YIELD POTENTIAL AND MINERAL COMPOSITION OF WHITE CLOVER (TRIFOLIUM REPENS L.)-TALL FESCUE (FESTUCA ARUNDINACEA SCHREB.) MIXTURES

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ABSTRACT

White clover was sown with tall fescue as tall fescue 25 %+white clover 75 %, tall fescue 50 %+white clover 50 %, tall fescue 75 %+white clover 25 %, 100% tall fescue and white clover. Plots were 2.5 x 5.0 m, arranged in a randomized block design with three replicates. Row distance 25 cm and sowing rates 10 kg ha^{-1} (white clover) and 20 kg ha^{-1} (tall fescue) were used. Plots were mowed about 5 cm (stubble height) and then allowed to re-grow to 25-30 cm (plant height). The green fodder yield, dry matter, crude protein, crude cellulose, K/P, Ca/P, Ca/Mg, K/Mg and Ca/K ratios were determined.

KEYWORDS: crude cellulose, crude protein, dry matter, green fodder yield, mineral contents

DETAILED ABSTRACT

The investigation was carried out in 2001-2003 on xeralf soil with pH 7.3 on the experimental area of Tekirdağ Agriculture Faculty, in Trakya University located at (40º 59´N, 27º 34´E), about 5 m altitude above sea level, with a typical subtropical climate. White clover was sown with tall fescue as follow: tall fescue 25 %+white clover 75 %, tall fescue 50 %+white clover 50 %, tall fescue 75 %+white clover 25 %, 100 % white clover and tall fescue. Three cuts were taken each year at full-bloom stage of white clover. The plots were cut about 5 cm (stubble height) and then allowed to re-grow to 25-30 cm (plant height). The green fodder yield was determined in one square meters and the yield of per hectare calculated. Botanical composition (grasses %, legumes % and forbs %) of the samples was determined on a dry matter basis after hand separation. The plots were not irrigated or fertilized after sowing and cutting. The dry matter (DM), crude protein (CP), crude cellulose (CC) contents and K/P, Ca/P, Ca/Mg, Ca/K and K/Mg ratios were determined. 25 % white clover + 75 % tall fescue mixture exhibited higher values than the other mixtures for the green fodder yield (17.69 t ha^{-1}). The DM ranged from 5.03 to 7.21 t ha^{-1}, the highest DM being determined in 25 % white clover + 75 % tall fescue mixture (7.21 t ha^{-1}), followed by 50 % white clover + 50 % tall fescue mixture (6.66 t ha^{-1}), 75 % white clover + 25 % tall fescue mixture (6.23 t ha^{-1}), pure white clover (6.09 t ha^{-1}) and pure tall fescue (5.03 t ha^{-1}). The CP in mixtures varied from 16.90-22.56 %. The highest CC contents (25.43-26.60 %) were determined for pure tall fescue and 75 % grass + 25 % clover mixture, respectively. The Ca/P, Ca/K, and Ca/Mg ratios for mixtures were changed 2.60-3.41, 0.64-0.79 and 1.95-2.37, respectively. The highest K/Mg ratio (3.62) was obtained from the pure tall fescue.

INTRODUCTION

Pastures can furnish high quality, low-cost feed for domestic animals. Efficient use of pastures, however, requires very careful planning and good management of both animals and forage crops. However, careless planning and bad management of pastures in the world has resulted in a great deficiency in forage production. However, permanent pastures were decreased. Permanent grasslands decreased in Turkey, progressively 46, 37, 24 and 9 million hectares in 1950, 1960, 1980 and 2001 respectively, while 15 EU countries' grassland to became less slowly like 64, 62, 59 and 56 million hectares in 1970, 1980, 1990 and 2000, respectively [6, 14]. Continuous reduce of grassland in EU and especially in Turkey has resulted in a great deficiency in forage production.

