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EFFECTS OF GRAZING ON SOME YIELD AND QUALITY TRAITS OF A ROTATION PASTURE MIXTURE UNDER MEDITERRANEAN ENVIROMENTAL CONDITIONS

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ABSTRACT

This study was conducted in the experimental fields of Field Crops Department of Agriculture Faculty in Ege University, Bornova, İzmir-TURKEY under Mediterranean environmental conditions in the years, 2003-2009. Three legumes (*Medicago sativa, Lotus corniculatus* and *Trifolium resupinatum*) and four grasses (*Bromus inermis, Festuca arundinaceae, Dactylis glomerata and Arrhenatherum elatius*) with *Sanguisorba minor* were sown in rows 15 cm apart and tested for some yield and quality characteristics under cattle grazing regime. *Medicago sativa* and *Festuca arundinaceae* were the permanent and most successful legume and grass in the mixture in terms of botanical composition and cover traits throughout the experimental years. With respect to dry matter and crude protein yield characteristics, same components of the mixture also performed very well and have been evaluated as recommendable for all resembling Mediterranean environments. It was also suggested that *Lotus corniculatus* and *Arrhenatherum elatius*, both exhibiting stable and sustainable dry matter and crude protein yield contribution to overall performances of the sward, should be included in this type of Mediterranean pasture mixture. The general performance of this rotation pasture mixture was quite sustainable and suggested to utilize the sward economically for another couple of years.

Key words: rotation pasture, Mediterranean climate, botanical composition, cover, dry matter and crude protein yield

INTRODUCTION

Pasture degradation is the most significant factor reducing productivity in animal husbandary due to the fewer incentivity for individuals to reduce grazing pressure such as limiting number of animals, grazing period and timely grazing of pasture in Turkey and resembling Mediterranean developing countries (Tan et al., 2000).

Because of long years of overgrazing, the pastures have not only lost productivity but also their quality. Depending on the zone and grazing pressure, plant cover of these pastures are very poor and as a result of above mentioned negative impacts, naturel pastures in these regions are far from being able to fullfill their main functions. Dramatically reduced plant covers of these grazing lands are now unable to hold the soil, causing severe wild and water erosion. These degraded lands are the least productive resources and can not be reclaimed and managed economically in the short term (Karagöz, 2009).

Despite Turkey and neighbouring Mediterranean countries faces many problems on productivity of grasslands and forage crop cultivation, there is also great potential for developing forage sources and improving feed resources for farm animals to reduce the grazing pressure on pastures, ensuring their sustainability.

Establisment of temporary or seasonal grazing areas, forage production in fallow lands under dryland conditions and enhancing hay and silage crop production are among the measures to the taken. Nevertheles, artificial pasture establishment, particularly rotation pastures in arable lands are also an effective way of increasing forage sources of the developing mediterranean countries (Avcioglu et al., 2007).

There are many forage crop choices to concider in rotation pasture establishment for 3-4 or more years in arable lands, on the contrary, legumes and grasses favourable under Mediterranean ecological conditions are quite limited due to the extremely hot and dry weather influences on plant growth. Various research studies indicated that some, C-3 and C-4 crops possessing resistance, tolerance and adaptation capacity to these harsh conditions were highly productive under above mentioned environmental conditions (Skuodiene, 2003; Sparnina and Bumane, 2003; Avcioglu et al., 2009; Geren et al., 2010). Concidering those promising crop material, this research study was aimed and conducted to test the yield and quality performance of a rotation pasture mixture under Mediterranean environmental conditions in succeeding years, 2003-2009.

MATERIALS AND METHODS

The experiment was carried out for 7 years (2003-2009) on a silty-sand loam soil with 7.1 pH in the area (35 m a.s.l., lat. 37°45´N, long. 27°24´E). Soil properties (soluble salt

Table 1. Monthly average temperatures and total precipitations at Bornova-Turkey Location.

