effect of defoliation techniques (cutting and grazing treatments) on rye grass persistency and tillering, Evans et al. (1998) revealed that grazing was more favourable than cutting and contrasting impacts of cutting and grazing management on sward components were obvious.

Average rate of grass component in the mixtures was highest (86.63 %) in Fa + Lc mixture and also high in Fa + Tr mixture (80.44 %), whereas grass component rate (43.94 %) was quite limited in Cd + Fa + Tr mixture. Others which generally represented weeds in the sward were higher in Cd + Fa + Tr (23.43%) and Cd + Tr mixture (16.80%). Since Tr is a cold season leguminous forage crop, it was concluded that Mediterranean hot climatic conditions were harmful to this component and a limiting factor for its regeneration. In addition, Tr is replaced mostly by weeds particularly during hot periods (Kadziuliene, 2003).

There was no significant difference between sowing methods for average rate of other families, but alternate-rows generally had higher values than the same rows. Although the statistical analysis indicated a significant variation between the harvest treatments, grass and other

family rates in the mixtures were quite similar and generally higher than legume component in both harvest treatments.

Fresh biomass yield (kg ha^{-1})

Total fresh biomass yield particularly increased in Fa containing mixtures and the mixture with Ms had also the highest fresh biomass yield (51870 kg ha^{-1}). Due to the aggressive and competitive growth habits of Fa and Ms, higher yield values were recorded in these mixtures. Demiroğlu and Avcıoğlu (2006) also reported that Fa and Ms are generally dominating legume and grass components in pasture mixtures. There was also significant difference between sowing techniques and alternate-rows having highest average fresh biomass yield (42865 kg ha^{-1}). This finding suggested that alternate row spacing was in favour of mixture crops in terms of competition for nutrients and water. Effect of harvest treatments on fresh biomass yield was also significant and average fresh biomass yield in grazing (43400 kg ha^{-1}) was higher than the average yield of cutting treatment (41250 kg ha^{-1}). Previous studies are consistent with the results of our study (Miles, 1960). Frame and Hunt (2006) also investigated the effects of cutting and grazing systems of herbage production in a perennial rye grass-dominant sward. Grazing treatments averaged 14 - 16% more of organic matter and 36 - 45% more of crude protein than cutting treatments. They suggested that these differences might be ascribed to recycling of N under grazing.

Hay yield (kg ha^{-1})

Hay yield differences among the mixtures were significant and Fa + Ms mixture had the highest average values (13504 kg ha^{-1}). Average hay yield of alternate-rows was also higher than those of same-rows. There were also significant difference among the harvest treatments in terms of hay yield, and the average yield of grazing treatment (11336 kg ha^{-1}) was found to be higher than cutting treatment (10604 kg ha^{-1}). It was also suggested that data related to fresh biomass yield were quite similar to hay yield results, most probably, because of the calculation procedures for hay yield data for which fresh biomass yield built up the basement.

Conclusion

It was concluded that when a rotation pasture establishment under Mediterranean climatic conditions is targeted, Fa + Ms mixture should be preferably seeded in alternate rows, mostly, and harvested by grazing.

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