There are several advantages to growing grass-legume mixtures in pastures. Legumes fix nitrogen (N), which can be used by the grass. This offsets the need for yearly topdressing of grass with N. Mixtures are also more productive during midsummer and have a higher nutritional value than grass alone. The mixtures protect against bloat, and increases longevity and production of the pasture. Grass-legume mixtures will usually result in better forage production and animal performance than will a single species grown alone. The choice of what species to grow on a particular site should be based on (a) species adaptation to the site, (b) species response to the grazing system, (c) potential forage yield and seasonal distribution, (d) palatability and nutritional value, and (e) persistence. In general, the low-growing, less productive species such as white clover or birdsfoot trefoil (Lotus corniculatus L.) persist better under close continuous grazing than the taller-growing species such as alfalfa (Medicago sativa L.) or sainfoin (Onobrychis sativa Lam.). When selecting a species for pasture, choose one that will perform best under the grazing system being used [6].

Establishing seeded grass-legume mixtures is one of the quickest ways to increase the quality forage production. The aim of this research was determine the yield potential and mineral contents in white clover-tall fescue mixtures.

MATERIALS AND METHODS

The investigation was carried out in 2001-2003 on xeralf soil with pH 7.3 on the experimental area of Tekirdağ Agriculture Faculty, in Trakya University located at (40º 59´N, 27º 34´E), about 5 m altitude above sea level, with a typical subtropical climate. The soil of experimental area was clay, low in organic matter (0.87 %), moderate in phosphorus content (61.7 kg ha^{-1}), and rich in potassium content (600.1 kg ha^{-1}). The climatic conditions are given in table 1.

A material of tall fescue (cv. Apache) and white clover (cv. Klondike) were provided by the Ulusoy Tohumculuk Üretim ve Pazarlama Şirketi, Ankara in Turkey. White clover was sown with tall fescue as follow:

Tall fescue 25 %+white clover 75 %

Tall fescue 50 %+white clover 50 %

Tall fescue 75 %+white clover 25 %

Tall fescue 100 %+ white clover 0 %

White clover 100 %+ tall fescue 0 %

The seed rates for each species in mixtures were calculated according to the equations [Utilization Value (UV) = Seed purity (%) x Germination ratio (%) / 100; Seed Rate in Mixture (kg ha^{-1}) = Ratio of plants in mixture (%) x

Sowing rate (kg ha^{-1}) / UV] reported by Avcıoğlu [5]. Plots were 2.5 x 5.0 m, arranged in a randomized block design with three replicates. Each plot consisted of 10 rows 25 cm apart and 5 m in length. The seeds were sown at a rates of 10 kg ha^{-1} (white clover) and 20 kg ha^{-1} (tall fescue) [3, 4, 16] on February 10th in 2001. Three cuts were taken each year at full-bloom stage of white clover. The plots were cut about 5 cm (stubble height) and then allowed to re-grow to 25-30 cm (plant height). The green fodder yield was determined in one square meters and the yield of per hectare calculated. Botanical composition (grasses %, legumes % and forbs %) of the samples was determined on a dry matter basis after hand separation. The plots were not irrigated or fertilized after sowing and cutting.

Approximately 500 g samples were dried at 78°C for 24 h, to determine the dry matter content (DM) [20, 21]. The crude protein (CP) and crude cellulose (CC) contents were determined using the micro-Kjeldahl and Weende methods. Wet combustion in a 2:1 mixture of HNO_3 and $HClO_4$ was used for mineral element analysis of samples. The phosphorus (P) content was determined by the vanadomolybdate yellow color. The calcium (Ca) and magnesium (Mg) contents were determined using an atomic absorption spectrophotometer; potassium (K) content was determined using flame photometer following the methods described by Tekeli et al. [22]. After mineral element contents (elemental form) determined, the K/P, Ca/P, Ca/Mg, Ca/K and K/Mg ratios were calculated. The results were analyzed using the TARIST statistical program.