Months	Temperature (ºC)								Total Precipitations (mm)							
	2003	2004	2005	2006	2007	2008	2009	1960 2009	2003	2004	2005	2006	2007	2008	2009	1960 2009
January	11.1	7.1	9.4	6.9	10.6	7.6	10.5	8.1	112.6	189.1	111.4	56.5	19.7	30.0	204.1	109.7
February	4.9	8.2	7.8	9.6	10.6	9.3	10.0	8.6	153.3	26.8	191.8	98.6	54.2	9.0	165.2	89.8
March	8.6	12.2	11.6	12.1	13.4	15.2	11.7	10.8	12.1	12.9	71.5	129.7	14.8	6.0	175.7	72.3
April	12.7	15.7	15.9	17.4	16.2	18.0	16.0	15.0	109.7	29.6	13.8	27.0	35.4	62.0	83.8	48.9
May	21.3	20.3	21.1	21.1	22.4	21.0	21.4	20.2	8.5	10.7	71.7	-	31.5	5.0	44.3	32.2
June	27.2	26.5	24.9	25.7	27.5	26.9	26.2	25.0	0.8	1.6	40.0	19.2	6.8	0.4	9.2	8.2
July	28.6	29.0	29.1	28.1	30.1	28.6	29.0	27.6	-	1.8	0.3	-	-	-	-	3.6
August	28.5	27.8	28.5	29.2	29.2	29.2	27.9	27.0	-	-	0.5	-	-	-	-	2.1
September	22.5	23.8	23.5	23.8	24.4	23.9	23.2	22.2	-	-	5.5	133.5	7.0	55.0	51.2	17.0
October	19.7	19.8	17.1	19.2	19.7	19.6	20.8	18.0	68.5	1.6	9.2	56.3	74.5	12.0	26.3	46.8
November	13.1	13.2	12.3	12.4	13.9	15.7	14.6	13.2	18.0	72.6	129.8	63.1	138.5	93.0	160.3	80.3
December	9.5	10.7	11.1	9.7	9.0	11.5	13.1	9.9	95.6	45.7	54.3	9.1	127.0	101.0	151.8	122.3
X - Σ	**17.3**	**17.9**	**17.7**	**17,9**	**18.9**	**18.9**	**18,7**	**17.1**	**579.1**	**392.4**	**699.8**	**593.0**	**509.4**	**373.4**	**1071,9**	**633.2**

0.009%, organic matter 1.13%, total N 0.12%, available P 360 ppm, K 400 ppm, Ca 5400 ppm) indicated that there was not any limiting factor in terms of soil properties to grow crops for herbage under grazing practices. Average annual temperature and precipitation data through experimental years (17.3, 17.9, 17.7, 17.9, 18.9, 18.9, 18.7 ºC and 579, 392, 699, 745, 487, 427, 1072 mm, in 2003 to 2009 respectively, were generally in accordance with long term average (17.1ºC and 633 mm) except also 2004, 2007, 2008 and 2009 (Table 1). After conventional seed bed preparation, a mixture of *Medicago sativa* (Ms) (10%, 3 kg ha^{-1}), *Lotus corniculatus* (Lc) (15%, 2.5 kg ha^{-1}), *Trifolium resupinatum* (Tr) (5%, 2 kg ha^{-1}) and grasses (*Bromus inermis* (Bi) (15%, 5 kg ha^{-1}), *Festuca arundinacea* (Fa) (25%, 5 kg ha^{-1}), *Dactylis glomerata* (Dg) (10%, 5 kg ha^{-1}), *Arrhenatherum elatius* (Ae) (15%, 6.5 kg ha^{-1}) and *Sanguisorba minor* (Sm) (5%, 1 kg ha^{-1}) were sown on a 7 ha lowland field in 15 cm row spacing on November, 21st 2002 (Avcioglu, 1981).

A total of 200 kg ha^{-1} NPK fertilizer was applied in early spring of each year. The experimental design was randomised plots (100x 100m) with 4 reps. Irrigation was applied regularly based on a proper soil tensiometer measurements. Pasture plots were grazed by dairy cattle for a week during each harvest period. Data were collected by 2 portable cages sized 2 x 1 m^2 in each plot. Botanical composition data were collected 3 times a year (April, July, October) prior to grazing. Cover rates of mixture crops and weeds (W) were assessed using quadrate (1 x 1 m^2) technique (Brown, 1963).

After the determination of amount and rate of all species in the herbage samples taken in mid-season cut, half of the seperated samples were dried in oven at 105 ^{0}C to a constant weight for dry matter content. Other halves of the samples were dried at 78 C for 18 hours and dried samples were ground and the amount of N was determined using the Kjehldal method. The amount of N from each sample was multipled by 6.25 and crude protein content was calculated for each crop component in the mixture. Data indicating overall performances of crop material throughout the seven years were statistically analyzed and summarized in Table 1 and Table 2. In variation analysis, the least significant difference (LSD) test was performed.

RESULTS AND DISCUSSION

Botanical Composition

Botanical composition data obtained from the swards were highly variable in terms of legume, grass and weed components (Table 2). Long term (7 yr) performance of experimental crops indicated the increased rates of *Ms* and *Fa* in the swards, but decreasing rates of *Tr* and *Dg* which is a grass well-known for its aggressive growth and competitive ability under continental climatic conditions (Lacefield et al., 2003). Another striking point among the results was that of a steady increase of weed infestation throughout the experimental years. Warda and Krywiec (2002) and Kadziulis and Kadziuliene (2002) revealed that, indigenous species are strong competitive crops and an acceptable rate of existence is unavoidable. *Ae* and *Sm* sustained a reasonable percentage in botanical composition due to their adaptation peculiarities under well irrigated and drained arable field conditions (Avcioğlu et al, 2009). The limited performances of *Dg*, *Bi* and particularly *Tr* which disappeared in the vegetation after 4 years, may be attributed to the restrictive effects of Mediterranean environmental factors prevailing in the experimental area.

Cover

General cover rate values in succeeding years demonstrated the gradually decreasing ratios of mixture

Table 2. Botanical compositions (%) and total cover (%) in succeeding years

Botanical compositions (%)								
Crops	2003	2004	2005	2006	2007	2008	2009	Mean
Ms	12.2	13.8	15.7	17.2	23.7	18.4	18.6	17.1
Lc	8.6	11.0	9.6	13.3	8.7	9.2	11.8	10.3
Tr	14.2	10.8	4.3	1.1	0.0	0.0	0.0	4.3
Bi	8.1	7.6	9.2	8.8	6.9	10.1	5.6	8.0
Dg	18.3	13.9	11.4	7.6	5.1	3.8	1.1	8.7
Ae	12.3	11.5	9.7	11.1	9.4	11.2	11.1	10.9
Fa	16.7	21.1	23.8	24.4	26.6	28.7	30.7	24.6
Sm	7.1	6.6	8.4	5.3	6.4	6.2	6.7	6.7
W	2.5	3.7	7.9	11.2	13.2	12.4	14.4	9.3
Σ								
LSD (.05)→ Year: ns Crops: 0.7 Year x Crops: 1.9								
Cover (%)								
Crops	2003	2004	2005	2006	2007	2008	2009	Mean
Ms	17	19	14	17	20	17	15	17
Lc	6	11	7	13	8	9	11	9
Tr	14	8	3	2	0	0	0	4
Bi	6	5	10	7	5	6	4	6
Dg	15	10	8	6	3	3	1	6
Ae	11	8	10	10	7	9	10	9
Fa	17	19	21	23	22	24	25	22
Sm	6	5	9	4	6	4	4	5
W	4	2	7	12	11	9	12	8
Σ	96	88	90	93	84	79	83	
LSD (.05)→ Year: 0.6 Crops: 0.7 Year x Crops: 1.9								

M. sativa (Ms), *L. corniculatus* (Lc), *T. resupinatum* (Tr), *B. inermis* (Bi), *D. glomerata* (Dg), *A. elatius* (Ae), *F. arundinaceae* (Fa), *S. minor* (Sm), Natives-weed (W)

crops, although Ms, Fa and Lc maintained satisfactory cover rates. This result may be due to the natural thinning of mixture crops and mainly because of partial weed competition and eventually infestation (Table 2). Moreover, in addition to restrictive impacts of Mediterranean ecological factors, it is obvious that grazing has to some extent adverse effect on pasture crops, and decreasing change of cover rates in the swards are expected. Lüscher and Aeschlimann (2006) pointed out the most probable detrimental effects of grazing on swards in addition to trampling and dung accumulation. Despite the increasing weed infestation and decreasing cover ratios of mixture crops, gradually increasing total yield performances were generally recorded during the experimental years (Table 2).