RESULTS AND DISCUSSION

Total yield, quality and seasonal distribution of forage may be greater importance to the livestock producer. The most important aspect of forage quality is the amount of usable or metabolic energy consumed by the animal. Forage quality is usually measured by the amount and availability of nutrients contained in the forage. The ultimate test of forage quality, however, is animal performance. Quality can be considered satisfactory when animals consuming the forage perform as desired. Three factors which effect animal performance are: (a) Intake-forage must be palatable if it is to be consumed in adequate quantities to produce the desired performance. (b) Digestibility nutrient content-once the forage is eaten; it must be digested and converted to animal products. (c) Toxic factors-the forage must be free of components which are harmful to the animals. Many factors affect forage quality for animal so that no one characteristic can serve to predict animal production. Some of the important factors that determine forage quality for animal are stage of maturity, chemical composition, legume-grass ratio, physical form, foreign material (particularly weeds and dust), damage or deterioration during harvest and storage, and the presence of anti-quality substances such as estrogens, thyrotoxic factors, and toxic amines and their condensation products.

There were significant ($P<0.01$) differences among white clover-tall fescue mixtures for green fodder yield, DM, CP and CC ratios statistically (Table 2 and 3). 25 % white clover + 75 % tall fescue mixture exhibited higher values than the other mixtures for the green fodder yield (17.69 t ha^{-1}). The DM ranged from 5.03 to 7.21 t ha^{-1}, the highest DM being determined in 25 % white clover + 75 % tall fescue mixture (7.21 t ha^{-1}), followed by 50 % white clover + 50 % tall fescue mixture (6.66 t ha^{-1}), 75 % white clover + 25 % tall fescue mixture (6.23 t ha^{-1}), pure white clover (6.09 t ha^{-1}) and pure tall fescue (5.03 t ha^{-1}) ($P<0.01$). Elgersma et al. [7] and Hall [8] reported 10.60-15.70 t ha^{-1} DM from grasses-legumes mixtures, whereas Søegaard [17] found this value to be only 1.99 t ha^{-1}. The DM values recorded in the present experiment were lower than those reported by Elgersma et al. [7] and Hall [8]. When the clover rates increased in mixture, CP content increased and CC of herbage decreased as expected (Table 3). The CP in mixtures varied from 16.90-22.56 %. The highest protein ratio was determined from the pure white clover. The present results were similar by Stypiňski [18], Hannaway et al. [10] and Hall [9]. They reported that the CP (12.00-26.60 %) in mixtures was increased while white clover rates in increasing.

After plant cell growth stops, cell walls thicken and the secondary wall is formed. In contrast to primary walls, secondary walls do not contain protein and may vary significantly in composition and structure among cell types. Secondary walls consist of a network of cellulose fibrils embedded in an amorphous matrix of hemi-cellulose, pectin and lignin. Generally, young plant cell walls are richer in pectin and lower in cellulose than older plant cell-walls. CC content usually correlates with digestibility of dry matter only to the extent that its availability is determined by lignifications or other limiting factors [19]. The highest CC contents (25.43-26.60 %) was determined for pure tall fescue and 75 % grass + 25 % clover mixture, respectively, which is in agreement with the figure 22.70-37.60 % reported by Açıkgöz [1].

Mineral elements are containing approximately 1.5-5 % of animal body [22]. NRC [13] reported that the requirement for major mineral nutrients for gestating beef cows or lactating beef cows is 0.60-0.80 % (w/w) for K, 0.18-0.44 % for Ca, 0.18-0.39 % for P, and 0.04-0.10 %

for Mg. Mineral elements balance are very important to keep animal health. A lack of one mineral element content can not be balanced the others. These elements could be certain ratio. For example, Ca and P are closely related to animal health and metabolism. It is very important to keep a proper balance of Ca and P in relation to vitamin D. A desirable ratio of Ca/P is between 2:1 and 1:1 [12]. Allison [2] suggested that when concentrations of K and nitrogen (N) are high, 0.25 % Mg in the forage may be required to prevent grass tetany. The tetany ratio is greater than 2:2; the forage is classified as tetany-prone [11]. The pure white clover exhibited higher value than the other mixtures for the K/P (6.31) ($P<0.01$) (Table 3). The Ca/P, Ca/K, and Ca/Mg ratios for mixtures were changed 2.60-3.41, 0.64-0.79 and 1.95-2.37, respectively (Table 4). The highest K/Mg ratio (3.62) was obtained from the pure tall fescue ($P<0.05$). Rodriguez Julià [15] reported 6.25 K/P, 2.64 Ca/P and 0.45 Ca/K ratios from white clover-grass mixtures, similar to the present findings.