Dry Matter Yield

There were significant differences among the dry matter (DM) yields of mixture crops and year totals in the duration of experimental years (Table 3). Sward total DM yields increased until 2006 and decreased in the succeeding years (2007-2009). DM yield data also confirmed that *Ms* and *Fa* performed far better than other legumes and grasses in the sward. These results may be attributed to the well-known adaptive capacity of none-hardy *Ms* cultivars and heat and drought resistant *Fa* crops under Mediterranean conditions (Hall et al., 2009). *Lc* and *Ae*, displaying satisfactory and sustainable DM yields in the course of experimental years, performed also better than *Tr* and *Dg*. The latter species are known as being susceptible to high atmospheric heat, light intensity and low air moisture, which are the essential characteristics of Mediterranean climate (Hall et al, 2009). Our results confirmed related information given by Lacefield et al. (2009) and Deak et al. (2007).

Existing as an indigenous species in the lowland areas of the region, *Sm* maintained a reasonable performance in sward, whereas weeds invaded the gaps left by disappearing individuals of *Tr*, *Bi* and *Dg* (Søegaard, 2002). The results of the long-term dry matter yield tests in the experiment supported the approach pointing out the promising performances of the sward through the contributions provided particularly by *Fa*, *Ms*, *Ae* and *Lc* in the mixture.

Table 3. Dry matter and crude protein yield (kg ha^{-1}) of mixture crops in succeeding years

DM yield (kg ha^{-1})								
Crops	2003	2004	2005	2006	2007	2008	2009	Mean
Ms	875	1190	2210	2470	3005	2490	2145	2055
Lc	645	950	1325	1665	1165	1200	1430	1197
Tr	1005	640	350	45	0	0	0	291
Bi	415	395	970	860	635	955	385	659
Dg	960	1080	1255	810	510	370	85	724
Ae	680	995	1040	1410	940	1305	965	1048
Fa	1198	1534	3888	4119	3698	4272	3746	3208
Sm	351	615	915	505	875	568	82	559
W	219	390	835	1380	1305	1230	1610	996
Σ	6348	7789	12788	13264	12133	12390	10448	
LSD (.05)→ Year: 36 Crops: 41 Year x Crops: 108								
Crude protein yield (kg ha^{-1})								
Crops	2003	2004	2005	2006	2007	2008	2009	Mean
Ms	180	225	472	579	590	478	502	432
Lc	118	158	254	291	237	238	303	228
Tr	204	123	66	9	0	0	0	57
Bi	48	39	104	75	59	110	45	69
Dg	95	92	99	74	46	35	9	64
Ae	94	104	131	185	123	168	138	135
Fa	97	117	356	365	268	340	361	272
Sm	45	88	99	68	120	73	12	72
W	25	38	110	119	136	98	183	101
Σ	906	984	1690	1766	1580	1540	1552	
LSD (.05)→ Year: 9 Crops: 10 Year x Crops: 26								

Crude Protein Yield

Crude protein yield of forage crops are of great significance in animal husbandry (Ayhan et al., 2006) Total crude protein yield of mixture was highest in 2006, 4 years after establishment and the total crude protein yield values of experimental years maintained a reasonable trend in succeeding years (Table 3). The major contributions were

provided by Ms (432 kg ha $^{-1}$), and Lc (228 kg ha $^{-1}$) which were high yielding and higher crude protein containing legume crops in the mixture and Ae (135 kg ha $^{-1}$) and Fa (272 kg ha $^{-1}$).

It should also be emphasized that warm season type of alfalfa cultivar and birdsfood trefoil grown in the experiment, which are heat and drought resistant crops, performed very well under Mediterranean environmental conditions of the experimental area (Soya et al., 1997; Radovic et al., 2003). Lazaridou and Noitsakis, (2003) demonstrated similar results and pointed out the significance and advantages of such leguminous forage crops to be included in this type of rotation pasture mixtures grown in arable lands of Mediterranean regions.

CONCLUSION

We concluded that *Medicago sativa* and *Festuca arundinaceae* were the permanent and most successful legume and grass crops in the mixture in terms of botanical composition and cover traits throughout the experimental years. With respect to dry matter and crude protein yield characteristics, same components of the mixture also performed very well and have been evaluated as recommendable for all resembling Mediterranean environments. It was also suggested that *Lotus corniculatus* and *Arrhenatherum elatius*, both exhibiting stable and sustainable dry matter and crude protein yield contribution to overall performances of the sward, should be included in this type of Mediterranean pasture mixture. The general performance of this rotation pasture mixture was quite sustainable and suggested to utilize the sward economically for another couple of years.

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