CONCLUSION

Total yield, quality and seasonal distribution of forage may be greater importance to the livestock producer. Growing white clover with tall fescue yield and distribution are balanced throughout the growing season. Besides, all mixtures were given a balanced feed for animals throughout the growing season. However; 25% white clover + 75% tall fescue mixture can be sown maximum forage yield in subtropical regions at dry land condition.

REFERENCES

[1] Açıkgöz E. Forage Crops. (3rd Edition) Uludağ Univ. Güçlendirme Vakfı Press No: 182, VİPAŞ AŞ Press No: 58, Bursa, 2001, 75-179.

[2] Allison C. Controlling Grass Tetany in Livestock. Guide B-809. New Mexico State University Press, Mexico, 2003, 2.

[3] Ates E., Tekeli A.S. Effects of row distances and cutting dates on herb yield and some morphological characters of Persian clover (T. resupinatum L.). Cuban J. Agric. Sci. 38 (2004), 317.

[4] Ateş E., Tekeli A.S. Assessing heritability and variance components of agronomic traits of four alfalfa (M. sativa L.) cultivars. Acta Agronomica Hungarica 52 (2004), 263.

[5] Avcıoğlu R. Turfgrass Techniques: Sowing, Planting and Maintenance of Grasslands. Ege University Press, İzmir, 1997, 128-130.

[6] Cherney J.H., Fick G.W. Perennial Forages for Pasture (Forage Crops Guidelines). Cornell Cooperative Extension in the Department of Crop and Soil Sciences, College of Agric. and Life Sci., 2001 Cornell Guide for Integrated management, Cornell University Extension Publications, USA, 2001, 76-78.

[7] Elgersma A., Schlepers H., Van Wenum J.H. Performance of white clover - perennial ryegrass mixtures under cutting. White clover in Europe: State of the art REUR Technical Series 29 Food and Agriculture Organization of the United ATIONS, 1993, 3-4.

Table 1: Monthly precipitation, mean temperature, relative air humidity, and long term mean (LTM= 1960-2003) in the experimental area.

Months	Total Rainfall (mm)				Mean Temperature (ºC)				Relative Air Humidity (%)			
	2001	2002	2003	LTM	2001	2002	2003	LTM	2001	2002	2003	LTM
January	50.0	14.7	95.8	56.5	7.3	3.7	7.1	4.9	87.2	79.1	82.8	82.6
February	86.6	35.9	105.8	51.4	7.2	8.2	1.1	5.2	79.3	78.7	77.3	80.5
March	22.8	55.0	20.1	56.4	12.3	9.4	4.5	7.2	74.5	76.2	77.0	80.4
April	68.6	37.9	75.8	44.4	12.4	10.9	8.8	11.9	76.5	74.0	79.7	78.4
May	57.2	5.6	5.6	39.1	16.9	17.1	17.9	16.5	67.0	68.6	75.6	76.9
June	9.2	43.8	9.8	35.3	21.3	22.3	23.0	21.1	61.5	66.7	70.1	73.4
July	20.8	42.9	35.1	31.1	25.7	26.0	24.8	23.5	65.3	66.6	69.9	70.6
August	8.6	31.9	0	15.3	25.2	24.3	25.2	23.2	67.0	69.7	69.4	71.6
September	51.1	141.8	37.3	34.3	21.1	20.1	19.3	19.8	71.3	79.4	74.8	74.6
October	1.5	35.7	105.4	56.5	16.6	16.1	16.0	15.1	71.7	76.0	78.6	78.6
November	109.9	76.1	19.8	72.9	9.8	12.8	10.6	10.3	77.6	82.9	85.4	81.6
December	210.6	83.3	61.9	87.4	2.1	5.6	6.4	6.9	84.1	77.5	82.2	82.5

Table 2: The green fodder yield and botanical composition of white clover-tall fescue mixtures (means of three cuts for per year).

					Botanical Composition (%)											
	Green Fodder Yield (t ha^{-1})				Grasses (¥)				Legumes (†)				Forbs (§)			
Treatments	2001	2002	2003	Average	2001	2002	2003	Average	2001	2002	2003	Average	2001	2002	2003	Average
75%Clover+25% Fescue	16.62	15.81	17.02	16.48	20.90	22.10	23.00	22.00	66.11	66.00	65.09	65.73	11.87	12.43	12.50	12.27
50%Clover+50% Fescue	14.49	15.00	14.00	14.50	43.25	45.00	44.17	44.14	44.43	44.69	43.97	44.36	11.23	11.60	11.68	11.50
25%Clover+75% Fescue	17.55	18.38	17.13	17.69	69.10	67.80	69.20	68.70	23.15	23.11	22.44	22.90	8.13	8.49	8.58	8.40
100% Clover	16.00	16.02	15.84	15.95	0.95	0.98	1.17	1.03	87.04	86.67	85.79	86.50	12.00	12.74	12.66	12.47
100% Fescue	10.34	9.98	10.11	10.14	92.90	93.40	93.60	93.30	1.60	1.41	1.59	1.53	5.20	5.09	5.22	5.17
Significant		**				**				**				**		
SE±		0.706				8.746				8.043				0.761		
LSD		1.376				1.175				2.003				1.578		

**: P< 0.01, ¥: Lolium multiflorum Lam., Poa annua L., Hordeum murinum L., Sorghum halepense (L.) Pers., †: Trifolium spumosum L., Vicia cracca T., §: Galium aparine L., Sinapsis alba L., Cirsium arvense L.

Table 3: The dry matter (DM), crude cellulose (CC), crude protein (CP), and K/P ratios in forages (means of three cuts for per year).

	DM (t ha^{-1})				CC (%)				CP (%)				K/P			
Treatments	2001	2002	2003	Average	2001	2002	2003	Average	2001	2002	2003	Average	2001	2002	2003	Average
75%Clover+25% Fescue	6.38	5.49	6.81	6.23	21.10	22.30	23.00	22.13	20.40	20.80	19.70	20.30	3.97	4.08	3.84	3.96
50%Clover+50% Fescue	6.84	6.89	6.24	6.66	24.70	24.30	23.80	24.27	18.40	18.00	17.80	18.07	4.55	4.70	5.00	4.75
25%Clover+75% Fescue	7.11	7.51	7.01	7.21	25.30	24.90	26.10	25.43	16.70	16.00	18.00	16.90	4.00	4.10	3.67	3.92
100% Clover	6.20	6.23	5.84	6.09	20.70	19.70	18.40	19.60	22.40	23.10	22.20	22.57	6.57	6.36	6.00	6.31
100% Fescue	5.29	4.74	5.06	5.03	26.80	27.30	25.70	26.60	18.20	17.70	16.90	17.60	3.70	4.52	3.90	4.04
Significant		**				**				**				**		
SE±		0.706				0.690				0.573				0.733		
LSD		1.376				2.503				1.922				0.250		

**: P< 0.01

Table 4: The Ca/P, Ca/Mg, Ca/K, and K/Mg ratios in forages (means of three cuts for per year).

Treatments	Ca/P				Ca/Mg				Ca/K				K/Mg			
	2001	2002	2003	Average	2001	2002	2003	Average	2001	2002	2003	Average	2001	2002	2003	Average
75%Clover+25% Fescue	2.89	3.24	3.27	3.13	2.02	2.07	2.57	2.22	0.72	0.79	0.85	0.79	2.77	2.60	3.02	2.80
50%Clover+50% Fescue	3.21	3.66	3.11	3.33	1.98	2.02	1.85	1.95	0.71	0.77	0.62	0.70	2.80	2.02	2.97	2.60
25%Clover+75% Fescue	2.75	2.82	2.22	2.60	2.08	2.63	1.82	2.18	0.67	0.69	0.61	0.66	3.10	3.80	3.00	3.30
100% Clover	4.03	3.47	2.73	3.41	2.12	2.40	2.02	2.18	0.61	0.64	0.68	0.64	2.92	3.13	2.80	2.95
100% Fescue	2.66	2.44	2.73	2.61	2.57	1.91	2.64	2.37	0.72	0.53	0.70	0.65	3.57	3.53	3.77	3.62
Significant			NS				NS				NS				*	
SE±															0.121	
LSD															0.608	

*: P< 0.05, NS: P> 0.05 and 0.01

[8] Hall M.H. Tall fescue (F. arundinacea Schreb.). Agronomy Facts Sheets. Agronomy Facts 28. Department of Crop and Soil Sciences-Cooperative Extension the Pennsylvania State Univ., 201 Willard Building, Univ. Park, PA 16802-2801, 1994, 2.

[9] Hall M.H. White Clover (T. repens L.). Agronomy Facts Sheets. Agronomy Facts 22. Department of Crop and Soil Sciences-Cooperative Extension the Pennsylvania State Univ., 201 Willard Building, Univ. Park, PA 16802-2801, 2004, 5.

[10] Hannaway D., Fransen S., Cropper J., Teel M., Chaney M., Griggs T., Halse R., Hart J., Cheeke P., Hansen D., Klinger R., Lane W. Tall Fescue (F. arundinacea Schreb.). PNW 504, Oregon State Univ. Press, USA, 1999, 2-5.

[11] Kvasnicka B., Krysl L.J. Grass Tetany in Beef Cattle. http://www.iowabeefcenter.org/pdfs/bch/03110.pdf, 2005.

[12] Miller D.A., Reetz-JR H.F. Forage fertilization. (5th Edition) In: Barnes R. F., Miller D. A., Nelson C. J. (Eds): Forages Vol. I: An Introduction to Grassland Agriculture. Iowa State Univ. Press, Ames, Iowa, 1995, 79.

[13] NRC. Nutrient Requirements of Domestic Animals. National Academy of Sciences National Research Council, Washington, D.C., USA, 2001, 105.

[14] Porqueddu C., Parente G., Elsaesser M. Potential of grasslands. Grassland Science in Europe 8 (2003), 11-19.

[15] Rodriguez Julià M. Desarollo y evaluación del sistema integrado de diagnostico y recomendación (DRIS) para la fertilización de las praderas permanentes. University of Basque State, Spain, 1991, 3-25.

[16] Šantrůček J., Svobodová M., Brant V. Changes of botanical composition of grass stands under different types of management. Plant, Soil and Environment 48 (2002), 499-504.

[17] Søegaard K. Nutritive value of white clover. White clover in Europe: State of the art REUR Technical Series 29 Food and Agriculture Organization of the United ATIONS, 1993, 1-2.

[18] Stypiňski P. The effects of white clover on chemical composition and nutritive value of companion grasses in grass/clover mixtures. White clover in Europe: State of the art REUR Technical Series 29 Food and Agriculture Organization of the United ATIONS, 1993, 3-4.

[19] Tanner G.R., Morrison I.M. The effect of saponification, reduction, and mild acid hydrolysis on the cell walls and cellulose treated cell walls of Lolium

perenne. J. Sci. Food Agric. 34 (1983), 137-144.

[20] Tekeli A.S., Ates E. Yield and its components in field pea (Pisum arvense L.) lines. J. Central European Agric. 4 (2003), 313-318.

[21] Tekeli A.S., Ates E. Determination of some agricultural characters in field pea (Pisum arvense L.) lines at Tekirdağ (Turkey) ecological conditions. Cuban J. Agric. Sci. 38 (2004), 313.

[22] Tekeli A.S., Avcıoğlu R., Ateş E. Changes in some morphological and chemical properties of Persian clover (T. resupinatum L) in relation to time and above-ground biomass, Ankara University Journal of Agricultural Sciences 9 (2003), 352.